National Imaging Associates, Inc.	
Clinical guidelines: **Single Photon Emission Computed Tomography (SPECT), including** • **Bone/Joint** • **Non-Bone Infection/Inflammation** • **Tumor** • **Cardiac** • **Neck** • **Lung** • **Brain** • **Radionuclide Cisternography (CSF)** • **Renal** • **Abdomen/Pelvis**	**Original Date: July 2008**
CPT Codes: ~~78803 ,78830, 78831, 78832, 78835~~SPECT, ~~single area, single day~~ 78803 (SPECT), Single Area, single day~~78830 – SPECT/CT, single area, single day~~ ~~78831 – SPECT, multiple areas~~ ~~78832 – SPECT/CT, multiple areas~~ ~~78835 – Radiopharmaceutical quantification measurement~~ 78830 – SPECT/CT, single area, single day 78831 – SPECT, multiple areas 78832 – SPECT/CT, multiple areas 78835 – Radiopharmaceutical quantification measurement	**Last Revised Date: May 2023 ~~April 2022~~**
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GENERAL INFORMATION

- *It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.*
- *Where a specific clinical indication is not directly addressed in this guideline, medical necessity determination will be made based on widely accepted standard of care criteria. These criteria are supported by evidence-based or peer-reviewed sources such as medical literature, societal guidelines and state/national recommendations.*

SPECT: Single-Photon Emission Computed Tomography (SPECT) is a nuclear medicine imaging technique used to localize data from gamma ray emitting injected radiopharmaceuticals to specific anatomical locations within the patient. The resulting 3D images can be reconstructed in multiple planes much like a CT scan uses XR, SPECT utilizes nuclear scintigraphy. The ability to manipulate the imaging data into distinct multiplanar slices improves the diagnostic capability and spatial resolution while using the same pharmaceutical as with traditional planar bone scan. Radiopharmaceuticals used vary based on the clinical indication. The technique is applied in brain, cardiac, pulmonary, abdominal, endocrine, and musculoskeletal imaging.

SPECT can be used localize a tumor, inflammatory process, or radioactive tracer distribution. Vascular flow and blood pool imaging are included if performed. The 78803 code represents single–day imaging of a single area, such as the head, neck, chest, or pelvis, or a single acquisition on one day.

SPECT/CT: (Single-photon emission computed tomography combined with Computed Tomography) is now available in many places. The CT portion helps correct the attenuation (decrease) of photons from the target as they get absorbed/reflected by the soft tissues before reaching the detector. CT helps with anatomic localization much like the CT of PET/CT.

When SPECT/CT is requested, additional CT approvals are NOT needed/provided (unless approvable for other separate indications per guidelines for that body part)~~needed~~. The ~~since the~~ CT portion of a SPECT/CT is included in the specific CPT ~~the covered~~ (~~i.e.~~i.e., 78830 – SPECT/CT, single area, single day and 78832 – SPECT/CT, multiple areas).

~~CPT codes.~~ This guideline ~~-~~includes both ~~refers~~ to SPECT ~~/ SPECT CT imaging~~ and SPECT/CT when routine dynamic and planar imaging is, or is projected to be, insufficient for the following ~~suspected conditions~~indications ~~for the following~~ (select 'ctrl' then 'left click' to jump to section)[1-6]:

- **Bone/Joint**
- **Non-Bone Infection/Inflammation**
- **Tumor**

Other Indications

Further evaluation of indeterminate findings on prior imaging (unless follow up is otherwise specified within the guideline):

- For initial evaluation of an inconclusive finding on a prior imaging report that requires further clarification
- One follow-up exam of a prior indeterminate MR/CT finding to ensure no suspicious interval change has occurred. (No further surveillance unless specified as highly suspicious or change was found on last follow-up exam.)

~~INDICATIONS FOR A~~ BONE/JOINT ~~SPECT/SPECT CT SCAN~~

~~When routine dynamic and planar imaging is, or is projected to be, insufficient for the following suspected conditions[1-6]:~~

MALIGNANCY

Note: For known bone metastases, whole body planar bone scan for staging and restaging is typically sufficient

- Screening evaluation of patients with malignancy presenting with elevated alkaline phosphatase, bone pain, or new pathological fracture
- Staging or Restaging evaluation when recent overlapping ~~whole-body~~whole-body imaging (CT or PET/CT of the neck, chest, abdomen and pelvis) has not been performed, cannot be performed, or is inconclusive in evaluation of bone metastases
- Staging and restaging for radionuclide bone therapy for predominant bone metastases

INFECTION

- Osteomyelitis: a plain x-ray **AND** an MRI of the area have been performed, unless MRI is contraindicated, technically limited or inconclusive[5, 6]
- Discitis: MRI is contraindicated, technically limited or inconclusive

BONE VIABILITY

- Detection of early avascular necrosis, bone infarct, or bone graft viability when patient has had a plain x-ray; and MRI is contraindicated or inconclusive[7]

TRAUMA

- Extremities: Detection of stress fractures and other occult skeletal trauma when there is persistent pain in the suspected area after negative or inconclusive x-ray and MRI[8]
- Spine:
    - For indications such as spondylolysis or determination of age of fracture after CT/MRI is inconclusive[9]
    - Spondylolysis evaluation in a child, with persistent pain after MRI and conservative treatment, in determining further treatment plan[10, 11]

INCONCLUSIVE

- Inconclusive MRI/CT
- Identification of a primary etiology (via most reactive/ inflammatory changes) when multiple etiologies are identified by MRI/CT, **AND** intervention planning is needed (includes primary facet joint target localization)[9, 12-16]

POSTOPERATIVE

- Evaluation of persistent symptoms in postoperative spine/joints/bones, after X-ray and CT are negative/inconclusive[9, 17-22]

EXTREMITIES

- For evaluation of unexplained extremity pain when clinical criteria and other imaging (x-ray, **AND** MRI/ Ultrasound/ CT) evaluation is inconclusive (e.g., differentiating complex regional pain syndrome from other causes of pain)[23-26]

FOLLOW-UP

- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

NOTE: Inconclusive includes the scenario when imaging findings do not explain patient clinical symptoms or lack of treatment efficacy.

~~BACKGROUND~~

~~**SPECT:** Single-photon emission computed tomography (SPECT) is a nuclear medicine imaging technique used to localize data from gamma ray emitting injected radiopharmaceuticals to specific anatomical locations within the patient. The resulting 3D images can be reconstructed in multiple planes, much like a CT scan. The ability to manipulate the imaging data into distinct multiplanar slices improves the diagnostic capability and spatial resolution while using the same pharmaceutical as with traditional planar bone scan. Radiopharmaceuticals used vary based on the clinical indication. The technique is applied in brain, cardiac, pulmonary, abdominal, endocrine, and musculoskeletal imaging.~~

~~**SPECTCT:** SPECTCT (Single-photon emission computed tomography with Computed Tomography) is now available in many places. The CT portion helps to correct the attenuation (decrease) of photons from the target, as it gets absorbed/reflected through the soft tissues before it reaches the detector.~~

~~It also helps with anatomic localization much like the CT of PETCT. The CT aspect of SPECTCT may or may not be of diagnostic quality depending on the vendor.~~

~~However, SPECTCT is now more common among newer gamma imaging scanners. SPECTCT leads to increased specificity and accuracy.~~

BONE SPECT~~/SPECTCT~~: Due to advances in cross-sectional imaging, the technique currently has limited indications for detecting bone pathology. It is ~~most commonly used~~most used in patients who have been found to have an unexpected single area abnormality on a planar (screening) bone scan. It is also used in those who cannot undergo MRI or CT imaging or to clarify the findings on MRI or CT. Although vast majority of bone scan indications have been replaced by MRI or CT over the decades, the recent advent of SPECT has shown comparable or complementary performance versus MRI for some indications as those listed above.[23, 24, 27, 28] For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT~~/ SPECTCT~~ imaging can improve the performance of conventional planar nuclear bone imaging.

TRACERS: Nuclear medicine bone imaging is commonly performed with Technetium-99m-MDP (methylene diphosphonate). For indications such as infection or inflammation, Indium-111/ Technetium-99m-HMPAO (hexamethylpropyleneamine oxime) labelled white blood cells, or Gallium-67 (for spine/sternum) can be used. Gallium is typically used for discitis evaluation, and imaging can be carried out to 2-3 days post tracer injection for better target-to-background ratio. Technetium-99m sulfur colloid scan is typically used concordantly for marrow mapping, to distinguish bone marrow from infection site.

Although 18F-labelled sodium fluoride (NaF) PET scanning is highly sensitive for detecting bone lesions, its routine use has not replaced conventional bone scanning due to the latter's "effectiveness, widespread availability, low cost and favorable dosimetry".[4] If a bone SPECT ~~/ SPECTCT~~ is not sufficient, specific PET tracers that detect both soft tissue and bone metastases (e.g., F18- FDG, F18- Fluciclovine, Ga68-Dotatate) have replaced largely the need for a separate NaF PET.

CRPS: In the evaluation of complex regional pain syndrome (CRPS), formerly reflex sympathetic dystrophy, three phase bone scintigraphy (flow, blood pool, and delayed images) and MRI imaging sensitivities reported in the medical literature, ranges widely.[26] In general, scintigraphy is more specific than MRI. SPECT imaging, however, is not routinely used for this indication.

~~INDICATIONS FOR~~ NON-BONE INFECTION / INFLAMMATION ~~SPECT/SPECT CT~~

When primary standard modality of CT / CTA / MRI / Ultrasound are inconclusive, limited, or cannot be done,[29] including:

- Fever of Unknown Origin when CT/MR are negative/inconclusive/limited
- Non-bone infection/inflammation when primary standard imaging is negative/ inconclusive, including infections related to
    - Transplant and vascular grafts when ultrasound / CTA are negative/inconclusive/limited[30, 31]
    - Prosthetic ~~valves, when~~valves when echocardiography AND Coronary CTA are inconclusive[32]
    - Cardiac implantable devices when echocardiography is inconclusive[32]

BACKGROUND

Infection-seeking tracers labelled with single-photon-emitting radionuclides include autologous leukocytes [white blood cells (WBC)] labelled with 99mTc-hexamethylpropyleneamine oxime (HMPAO) or 111In-diethylenetriaminepentaaceticacid (DTPA). Imaging is typically completed the same day (for Technetium-Tc labelled agents) or the 2nd day (for Indium-labelled agents). ~~CT portion of~~ SPECT ~~CT~~ localizes the infection agent accumulation to the anatomic site more precisely than does planar imaging. The tracer activity is not affected by artifact from implants and devices. They are typically used when other modalities such as CT or MRI have not yielded conclusive results or have not explained clinical status.

For infections related to vascular grafts, nuclear medicine modalities are particularly useful to mapping the extent of the infection (focal uptake) for surgical planning. Primary imaging is first done with ultrasound for extracavitary graft and CTA for intracavitary graft.[30]

~~INDICATIONS FOR~~ TUMOR~~OR SPECT/SPECT CT~~

- Iodine imaging for subsequent post thyroidectomy staging of differentiated thyroid cancers, in the setting of[33]:
    - Post thyroidectomy neck CT/MR showing residual unresectable thyroid tissue/ disease in the neck
    - Distant metastases as seen on CT/MR
    - Post thyroidectomy unstimulated thyroglobulin > 5-10ng/ml
    - Radioactive iodine therapy is being considered for high risk or recurrent tumor
    - Post radioiodine treatment (post therapy scan)
    - During surveillance, with rising thyroglobulin or stable / rising antithyroglobulin antibodies or abnormal ultrasound neck

Note: Refer to neck ~~SPECT/SPECTCT~~ for thyroid nodules

- For initial or restaging of Neuroendocrine tumors (typically In111-octreotide and Iodine-123 MIBG), for any part of the body,[34]
    - When CT/MRI OR PET imaging is not available, cannot be done, has contraindications, or is inconclusive
    - I-131 MIBG: when I131 MIBG therapy is being considered
    - In111- octreotide: Somatostatin analog therapy is being considered and Ga68 Dotatate PET is not available

- Imaging during / post therapy with therapeutic agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, when it can change management

- Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, head and neck, and gynecological cancers

BACKGROUND

Thyroid cancers are imaged by Iodine-123 or Iodine-131 tracers. Prior to treatment, sometimes a whole body I-123 imaging may be done if it is an aggressive cancer or if there is a suspicion of metastases. Whole body imaging with I-131 is acquired up to 10 days post therapeutic dosage with I-131 for thyroid cancers. Subsequent surveillance is done by monitoring thyroglobulin, thyroglobulin antibodies, and ultrasound neck. If there is concern for recurrence, typically whole body I-123 or I-131 imaging is done. ~~after either stimulation (thyroid hormone withdrawal or thyrogen stimulation).~~ SPECT~~/ SPECTCT~~ is then ~~frequently~~ done of the neck and of any other areas that need clarification on planar imaging.

Indium octreotide and Iodine MIBG (meta-iodobenzylguanidine) imaging are used to assess neuroendocrine tumors for somatostatin (SSTR) receptors to enable treatment with somatostatin analogs, such as octreotide acetate (Sandostatin).

177Lu-Dotatate is a treatment for neuroendocrine cancers that have SSTR expression as seen on Gallium-68 PET or Indium-111 pentetreotide/-Octreotide imaging. 90Y-ibritumomab tiuxetan (or Zevalin®) is used as treatment for refractory non-Hodgkin's lymphoma and may need initial biodistribution assessment with Indium-111 ibritumomab tiuxetan. Therapeutic agents have gamma or bremsstrahlung radiation that can be harnessed to image and evaluate the biodistribution of the therapeutic tracer.

Lymphoscintigraphy with sentinel node mapping is often used in ~~early stage~~early-stage breast, melanoma, and gynecological cancers immediately prior to surgical resection of primary lesion. This evaluates initial lymph nodes draining the target region. These lymph nodes are resected during surgery to evaluate for possible involvement, in which case the cancer is upstaged~~. For exact anatomic correlation, SPECT/ SPECTCT is preferred, but may not be performed due to time constraints before surgery. It is limited to newer systems with faster SPECTCT acquisition times or if planar imaging is inconclusive.~~

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~~INDICATIONS FOR~~ CARDIAC ~~SPECT/SPECT CT~~

See~~As addressed in~~ MPI and MUGA guidelines.

~~INDICATIONS FOR~~ NECK ~~SPECT/ SPECT CT~~ (NON-CANCER)

- Parathyroid adenoma: Clinically or laboratory proven hyperparathyroidism AND ultrasound of the neck has been completed. If CT is already done~~completed~~, it should be inconclusive.[35]
- Thyroid: Abnormal thyroid function tests and planar imaging is inconclusive for the location of a focal thyroid lesion.

BACKGROUND

Parathyroid adenomas are evaluated typically initially by cervical ultrasound. ~~Parathryoid~~Parathyroid SPECT~~/ SPECTCT~~ with Tc99m sestamibi or Iodine and sestamibi tracer combo has similar diagnostic performance to 4D-CT with less radiation dose.

Thyroid disorders that are diffuse typically do not need SPECT~~/ SPECTCT~~ imaging. However, it may be needed in cases of differentiation of a single cold nodule in the background of multinodular goiter to direct biopsy. Iodine-123 tracer is typically used for these.

~~INDICATIONS FOR~~ LUNG ~~SPECT/ SPECTCT~~

- Quantification of lung function prior to lung resection/radiation
- Evaluation of congenital cardiac, thoracic, or pulmonary disease, or lung transplants or bronchopleural fistulae[36]
- Chronic thromboembolic pulmonary hypertension
- Suspected acute pulmonary embolism with comorbidities (such as COPD, left heart failure, pneumonia, tumor) AND chest x-ray has been performed, AND chest CTA cannot be performed or limited
- Calculation of lung shunt fraction prior to hepatic radioembolization

BACKGROUND

Ventilation perfusion scans are typically done for pulmonary embolism (PE) assessment when chest CTA cannot be performed, for young patients, or in pregnancy when they have a normal chest x-ray (due to lower radiation exposure). SPECT~~/ SPECTCT~~ of the ventilation images is markedly limited in the US as the two ventilation tracers used in the US (Tc99m DTPA, Xenon) are not highly amenable to SPECT imaging. This and the overdiagnosis of small insignificant PE on SPECT~~/SPECTCT~~, like CTA, have enabled planar images to be the preferred method of evaluation of acute PE. However, for the purposes of lung surgery evaluation, congenital heart disease, and chronic pulmonary hypertension, the lung perfusion images have more significance, and these are amenable to SPECT ~~/ SPECTCT~~ with further increases in sensitivity and specificity.

~~INDICATIONS FOR~~ BRAIN ~~SPECT/ SPECT CT~~[37]

- For preoperative localization of epileptic foci after EEG, Brain MRI and PET are done and insufficient[38, 39]
- DAT scan[40-42]
    - To differentiate essential tremor and drug-induced parkinsonism from parkinsonian syndromes
    - For early/inconclusive parkinsonian features
    - For dementia: differentiating Dementia with Lewy Bodies (DLB) from other dementia types. If FDG PET was completed for this indication, and~~it~~ was inconclusive.
- To evaluate cerebrovascular reserve in planning appropriate endovascular/vascular intervention or neurovascular surgical approach[43, 44] - can include:
    - Evaluation for vascular diseases such as Moyamoya
    - Carotid balloon occlusion
    - Hyperperfusion syndromes
    - Shunting for idiopathic normal pressure hydrocephalus[45]
- Brain perfusion study for evaluation of brain death when CT or MRI already done and planar images are inconclusive[46]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Injected brain tracers used include 99mTc-bicisate (ECD; ethyl cysteinate dimer), 99mTc-exametazime (HMPAO; hexamethylpropylene amine oxime), and 99mTc-pentetate (DTPA; diethylenetriaminepentaacetic acid). I123 Ioflupane is used for DAT scan (Dopamine Transporter Scan). Brain imaging is ~~studies are~~routinely ~~-~~performed and included ~~s a default~~ with brain SPECT imaging ~~/ SPECTCT~~ unless it is a done for brain death. ~~scintigraphy~~. These tracers cross the blood brain barrier where they emit gamma rays that are detected by the imaging system. A 3D image of the brain is created using computerized techniques with the degree of radionuclide activity corresponding to neuronal activity or cerebral blood flow.

Epilepsy: 15–30% of patients with refractory focal epilepsy do not have distinct lesions on MRI. The next investigation for a possible surgically resectable epileptogenic focus includes PET. If this is negative or inconclusive, ictal (during seizure) brain SPECT~~/ SPECTCT~~ can be obtained, which can reveal increased uptake at the epileptogenic area.

Stroke/ Trauma/ Presurgical planning: These situations are usually evaluated with brain MRI (or brain CT if there is a contraindication to brain MRI). However, if these results are inconclusive or limited, could not be performed, do not explain the clinical picture, or if additional information is needed for surgeries, Brain SPECT images are obtained, often to evaluate

vascular reserve. Brain images are obtained at rest and after vasodilatory acetazolamide injection challenge. These may clarify inconclusive clinical or imaging abnormalities or assess vascular reserve for surgeries. This can also be done with other challenges as well, such as carotid balloon occlusion. In the assessment of transient ischemic disease, reduced perfusion can be seen earlier than changes on conventional imaging and may help plan appropriate therapeutic intervention. In traumatic brain injury (including whiplash, post-concussion syndromes), SPECT studies have shown areas of hypoperfusion without corresponding MRI or CT findings.[47]

Brain Death: This is typically used in the ICU setting, when clinical assessment and electroencephalography are less reliable in diagnosing brain death because of conditions such as severe hypothermia, coma caused by barbiturates, electrolyte or acid–base imbalance, endocrine disturbances, drug intoxication, poisoning, and neuromuscular blockade. Brain death scintigraphy may also be helpful in patients who are being considered as possible organ donors or when family members require documentation of lack of blood flow.

Dementia: Brain SPECT imaging has been largely replaced by brain PET due to better resolution.

DAT scan (Dopamine transporter Imaging): I123 Ioflupane tracer demonstrates the location and concentration of dopamine transporters (DATs) in the synapses of striatal dopaminergic neurons. This is decreased in presynaptic parkinsonian syndromes (Parkinson's disease, multiple system atrophy, and progressive supranuclear palsy) but is not affected in mimicking conditions such as essential tremor, drug-induced parkinsonism or psychogenic parkinsonism. It is also useful in the differentiation of Alzheimer dementia from Dementia with Lewy Bodies. The latter is in the spectrum of parkinsonism but may or may not have clinical symptoms of parkinsonism, such as bradykinesia, rigidity, or tremor at rest.

~~INDICATIONS FOR A~~ RADIONUCLIDE CISTERNOGRAPHY (CSF) ~~SPECT/SPECT CT SCAN~~

- CSF imaging (for evaluation of hydrocephalus, leak, shunt, normal pressure hydrocephalus, spontaneous intracranial hypotension) when[45]
    - Brain/spine or respective site imaging already performed with appropriate CT/ MRI / CT myelography, and deemed to be insufficient; AND
    - Planar images projected to be insufficient for localization of abnormality
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Cerebrospinal fluid (CSF) flow studies for the evaluation of obstructive or non-obstructive hydrocephalus of various etiologies or CSF leaks (CSF cisternography) are performed after the intrathecal administration of radionuclide. The radionuclides used for CSF flow studies are Indium-111 DTPA for cisternography and leaks.[48] Persistence of activity in the lateral ventricles after 24 hours of imaging is diagnostic of normal pressure hydrocephalus. Cine phase contrast MRI is the preferred technique for evaluating CSF flow dynamics and helps determines which patients with NPH will benefit from treatment.[49, 50]

To evaluate ventriculoperitoneal shunt patency, Tc-99m DTPA radionuclide is injected into the shunt reservoir. Normal shunt patency is confirmed by showing activity along the entire course of the shunt, ultimately spilling into the abdominal cavity.

CSF leaks are more commonly acquired either iatrogenic or post-traumatic[51] than congenital or spontaneous and can occur anywhere along the cranial spinal axis. Scintigraphy for detecting CSF leaks has been superseded by CT and MRI myelographic techniques or thin section skull base CT due to their better spatial resolution.[51, 52] Diagnosis using scintigraphy requires intrathecal administration of radionuclide followed by imaging typically at 3,6, 24, and 48 hours. Pledgets can be placed in the nasal cavity or auditory canal in the setting of CSF rhinorrhea and otorrhea, respectively. CSF leak path is traced. Initial diagnostic imaging is typically done with high resolution CT, CT/MR cisternography.[53-55]

Spontaneous idiopathic hypotension (SIH), also known as craniospinal hypotension, poses a diagnostic challenge due to its protean clinical symptoms, inconsistently demonstrated imaging findings on conventional MRI scanning, and lack of awareness of the diagnosis among clinicians. SIH often presents a variable mix of symptoms, including orthostatic headaches, visual defects or blurred vision, limb paresthesia, transient 3rd cranial nerve palsy, numbness in the face or limbs, cognitive deficits, behavioral changes, neck pain and stiffness, taste alteration, or parkinsonism. In this condition a CSF leak anywhere along the neuraxis is not detected in nearly one-third of patients thought to be due to the slow or intermittent nature of these leaks.[56] Radionuclide cisternography was found to be more sensitive than CT myelography in a few limited case series.[57-59] Imaging at multiple time points up to 48 hours, as well as direct and

indirect signs, aid in the detection of intermittent or slow leaks, with lower radiation exposure than CT myelography.[60] SPECT-CT allows improved anatomical localization and characterization.[61, 62]

~~INDICATIONS FOR~~ RENAL ~~SPECT/ SPECTCT~~[63, 64]

Complex clinical scenarios involving the following indications wherein cross-sectional imaging and routine dynamic planar imaging alone is, or projected to be, insufficient:

- Evaluation of renal collecting system for trauma, surgery, obstruction in ADULTS, or with signs, symptoms, and laboratory findings supporting the need for such an evaluation in adults; **AND**
    - CT has been performed and is inconclusive or contraindicated
- For evaluation of renal collecting system for obstruction or vesicoureteral reflux in children and young females:
    - After ultrasound and VCUG (voiding cystourethrography) / VUS (voiding urosonography) are inconclusive or discordant with clinical picture[63, 65]
- For diagnosis of reno-vascular hypertension with signs, symptoms, laboratory findings, or other imaging supporting the need for such a diagnosis when
    - Duplex ultrasound is inconclusive; **AND**
    - MRA or CTA cannot be performed or is contraindicated; **AND**
    - The patient has adequate renal function (GFR >30) mL/min/1.73 m^2) to undergo the study[63]
- Further evaluation of renal perfusion and split function after completion of ultrasound, including in the setting of surgery, trauma, infection, congenital and mass abnormalities[63]
- Diagnosis of renal transplant complications after ultrasound has been performed[31, 63]
- Evaluation of renal infections and discrimination of pyelonephritis from cortical scarring[63]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Renal scintigraphy remains an important technique for evaluation of the renal circulation, parenchyma, and collecting system. Through the acquisition of serial images over time and graphic depiction of radionuclide activity, information about renal blood flow and function not typically afforded by cross-sectional imaging can be achieved through qualitative and quantitative means. Tailored studies utilizing the administration of diuretic or angiotensin-converting enzyme inhibitors, in conjunction with the radionuclide imaging agent, allow~~s~~ for evaluation of suspected hydronephrosis or renovascular hypertension, respectively. The ability to create 3D multiplanar images with the SPECT~~/SPECTCT~~ technique ~~greatly~~ improves the diagnostic capability over traditional planar imaging.

Tubular secretion agents, such as ^{99m}Tc-MAG3, are used for diuretic renography because tubular tracers are much more efficiently extracted by the kidney than ^{99m}Tc-DTPA (diethylene triamine pentaacetic acid), and washout is therefore easier to evaluate. 99mTc-DTPA is filtered

purely by the glomerulus and thus can be used both to image the kidney and to measure glomerular filtration rate. T- 99m DMSA (Dimercaptosuccinic acid) is especially useful for pyelonephritis and scar evaluations.

OVERVIEW

Diuresis renography can evaluate severity of urinary tract obstruction and can differentiate an obstructed collecting system from a dilated, but non-obstructing, system. It can also provide the differential function in each kidney. Multiple follow-up exams may be needed to detect gradual improvement or worsening.

Captopril Renography is done by imaging before and after administration of acetylcholine esterase inhibitor in patients with high index of suspicion of renovascular hypertension. It is used to identify subgroup in whom hypertension caused by renal artery stenosis could potentially respond to revascularization.[63]

Renal scintigraphy can be used to screen for postoperative complications in renal allograft dysfunction. These can include infarcts, acute tubular necrosis (ATN), collecting system obstruction, urine leaks, drug-induced nephrotoxicity, and rejection. ATN is differentiated from acute rejection as it usually occurs within the first few days after transplantation whereas acute rejection occurs from one week to months after transplantation. Baseline study may be for future comparison.

Renal scintigraphy can also be used to assess differential function in each kidney and in each segment of the kidney for further treatment implications in cases of surgery, trauma, infection, and congenital and mass abnormalities.

~~INDICATIONS FOR~~

ABDOMEN ~~/~~ PELVIS ~~SPECT/ SPECT CT SCAN~~

- Hepatic radioembolization[66]
  - For evaluation of pulmonary and gastrointestinal shunts or dosimetry calculations prior to procedure (typically utilizing Tc MAA) (78835 – Radiopharmaceutical quantification measurement)
  - Post-procedure imaging in lieu of PET to determine dose effect/dose toxicity (using the Y90 radiation itself)[67](78835 – Radiopharmaceutical quantification measurement)
- For evaluation of the following:
  - Intermittent/occult gastrointestinal bleeding after initial workup is indeterminate/contraindicated (scopes, CTA)[68]
  - Indeterminate or vascular hepatic lesions or bleed, when CT/MRI are contraindicated/inconclusive[69, 70]
  - Indeterminate accessory splenic tissue/asplenia when CT/MRI are contraindicated/inconclusive[71]
- Liver transplant (and other hepatic surgery/radiation) preoperative and postoperative function and complications when ultrasound/CT/MR are indeterminate or contraindicated[69]
- Localization of:
  - Suspected ectopic/residual gastric tissue (e.g., Meckel's diverticulum)[68]
  - Abnormalities in hepatobiliary scintigraphy (e.g., biliary abnormalities/leaks) when ultrasound (in infants) or CT is inconclusive/contraindicated[69]
- Peritoneal imaging for evaluation of complications of shunts, dialysis, or peritoneal integrity, when CT is inconclusive/contraindicated[68]
- A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention, or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

BACKGROUND

Most indications utilize a series of standard planar images over time to determine the progression of the radionuclide through the respective system. However, SPECT ~~/ SPECTCT~~ improves anatomic localization, increases diagnostic certainty and accuracy, and decreases the need for delayed imaging.

99mTc-labeled autologous red blood cells (99mTc-RBCs) are injected in intermittent gastrointestinal bleeds and imaged intermittently up to 24 hours to localize bleeds. It can detect bleeding rates as low as 0.1 cc/min to 0.5 cc/min (vs CTA-0.3-1ml/min and angiography 0.5-1ml/min). SPECT~~/SPECTCT~~ increases the sensitivity and specificity of bleeding-site

localization. It has lower radiation exposure than CTA, particularly relevant in children (e.g., Meckel diverticulum studies).[72]

Tc99m sulfur colloid (and sometimes Tc99m RBC) ARE used to identify indeterminate vascular hepatic lesions, such as hemangiomas and hemangioendotheliomas. Denatured Tc99m RBC is useful for identifying indeterminate accessory splenic tissue.

Hepatic radioembolization is used for liver-dominant malignancy or metastases that are unresectable. It involves intraarterial injection of yttrium-90 (Y90)-labeled glass or resin microspheres. **A Tc99m MAA nuclear scan (typically requiring SPECT)** is performed before the actual treatment with Y90. MAA, which is similar in size to the Y90 microspheres, mimics the distribution of the Y90 particles and should embolize within the tumor's hepatic arterioles, thus outlining the expected localization of the radiation. The scan is compared to a CTA/MRA to evaluate for any possible shunting of the treatment agent to the lungs or the GI tract. Coils can be placed as needed to minimize any shunting of Y90 to areas other than the desired target.

Post-procedure imaging (within 24 hours) with either SPECT or PET (at the discretion of the treating physicians) is then performed to confirm the final distribution of the Y90 and to calculate the actual radiation dose delivered to the tumor. Utilizing the Bremsstrahlung radiation of the Y90 embolization agent, SPECT ~~or SPECT/CT~~ can be completed with routine nuclear medicine collimators. However, due to their higher energy level (as compared to routine nuclear medicine agents), the Y90 photons scatter and/or pass through the collimator septa and degrade the image quality. Alternatively, PET scanning can be done, again using the Y90 treatment agent itself; but for PET via a minor decay pattern that emits a positron (32 in every one million decays) that is detectable with PET scanners. FDG PET may be needed later (ideally performed >12 weeks after treatment) to access tumor response to this radiation, in accordance with the tumor-specific guidelines for FDG PET restaging so may still require inconclusive conventional imaging, if necessary for the type of cancer being treated.

Peritoneal imaging includes evaluation of patency of peritoneovenous shunts, diaphragmatic perforations, or peritoneal loculations, especially prior to intraperitoneal chemotherapy. This is accomplished by injection of Tc99m MAA into the peritoneal cavity.

SPECT~~/ SPECTCT~~ in **hepatobiliary imaging** can help localize abnormalities by distinguishing superimposed bowel activity and clarifying biliary abnormalities and bile leaks. It may obviate the need for delayed imaging and increase diagnostic certainty. Imaging is achieved utilizing the IV administration of Tc99m-labeled iminodiacetic acid, which is excreted by hepatocytes like bile.

Liver transplant complications are best evaluated by ultrasound, CT, and MR; however, limited applications in pediatric patients may exist when radiation doses or sedation considerations exist.

POLICY HISTORY

BONE/JOINT SPECT/SPECT CT SCAN

Date	Summary
May 2023	Updated and explained CPT code and removed most mentions of SPECT/CT since CPT codes for SPECT/CT are not managed
April 2022	• Reorganized indications for clarity • Within MALIGNANCY ○ Simplified staging or restaging evaluation by removing "for the following" and the sub-bullets for breast cancer, prostate cancer, primary bone cancers, and monitoring of cancers with predominantly bone metastases ○ Clarified staging or restaging evaluation to be performed if other imaging has not been performed, is contraindicated, or is inconclusive in evaluation of bone metastases
February 2021	• First line: "When routine dynamic planar imaging is insufficient", is elaborated to "When routine dynamic and planar imaging is, or is projected to be insufficient for the following suspected conditions"; ACR 2019, NCCN 2020, SNMMi 2020 references added. • New topic divisions were created under Malignancy, Infection, Bone viability, Trauma, Inconclusive, Postoperative, Extremities and Follow-up • First indication under Malignancy for screening evaluation: "recent/active" phrase was removed as a specifier for malignancy • "or before radionuclide bone therapy" was removed from the prostate cancer indication • "Primary bone cancers (such as Ewings, Osteosarcoma)" was added under staging/restaging for Malignancy • Under Infection, osteomyelitis and discitis indications were separated. Osteomyelitis indication has not changed, while requirement for x-ray was removed for discitis. ACR 2019, 2017 references added. • Under bone viability, removed CT indication, that was previously needed as an alternative to x-ray. Changed reference to ACR 2016 • Under trauma, subdivided indications for extremities and spine. Under extremities, changed requirement to needing both x-ray and

	~~MRI; changed reference to ACR 2017. Under spine, added the following indications:~~ ~~○ "for indications such as spondylolysis or determination of age of fracture after CT/MRI is inconclusive (ACR 2015).~~ ~~○ Spondylolysis evaluation in a child, with persistent pain after MRI and conservative treatment, in determining further treatment plan (Cheung 2018; Goetzinger 2020)"~~ ~~• Under inconclusive category, previous" Resolution of questionable/inconclusive abnormal skeletal radiographs when MRI or CT is inconclusive or cannot be performed" was replaced by "inconclusive MR/CT"~~ ~~• Under inconclusive category, added "Identification of a primary etiology (via most reactive/ inflammatory changes) when multiple etiologies are identified by MRI/CT, AND intervention planning is needed (includes primary facet joint target localization) (Cohen 2020; Tender, 2019, Russo 2017, ACR 2015)"~~ ~~• Under Postoperative indication, updated references and clarified prior "Painful knee and hip arthroplasties after x-ray has been done and when CT/MR are inconclusive/limited/inconclusive (Backer, 2020; Van Der Bruggen, 2018)" to "Evaluation of persistent symptoms in postoperative spine/joints/bones, after X-ray and CT are negative/inconclusive (Peters, 2019; Paycha, 2018; Backer, 2020; Van Der Bruggen, 2018, ACR 2015)"~~ ~~• Extremity pain: changed prior requirement of "xray, MRI, Ultrasound or CT" to "x-ray, AND MRI/, Ultrasound/ or CT"~~ ~~• Background: Under bone SPECT/SPECTCT, the following was removed:" Bone Single-Photon Emission Computed Tomography (SPECT or SPECTCT):"~~ ~~• Background: Under bone SPECT/SPECTCT, the following was added at the end where SPECT/SPECTCT performance was comparable to MRI: "as those listed above (Deidrichs, 2017; Ha, 2015; Huellner, 2013; Israel, 2019). For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT/ SPECTCT imaging can improve the performance of conventional planar nuclear bone imaging."~~ ~~• Background: Under TRACERS, added that Tc sulfur colloid scan is used to distinguish bone marrow from infection site; and deleted~~

	the following: "For patients with impaired renal function who cannot receive iodinated or gadolinium-based contrast agents or undergo MRI for other reasons, SPECT/ SPECTCT imaging can improve the performance of conventional planar nuclear bone imaging." • Added updated references
May 2020	• Background: Added info regarding SPECTCT including references; deleted duplicate info; added radiotracers for infection; clarified some of the explanation. • Updated references to include SPECTCT, and its comparison to MRI • Modified Cancer guidelines to reflect NCCN 2020 and Appropriate Use Criteria By Donohoe 2019 • Added clarification for "inconclusive" • For infection imaging, added if MRI" technically limited or inconclusive"
April 2019	• Emphasized the indication is for High Risk patients and not routine workup for all patients with cancer • Updated references

NON-BONE INFECTION/ INFLAMMATION SPECT/SPECT CT

Date	Summary
	—
April 2022	• No significant changes
February 2021	• Added the specific preliminary imaging needed. • Added "when CT/MR are negative/inconclusive/limited" to Fever of Unknown Origin. • Added: "a. Transplant and vascular grafts, when ultrasound / CTA are negative/inconclusive/limited (Lauri, 2020; Volkan Salanci, 2021). b. Prosthetic valves, when echocardiography AND Coronary CTA are inconclusive (Galea, 2020). c. Cardiac implantable devices when echocardiography is inconclusive (Galea, 2020)." • Added new references.
May 2020	Added indications:

	When CT / CTA / MRI are inconclusive, limited, or cannot be done (ACR 2018): • Fever of Unknown Origin • Non bone infection/ inflammation, including those associated with implant/grafts/devices

TUMOR SPECT/SPECT CT

Date	Summary
	—
April 2022	• Renamed GL as Single Photon Emission Computed Tomography (SPECT)
February 2021	• Updated references and added the following to Iodine imaging: ○ Iodine imaging for subsequent post thyroidectomy staging of differentiated thyroid cancers, in the setting of (NCCN 2020): ○ Post thyroidectomy neck CT/MR showing residual unresectable thyroid tissue/ disease in the neck ○ Distant metastases as seen on CT/MR ○ Post thyroidectomy unstimulated thyroglobulin >5-10ng/ml ○ Radioactive iodine therapy is being considered for high risk or recurrent tumor ○ Post radioiodine treatment (post therapy scan) ○ During surveillance, with rising thyroglobulin, or stable / rising antithyroglobulin antibodies, or abnormal ultrasound neck. Refer to neck SPECT/SPECTCT for thyroid nodules. • Updated references and added the following to neuroendocrine cancers: ○ when CT/MRI OR PET imaging is not available, cannot be done, has contraindications, or is inconclusive. ○ I-131 MIBG: when I131 MIBG therapy is being considered ○ In111- octreotide: Somatostatin analog therapy is being considered and Ga68 Dotatate PET is not available • Changed therapy imaging as follows: "Imaging during/ post therapy with therapeutic agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, when it can change management" • Added head and neck cancer to lymphoscintigraphy. Added references.

May 2020	Added: • Iodine imaging for initial and subsequent staging of Thyroid cancers, for any part of the body, when ultrasound of the neck has been done (ACR 2015). • Indium octreotide and Iodine MIBG Imaging for initial or restaging of Neuroendocrine tumors, for any part of the body, when CT/MRI and PET imaging is not available, cannot be done, has contraindications, or is inconclusive (ACR 2015). • Imaging during therapy with therapeutic dose agents such as 131 Iodine, 177Lu-Dotatate, 111In Zevalin, or for their dosimetry calculations. • Lymphoscintigraphy with sentinel node localizations, for preoperative planning in melanoma, breast, and gynecological cancers

CARDIAC SPECT/SPECT CT – As addressed in MPI and MUGA guidelines

NECK SPECT/SPECT CT (NON-CANCER)

Date	Summary
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April 2022	• No significant changes
February 2021	• Added to parathyroid adenoma: "If CT is already completed, it should be inconclusive (Itani 2020)." • Added new references
May 2020	Added indications: • Clinically or laboratory proven hyperparathyroidism AND ultrasound of the neck completed. • Abnormal Thyroid tests and planar imaging is inconclusive for a focal lesion.

LUNG SPECT/SPECT CT

Date	Summary
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April 2022	• No significant changes
February 2021	• Added new references

	• Removed "AND planar images are inconclusive." for pulmonary embolism as it is not possible to view these planar images at the time of authorization. • Added new indication: Calculation of lung shunt fraction prior to hepatic radioembolization
May 2020	Added indications: • Quantification of lung function prior to lung resection/ radiation and evaluation of congenital cardiac, thoracic, or pulmonary disease, or lung transplants or bronchopleural fistulae (ACR 2018). • Chronic Thromboembolic pulmonary hypertension • Suspected acute pulmonary embolism with comorbidities (such as COPD, left heart failure, pneumonia, tumor) AND chest x-ray has been done, AND chest CTA cannot be done or limited, AND planar images are inconclusive.

BRAIN SPECT/SPECT CT

Date	Summary
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April 2022	• Removed For patient with history of stroke or trauma with recent Bract CT or MRI based on updated ACR Appropriateness Criteria
February 2021	• To the cerebrovascular reserve indication, added "- can include: ○ evaluation for vascular diseases such as Moya-Moya ○ carotid balloon occlusion ○ hyperperfusion syndromes ○ shunting for idiopathic normal pressure hydrocephalus (ACR 2020)" • Broke up DAT scan indication into three sub-indications and clarified further. Added that if FDG PET was completed, it had to be inconclusive for dementia imaging by DAT • Updated references
May 2020	• Eliminated dementia indication, as it has been replaced by PET • Combined stroke and trauma into one indication • Gave specific indications for parkinsonism per SNMMI guidelines • Added brain death indication • Added the requirement of PET for epilepsy imaging, as brain SPECT is typically done in the ictal phase which is very laborious (Duncan 2016).

	• Updated background to be more specific to the indications described and included tracers. • Updated references
April 2019	Updated references only

RADIONUCLIDE CISTERNOGRAPHY (CSF) SPECT/SPECT CT SCAN

Date	Summary
	—
April 2022	• No significant changes
February 2021	• Planar imaging requirement changed to "projected to be, insufficient for localization of focal abnormality" • Updated references
May 2020	• Initial indications distilled into one for all CSF imaging • Abbreviated background, added references
April 2019	• Added content explaining this study is appropriate after other imaging has been completed or is contraindicated • Updated references

RENAL SPECT/SPECT CT

Date	Summary
	—
April 2022	• No significant changes
February 2021	• Changed 2nd line to "dynamic planar imaging alone is or projected to be insufficient" • Updated references
May 2020	• Added congenital vesicoureteral reflux and obstruction indications per ACR 2015/2017 • Added surgery, trauma, infection, congenital and mass abnormalities to indications of renal function and urinary tract evaluation • Clarified kidney injury evaluation indication to include specifically renal perfusion and split function • Updated and added references • Changed background to remove duplicated SPECT content, adding a short paragraph on most indications, and tracers and decreasing renal transplant background.
April 2019	• Changed the following indication: "Diagnosis of acute tubular necrosis intrinsic renal acute kidney injury when other causes of renal failure have been excluded and evaluated with US"

	• Added Background information to provide a summary of non-transplant related application • Updated references

ABDOMEN/PELVIS SPECT/ SPECTCT SCAN

Date	Summary
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April 2022	• For Hepatic radioembolization ○ Clarified Tc MAA for evaluation of pulmonary and GI shunts or dosimetry calculations ○ Clarified Y90 for post-procedure imaging in lieu of PET for dose effect/dose toxicity • In Background, added further details on Y90 and imaging
February 2021	• For hepatic radioembolization 2nd sub bullet: changed post procedure imaging as "Post procedure imaging in lieu of PET to determine dose effect/ dose toxicity" • In second indication, deleted needing planar images and changed to updated reference; also changed prerequisite imaging from CT/CTA to CTA, per ACR 2016. • To the liver transplantation indication, added "(and other hepatic surgery/radiation) preoperative and post operative" function assessment • For peritoneal imaging, added "evaluation of complications of shunts, dialysis or peritoneal integrity" • For peritoneal imaging, removed "planar imaging is or is projected to be, insufficient AND" • In background for hepatic radioembolization, added the following for post procedure imaging in the last line: "evaluation for suboptimal/excessive tumor radiation exposure, and establishing dose-effect and dose-toxicity via quantitative data when planning subsequent treatments. Quantitative assessments would be better with Y90 PET." • Added new references
May 2020	• Added hepatobiliary, and gastrointestinal bleed indications • Added ectopic gastric mucosa and peritoneal shunt applications • Added hepatic radioembolization indications, and removed hepatic chemoembolization indications • Used wording of ACR for existing indications • Removed duplicate SPECT background info • Added short paragraph on most of the indications in background.

	• ~~Added and updated references~~
~~April 2019~~	• ~~Added 'when ultrasound is inconclusive' to the following indications:~~ ○ ~~Detection of space-occupying lesions….when US is inconclusive~~ ○ ~~Evaluation of hepatic primary or metastatic tumors….when US is inconclusive~~ • ~~Updated references~~

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POLICY HISTORY

BONE/JOINT SPECT/SPECT CT SCAN

Date	Summary
May 2023	• Updated and explained CPT code and removed most mentions of SPECT/CT since CPT codes for SPECT/CT are not managed
April 2022	• Reorganized indications for clarity • Within MALIGNANCY ○ Simplified staging or restaging evaluation by removing "for the following" and the sub-bullets for breast cancer, prostate cancer, primary bone cancers, and monitoring of cancers with predominantly bone metastases ○ Clarified staging or restaging evaluation to be performed if other imaging has not been performed, is contraindicated, or is inconclusive in evaluation of bone metastases

NON-BONE INFECTION/ INFLAMMATION SPECT/SPECT CT

Date	Summary
May 2023	• Wording adjustment
April 2022	• No significant changes

TUMOR SPECT/SPECT CT

Date	Summary
May 2023	• Wording adjustment
April 2022	• Renamed GL as Single Photon Emission Computed Tomography (SPECT)

CARDIAC SPECT/SPECT CT – As addressed in MPI and MUGA guidelines

NECK SPECT/SPECT CT (NON-CANCER)

Date	Summary
May 2023	• Wording adjustment
April 2022	• No significant changes

LUNG SPECT/SPECT CT

Date	Summary
May 2023	• Wording Adjustment
April 2022	• No significant changes

BRAIN SPECT/SPECT CT

Date	Summary
May 2023	• Wording adjustment
April 2022	• Removed For patient with history of stroke or trauma with recent Bract CT or MRI based on updated ACR Appropriateness Criteria

RADIONUCLIDE CISTERNOGRAPHY (CSF) SPECT/SPECT CT SCAN

Date	Summary
May 2023	• Wording adjustment
April 2022	• No significant changes

RENAL SPECT/SPECT CT

Date	Summary
May 2023	• Wording adjustment
April 2022	• No significant changes

ABDOMEN/PELVIS SPECT/ SPECTCT SCAN

Date	Summary
May 2023	• Wording adjustment
April 2022	• For Hepatic radioembolization ○ Clarified Tc MAA for evaluation of pulmonary and GI shunts or dosimetry calculations ○ Clarified Y90 for post-procedure imaging in lieu of PET for dose effect/dose toxicity • In Background, added further details on Y90 and imaging

~~**ADDITIONAL RESOURCES**~~

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Reviewed / Approved by NIA Clinical Guideline Committee

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~~**GENERAL INFORMATION**~~

~~It is an expectation that all patients receive care/services from a licensed clinician. All appropriate supporting documentation, including recent pertinent office visit notes, laboratory data, and results of any special testing must be provided. If applicable: All prior relevant imaging results and the reason that alternative imaging cannot be performed must be included in the documentation submitted.~~