Clinical Appropriateness Guidelines: Advanced Imaging

Imaging Program Guidelines

Effective Date: March 12, 2018

Proprietary

Guideline	Last Revised	Last Reviewed
Administrative	07-26-2016	07-26-2016
Head and Neck	11-01-2016	08-15-2017
Chest	09-07-2017	09-07-2017
Cardiac	11-14-2017	11-14-2017
Abdomen and Pelvis	11-01-2016	11-27-2017
Spine	07-26-2016	02-14-2017
Extremity	07-26-2016	09-22-2017
PET or PET/CT	09-07-2017	09-07-2017
MRI Bone Marrow Blood Supply	08-27-2015	07-26-2016
Magnetic Resonance Spectroscopy (MRS)	06-19-2012	07-26-2016
Quantitative CT (QCT) Bone Mineral Densitometry	11-01-2016	11-01-2016

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Description and Application of the Guidelines

AIM's Clinical Appropriateness Guidelines (hereinafter "AIM's Clinical Appropriateness Guidelines" or the "Guidelines") are designed to assist providers in making the most appropriate treatment decision for a specific clinical condition for an individual. As used by AIM, the Guidelines establish objective and evidence-based, where possible, criteria for medical necessity determinations. In the process, multiple functions are accomplished:

- To establish criteria for when services are medically necessary
- To assist the practitioner as an educational tool
- To encourage standardization of medical practice patterns
- To curtail the performance of inappropriate and/or duplicate services
- To advocate for patient safety concerns
- To enhance the quality of healthcare
- To promote the most efficient and cost-effective use of services

AIM's guideline development process complies with applicable accreditation standards, including the requirement that the Guidelines be developed with involvement from appropriate providers with current clinical expertise relevant to the Guidelines under review and be based on the most up to date clinical principles and best practices. Relevant citations are included in the "References" section attached to each Guideline. AIM reviews all of its Guidelines at least annually.

AIM makes its Guidelines publicly available on its website twenty-four hours a day, seven days a week. Copies of AIM's Clinical Appropriateness Guidelines are also available upon oral or written request. Although the Guidelines are publicly-available, AIM considers the Guidelines to be important, proprietary information of AIM, which cannot be sold, assigned, leased, licensed, reproduced or distributed without the written consent of AIM.

AIM applies objective and evidence-based criteria and takes individual circumstances and the local delivery system into account when determining the medical appropriateness of health care services. The AIM Guidelines are just guidelines for the provision of specialty health services. These criteria are designed to guide both providers and reviewers to the most appropriate services based on a patient's unique circumstances. In all cases, clinical judgment consistent with the standards of good medical practice should be used when applying the Guidelines. Guideline determinations are made based on the information provided at the time of the request. It is expected that medical necessity decisions may change as new information is provided or based on unique aspects of the patient's condition. The treating clinician has final authority and responsibility for treatment decisions regarding the care of the patient and for justifying and demonstrating the existence of medical necessity for the requested service. The Guidelines are not a substitute for the experience and judgment of a physician or other health care professionals. Any clinician seeking to apply or consult the Guidelines is expected to use independent medical judgment in the context of individual clinical circumstances to determine any patient's care or treatment.

The Guidelines do not address coverage, benefit or other plan specific issues. If requested by a health plan, AIM will review requests based on health plan medical policy/guidelines in lieu of AIM's Guidelines.

The Guidelines may also be used by the health plan or by AIM for purposes of provider education, or to review the medical necessity of services by any provider who has been notified of the need for medical necessity review, due to billing practices or claims that are not consistent with other providers in terms of frequency or some other manner.

Administrative Guideline: Ordering of Multiple Studies

Requests for multiple imaging studies to evaluate a suspected or identified condition and requests for repeated imaging of the same anatomic area are subject to additional review to avoid unnecessary or inappropriate imaging.

Simultaneous Ordering of Multiple Studies

In many situations, ordering multiple imaging studies at the same time is not clinically appropriate because:

- Current literature and/or standards of medical practice support that one of the requested imaging studies is more appropriate in the clinical situation presented; or
- One of the imaging studies requested is more likely to improve patient outcomes based on current literature and/or standards of medical practice; or
- Appropriateness of additional imaging is dependent on the results of the lead study.

When multiple imaging studies are ordered, the request will often require a peer-to-peer conversation to understand the individual circumstances that support the medically necessity of performing all imaging studies simultaneously.

Examples of multiple imaging studies that may require a peer-to-peer conversation include:

- CT brain and CT sinus for headache
- MRI brain and MRA brain for headache
- MRI cervical spine and MRI shoulder for pain indications
- MRI lumbar spine and MRI hip for pain indications
- MRI or CT of multiple spine levels for pain or radicular indications
- MRI foot and MRI ankle for pain indications
- Bilateral exams, particularly comparison studies

There are certain clinical scenarios where simultaneous ordering of multiple imaging studies is consistent with current literature and/or standards of medical practice. These include:

- Oncologic imaging – Considerations include the type of malignancy and the point along the care continuum at which imaging is requested
- Conditions which span multiple anatomic regions – Examples include certain gastrointestinal indications or congenital spinal anomalies

Repeated Imaging

In general, repeated imaging of the same anatomic area should be limited to evaluation following an intervention, or when there is a change in clinical status such that imaging is required to determine next steps in management. At times, repeated imaging done with different techniques or contrast regimens may be necessary to clarify a finding seen on the original study.

Repeated imaging of the same anatomic area (with same or similar technology) may be subject to additional review in the following scenarios:

- Repeated imaging at the same facility due to motion artifact or other technical issues
- Repeated imaging requested at a different facility due to provider preference or quality concerns
- Repeated imaging of the same anatomic area (MRI or CT) based on persistent symptoms with no clinical change, treatment, or intervention since the previous study
- Repeated imaging of the same anatomical area by different providers for the same member over a short period of time

Administrative Guideline: Pre-Test Requirements

Critical to any finding of clinical appropriateness under the guidelines for specific imaging exams is a determination that the following are true with respect to the imaging request:

- A clinical evaluation has been performed prior to the imaging request (which should include a complete history and physical exam and review of results from relevant laboratory studies, prior imaging and supplementary testing) to identify suspected or established diseases or conditions.
- **For suspected diseases or conditions:**
  - Based on the clinical evaluation, there is a reasonable likelihood of disease prior to imaging; and
  - Current literature and standards of medical practice support that the requested imaging study is the most appropriate method of narrowing the differential diagnosis generated through the clinical evaluation and can be reasonably expected to lead to a change in management of the patient; and
  - The imaging requested is reasonably expected to improve patient outcomes based on current literature and standards of medical practice.
- **For established diseases or conditions:**
  - Advanced imaging is needed to determine whether the extent or nature of the disease or condition has changed; and
  - Current literature and standards of medical practice support that the requested imaging study is the most appropriate method of determining this and can be reasonably expected to lead to a change in management of the patient; and
  - The imaging requested is reasonably expected to improve patient outcomes based on current literature and standards of medical practice.
- If these elements are not established with respect to a given request, the determination of appropriateness will most likely require a peer-to-peer conversation to understand the individual and unique facts that would supersede the pre-test requirements set forth above. During the peer-to-peer conversation, factors such as patient acuity and setting of service may also be taken into account.

Computed Tomography (CT) Head

CPT Codes

70450..... CT of head, without contrast

70460..... CT of head, with contrast

70470..... CT of head, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- From the skull base to vertex, covering the entire calvarium and intracranial contents
- Scan coverage may vary, depending on the specific clinical indication

Technology Considerations

- MRI of the head is preferable to CT in most clinical scenarios, due to its superior contrast resolution and lack of beam-hardening artifact adjacent to the petrous bone (which may limit visualization in portions of the posterior fossa and brainstem on CT).
- Exceptions to the use of brain MRI as the neuroimaging procedure of choice and situations where CT is preferred:
  - initial evaluation of recent craniocerebral trauma
  - evaluation of acute intracranial hemorrhage (parenchymal, subarachnoid, subdural, epidural)
  - evaluation of calcified intracranial lesions
  - osseous assessment of the calvarium, skull base and maxillofacial bones, including detection of calvarial and facial bone fractures

Common Diagnostic Indications

This section begins with general indications for CT Head, followed by Neurologic Signs and Symptoms and Vascular indications.

General Head/Brain

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Acoustic neuroma

Management of known acoustic neuroma when at least one of the following applies:

- Symptoms suggestive of recurrence or progression
- Following conservative treatment or incomplete resection at 6, 18, 30, and 42 months
- Post resection, baseline imaging and follow up at 12 months after surgery

Congenital or developmental anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital anomaly or developmental condition

Examples *include Chiari malformation, craniosynostosis, macrocephaly, and microcephaly.*

Dementia**

- Initial evaluation to exclude a secondary cause of symptoms
- Evaluation of rapidly progressive symptoms

*** requires contraindication to MRI*

Common Diagnostic Indications

Hearing loss, sensorineural**

Diagnosis—detection of acoustic neuroma or other retrocochlear lesion in persons diagnosed with sensorineural hearing loss characterized by <u>either</u> of the following features:

- Gradual onset of unilateral or asymmetric hearing loss demonstrated by audiometric testing (15 dB or greater at 2 consecutive frequencies between 0.5 and 3 kHz)
- Hearing loss associated with at least one neurologic sign or symptom known to increase the pretest probability of a retrocochlear lesion

*** requires contraindication to MRI*

Horner's syndrome**

*** requires contraindication to MRI*

Hydrocephalus/ventricular assessment

Diagnosis of suspected increased intracranial pressure or hydrocephalus

Management of ventricular shunt

Infectious disease

Diagnosis or management (including perioperative evaluation) of infection involving the brain or related structures

Inflammatory disease

Diagnosis or management of inflammatory disease with CNS involvement

Lumbar puncture risk assessment

- Evaluation prior to lumbar puncture when **<u>at least one</u>** of the following is present:
  - Papilledema
  - Abnormal neurological exam
  - Absent venous pulsations on funduscopic exam
  - Altered mental status
  - Evidence for meningeal irritation

Movement disorders

Initial evaluation of the following movement disorders, to exclude an underlying structural lesion

- Hemifacial spasm
- Huntington's disease
- Multiple system atrophy (MSA)
- Parkinson's disease with atypical features
- Progressive supranuclear palsy
- Secondary dystonia
- Other focal or lateralizing movement disorder, such as hemiballismus, athetosis or chorea

Note: *Imaging is generally not indicated for evaluation of typical Parkinson's disease, essential tremor or primary dystonia.*

Multiple sclerosis and other white-matter diseases**

Diagnosis of suspected demyelinating disease

Management or surveillance of established disease

*** requires contraindication to MRI*

Common Diagnostic Indications

Neurocutaneous disorders

Diagnosis or management (including perioperative evaluation) of CNS lesions associated with a known neurocutaneous disorder

Examples *include neurofibromatosis, Sturge-Weber syndrome, tuberous sclerosis, von Hippel-Lindau disease*

Papilledema

Pituitary adenoma

Diagnosis of suspected pituitary adenoma when supported by symptoms and laboratory findings

Management (including perioperative evaluation) of known adenoma

Seizure disorder

- Initial evaluation, to rule out a structural brain lesion as a cause of seizure
- Evaluation of seizures increasing in frequency or severity
- Prior to discontinuation of anticonvulsant therapy in patients who have not been previously imaged

Trauma

Initial evaluation when a mechanism of injury has been identified and at least one of the following features is present:

- Age 65 or greater
- Retrograde amnesia
- At least two (2) episodes of emesis
- Evidence of open, depressed or basilar skull fracture
- Focal neurologic findings
- Glasgow coma score less than 15 or altered mental status
- High risk mechanism of injury
- Seizure

Tumor (benign or malignant)

Diagnosis of suspected tumor when supported by the clinical presentation

Management (including perioperative evaluation) of established tumor when imaging is required to direct treatment

Surveillance of established tumor

Common Diagnostic Indications

Neurologic Signs & Symptoms

This section contains indications for Bell's palsy, headache, mental status change, syncope, vertigo/dizziness, and visual disturbance.

Advanced imaging based on nonspecific signs or symptoms is subject to a high level of clinical review.

Appropriateness of imaging depends upon the context in which it is requested. At a minimum, this includes a differential diagnosis and temporal component, along with documented findings on physical exam.

Additional considerations which may be relevant include comorbidities, risk factors, and likelihood of disease based on age and gender.

In general, the utility of structural brain imaging is limited to the following categories, each with a unique set of clinical presentations:

- Identification of a space occupying lesion or other focal abnormality (tumor, CVA)
- Detection of parenchymal abnormalities (atrophy, demyelinating disease, infection, ischemic change)
- Identification of ventricular abnormalities (hydrocephalus)

There are a number of common symptoms or conditions for which the likelihood of an underlying central nervous system process is extremely low. The following indications include specific considerations and requirements which help to determine appropriateness of advanced imaging for these symptoms.

Bell's palsy (peripheral facial weakness)

Evaluation of hemifacial weakness when either of the following is present:

- Additional neurologic findings suggestive of intracranial pathology
- Symptoms persisting beyond six (6) weeks

Headache

New headache

- When associated with one or more red flag features (see **Table** below); **OR**,
- Headache has not improved or has worsened during a course of physician-directed treatment, and the patient has been reevaluated by a clinician following completion of therapy.

Recurrent headache

- When associated with at least one red flag feature (see **Table**) and advanced imaging (CT or MRI) has not been performed to evaluate the headache; **OR**,
- When CT or MRI has been performed to evaluate the headache, and a red flag feature has developed since the prior imaging study; **OR**,
- Headaches are increasing in frequency and/or severity despite at least four (4) weeks of physician-directed treatment and reevaluation by a clinician following completion of therapy.

Common Diagnostic Indications

Table: Red flag features for headache

Headache Characteristics	Associated clinical features and conditions
• Brought on by exertion or valsalva • Cluster headache not previously evaluated with MRI • Postural/positional • Thunderclap or sentinel headache—sudden onset and severe (worst headache of life) reaching maximal intensity within minutes	• Abnormal neurological exam during the headache episode or in between episodes *(Note: photophobia and nausea are not considered abnormalities on neurologic exam)* • Neck or facial pain (concern for dissection)—see **Dissection** indication in **CTA/MRA Head** guideline • Neck stiffness and fever—see **Infectious disease** and **Inflammatory disease** indications • Risk factors for venous thrombosis—see **Venous thrombosis** indication
Patient Populations	**High-risk vascular patient**
• Age over 50 years with new onset of headache • Known malignancy • Increased genetic risk for intracranial neoplasms (including basal cell nevus syndrome, Gorlin syndrome, Li-Fraumeni syndrome, neurofibromatosis type 1 and type 2, Turcot syndrome, and von Hippel-Lindau syndrome) • Immunodeficiency (including HIV)	• Personal or family history (at least one first-degree relative) of aneurysm, subarachnoid hemorrhage (SAH), or arteriovenous malformation (AVM) • Heritable condition associated with intracranial aneurysm formation, including autosomal dominant polycystic kidney disease, Ehlers-Danlos syndrome, Marfan syndrome, neurofibromatosis type 1 and type 2, and other rare conditions (including hereditary hemorrhagic telangiectasia, multiple endocrine neoplasia, pseudoxanthoma elasticum)

Mental status changes, with documented objective evidence from neurologic exam

Syncope

Evaluation for a structural brain lesion when associated with <u>at least one</u> of following:

- Documented abnormality on neurological examination
- Presence of at least one persistent neurological symptom
- Witnessed or highly suspected seizure activity at the time of the episode

Vertigo and dizziness

Evaluation for a structural brain lesion when <u>either</u> of the following is present:

- Abnormal audiogram or auditory brainstem response
- Signs or symptoms suggestive of a CNS lesion

Note: *Vertigo or dizziness which is clearly related to positional change does not require advanced imaging.*

Visual disturbance

Evaluation for central nervous system pathology when suggested by the ophthalmologic exam

Common Diagnostic Indications

Vascular indications

This section contains indications for aneurysm, cerebrovascular accident/transient ischemic attack, congenital/developmental vascular anomalies, hemorrhage/hematoma, and venous thrombosis.

Aneurysm

- **Screening** in asymptomatic high-risk individuals
  - At least two (2) first degree relatives with intracranial aneurysm or subarachnoid hemorrhage
  - Presence of a heritable condition which predisposes to intracranial aneurysm (examples include autosomal dominant polycystic kidney disease and Ehlers-Danlos syndrome type IV)
- **Diagnosis** of suspected aneurysm based on neurologic signs or symptoms (for isolated headache, see **Headache** indication)
- **Management** (including perioperative evaluation) of known (treated or untreated) intracranial aneurysm when associated with new or worsening neurologic symptoms
- **Surveillance** of known aneurysm in the absence of new or worsening symptoms
  - Initial evaluation at 6–12 months following diagnosis, then every 1–2 years
  - Follow-up after treatment with clips, endovascular coil or stenting

Cerebrovascular accident (CVA or stroke) and transient ischemic attack (TIA)

Diagnosis of signs or symptoms suggestive of acute infarction

Note: *CT is preferred for evaluation of acute intracranial hemorrhage. MRI is preferred for evaluation of subacute and chronic hemorrhage.*

Management of CVA when imaging is required to direct treatment

Congenital or developmental vascular anomaly

Diagnosis or management of known or suspected vascular anomaly

Examples *include arteriovenous malformation (AVM), cavernous malformation, dural arteriovenous fistula (DAVF).*

Hemorrhage / hematoma

Diagnosis of suspected hemorrhage (intracranial or subarachnoid) or hematoma

Management (including perioperative evaluation) of known hemorrhage (intracranial or subarachnoid) or hematoma, when imaging is required to direct treatment

Common Diagnostic Indications

Venous thrombosis (including dural venous sinus thrombosis, venous sinus thrombosis, cerebral vein thrombosis)

Diagnosis (requires at least one clinical finding AND one risk factor, OR at least two clinical findings as specified below)

- Clinical findings
  - Abnormal neurological exam
  - Headache
- Risk factors
  - Bechet's disease
  - Coagulopathy (examples: protein S, protein C, antithrombin 3, antiphospholipid antibody)
  - Drugs (including all trans retinoic acid [ATRA])
  - Iron deficiency anemia
  - Known malignancy
  - Meningitis /intracranial infection
  - Oral contraceptive
  - Pregnancy
  - Prior episodes of venous sinus thrombosis
  - Trauma

Management (including perioperative evaluation) of established venous thrombosis

References

1. Agid R, Shelef I, Scott JN, Farb RI. Imaging of the intracranial venous system. *Neurologist*. 2008;14(1):12-22.
2. Agostoni E, Aliprandi A, Longoni M. Cerebral venous thrombosis. *Expert Rev Neurother*. 2009;9(4):553-564.
3. Albanese A, Asmus F, Bhatia KP, et al. EFNS guidelines on diagnosis and treatment of primary dystonias. *Eur J Neurol*. 2011 Jan;18(1):5-18.
4. Alberti A, Venti M, Biagini S. Headache and cerebral vein and sinus thrombosis. *Front Neurol Neurosci*. 2008;23:89-95.
5. Alons IME, van den Wijngaard IR, Verheul RJ, et al. The value of CT angiography in patients with acute severe headache. *Acta Neurol Scand*. 2015; 131(3); 164-8.
6. American Academy of Otolaryngology — Head and Neck Surgery Foundation. Choosing Wisely: Five Things Physicians and Patients Should Question. ABIM Foundation; February 21, 2013. Available at www.choosingwisely.org.
7. American College of Emergency Physicians. Choosing Wisely: Avoid computed tomography (CT) scans of the head in emergency department patients with minor head injury who are at low risk based on validated decision rules. ABIM Foundation. 2013. http://www.choosingwisely.org. Accessed May 4, 2016
8. Antonini G, Di Pasquale A, Cruccu G, et al. Magnetic resonance imaging contribution for diagnosing symptomatic neurovascular contact in classical trigeminal neuralgia: a blinded case-control study and meta-analysis. *Pain*. 2014; 155(8):1464-1471.
9. Arab AF, Ahmed ME, Ahmed AE, et al. Accuracy of Canadian CT head rule in predicting positive findings on CT of the head of patients after mild head injury in a large trauma centre in Saudi Arabia. *Neuroradiol J*. 2015 Dec;28(6):591-7.
10. Baugh RF, Basura GJ, Ishii LE, et al. Clinical practice guideline: Bell's palsy. *Otolaryngol Head Neck Surg*. 2013 Nov;149(3 Suppl):S1-S27.
11. Beck J, Raabe A, Szelenyi A, et al. Sentinel headache and the risk of rebleeding after aneurysmal subarachnoid hemorrhage. *Stroke*. 2006;37(11):2733-2737.
12. Berardelli A, Wenning GK, Antonini A, et al. EFNS/MDS-ES/ENS [corrected] recommendations for the diagnosis of Parkinson's disease. *Eur J Neurol.* 2013 Jan;20(1):16-34.
13. Bildik F, Aygun D. Clinical warning criteria in evaluation by computed tomography the secondary neurological headaches in adults. *Eur J Neurol.* 2003;10(4):437-442.
14. Bramley R, Whitehouse RW, Taylor PM. The Canadian CT Head Rule for patients with minor head injury: consequences for radiology departments in the U.K. *Clin Radiol.* 2002 Feb;57(2):151-2; author reply 152-3.

15. Brazilian Association of Otorhinolaringology, Brazilian College of Radiology. Sensorineural hearing loss: radiologic diagnosis. *Rev Assoc Med Bras*. 2012 Sep-Oct;58(5):519-529.
16. Brown RD Jr, Huston J, Hornung R, et al. Screening for brain aneurysm in the Familial Intracranial Aneurysm study: frequency and predictors of lesion detection. *J Neurosurg*. 2008 Jun;108(6):1132-8.
17. Caranci F, Briganti F, Cirillo L, Leonardi M, Muto M. Epidemiology and genetics of intracranial aneurysms. *Eur J Neurol.* 2013;82(10):1598-1605.
18. Cardoso TA, Coan AC, Kobayashi E, Guerreiro CA, Li LM, Cendes F. Hippocampal abnormalities and seizure recurrence after antiepileptic drug withdrawal. *Neurology*. 2006 Jul 11;67(1):134-136.
19. Christiaans MH, Kelder JC, Arnoldus EPJ, Tijssen CC. Prediction of intracranial metastases in cancer patients with headache. *Cancer*. 2002;94(7):2063-2068.
20. Cianfoni A, Pravatà E, De Blasi R, Tschuor CS, Bonaldi G. Clinical presentation of cerebral aneurysms. *Eur J Neurol.* 2013;82(10):1618-1622.
21. Cueva RA. Clinical thresholds for when to test for retrocochlear lesions: pro. *Arch Otolaryngol Head Neck Surg.* 2010 Jul;136(7):725-7.
22. Cumurciuc R, Crassard I, Sarov M, Valade D, Bousser MG. Headache as the only neurological sign of cerebral venous thrombosis: A series of 17 cases - Commentary. *Headache*. 2006;46(1):189.
23. Da Rocha AJ, da Silva CJ, Gama HPP, et al. Comparison of magnetic resonance imaging sequences with computed tomography to detect low-grade subarachnoid hemorrhage: Role of fluid-attenuated inversion recovery sequence. *J Comput Assist Tomogr.* 2006; 30(2):295-303.
24. Damak M, Crassard I, Wolff V, Bousser M-G. Isolated lateral sinus thrombosis: a series of 62 patients. *Stroke*. 2009;40(2):476-481.
25. Davidson HC. Imaging evaluation of sensorineural hearing loss. *Semin Ultrasound CT MR*. 2001 Jun;22(3):229-49. Review.
26. Davis T, Ings A; National Institute of Health and Care Excellence. Head injury: triage, assessment, investigation and early management of head injury in children, young people and adults (NICE guideline CG 176). Arch Dis Child Educ Pract Ed. 2015 Apr;100(2):97-100.
27. De Falco F a. Sentinel headache. *Neurol Sci*. 2004;25 Suppl 3:S215-S217.
28. Delgado Almandoz JE, Jagadeesan BD, Refai D, et al. Diagnostic yield of computed tomography angiography and magnetic resonance angiography in patients with catheter angiography-negative subarachnoid hemorrhage. *J Neurosurg.* 2012Aug;117(2):309-15.
29. Delgado Almandoz JE, Kelly HR, Schaefer PW, Lev MH, Gonzalez RG, Romero JM. Prevalence of traumatic dural venous sinus thrombosis in high-risk acute blunt head trauma patients evaluated with multidetector CT venography. *Radiology*. 2010;255(2):570-577.
30. Detsky ME, McDonald DR, Baerlocher MO, Tomlinson G a, McCrory DC, Booth CM. Does this patient with headache have a migraine or need neuroimaging? *JAMA*. 2006;296(10):1274-1283.
31. Devenney E, Neale H, Forbes RB. A systematic review of causes of sudden and severe headache (Thunderclap Headache): should lists be evidence based? *J Headache Pain*. 2014;15(1):49.
32. Donington J, Ferguson M,Thoracic Oncology Network of American College of Chest Physicians; Workforce on Evidence-Based Surgery of Society of Thoracic Surgeons, et al. American College of Chest Physicians and Society of Thoracic Surgeons consensus statement for evaluation and management for high-risk patients with stage I non-small cell lung cancer. *Chest*. 2012 Dec;142(6):1620-35.
33. Edlow JA, Panagos PD, Godwin SA, Thomas TL, Decker WW. Clinical policy: Critical issues in the evaluation and management of adult patients presenting to the emergency department with acute headache. *J Emerg Nurs*. 2009;35(3):e43-e71.
34. Fischera M, Marziniak M, Gralow I, Evers S. The incidence and prevalence of cluster headache: A meta-analysis of population-based studies. *Cephalalgia*. 2008;28(6):614-618.
35. Fogang Y, Naeije G, Ligot N. Transient Neurologic Deficits: Can Transient Ischemic Attacks Be Discrimated from Migraine Aura without Headache? *J Stroke Cerebrovasc Dis*. 2015;24(5):1047-1051.
36. Frishberg BM, Rosenberg JH, Matchar DB, et al. Evidence-based guidelines in the primary care setting: neuroimaging in patients with nonacute headache. Available from *Am Acad Neurol* [online]. 2000:1-25.
37. Gross BA, Frerichs KU, Du R. Sensitivity of CT angiography, T2-weighted MRI,and magnetic resonance angiography in detecting cerebral arteriovenous malformations and associated aneurysms. *J Clin Neurosci.* 2012 Aug;19(8):1093-5.
38. Harnan SE, Pickering A, Pandor A. et al. Clinical decision rules for adults with minor head injury: a systematic review. *J*

Trauma. 2011 Jul;71(1):245-51
39. Hawasli AH, Chicoine MR, Dacey RG. Choosing Wisely. *Neurosurgery*. 2015;76(1):1-6.
40. Honningsvåg L-M, Hagen K, Håberg A, Stovner LJ, Linde M. Intracranial abnormalities and headache: A population based imaging study (HUNT MRI). *Cephalalgia*. 2015.
41. Hughes PD, Becker GJ. Screening for intracranial aneurysms in autosomal dominant polycystic kidney disease. *Nephrology* (Carlton). 2003 Aug;8(4):163-70.
42. Iurlaro S, Beghi E, Massetto N, et al. Does headache represent a clinical marker in early diagnosis of cerebral venous thrombosis? A prospective multicentric study. *Neurol Sci.* 2004;25 Suppl 3:S298-S299.
43. Josephson CB, White PM, Krishan A, Al-Shahi Salman R. Computed tomography angiography or magnetic resonance angiography for detection of intracranial vascular malformations in patients with intracerebral haemorrhage. *Cochrane Database Syst Rev.* 2014;9:CD009372.
44. Kernick DP, Ahmed F, Bahra A, et al. Imaging patients with suspected brain tumour: Guidance for primary care. *Br J Gen Pract.* 2008;58(557):880-885.
45. Kesser BW. Clinical thresholds for when to test for retrocochlear lesions: con. *Arch Otolaryngol Head Neck Surg*. 2010 Jul;136(7):727-9.
46. Kirby S, Purdy RA. Headaches and Brain Tumors. *Neurol Clin.* 2014;32(2):423-432.
47. Kurth T, Buring JE, Rist PM. Headache, migraine and risk of brain tumors in women: prospective cohort study. *J Headache Pain*. 2015;16(1).
48. Kuruvilla DE, Lipton RB. Appropriate Use of Neuroimaging in Headache. *Curr Pain Headache Rep*. 2015 Jun;19(6):490.
49. Lehman VT, Barrick BJ, Pittelkow MR, Peller PJ, Camilleri MJ, Lehman JS. Diagnostic imaging in paraneoplastic autoimmune multiorgan syndrome: retrospective single site study and literature review of 225 patients [published online 2014 Jul 29]. *Int J Dermatol*. doi: 10.1111/ijd.12603.
50. Loder E, Weizenbaum E, Frishberg B, Silberstein S. Choosing wisely in headache medicine: The american headache society's list of five things physicians and patients should question. *Headache*. 2013;53(10):1651-1659.
51. Lynch KM, Brett F. Headaches that kill: A retrospective study of incidence, etiology and clinical features in cases of sudden death. *Cephalalgia*. 2012;32(13):972-978.
52. Maeda M, Yagishita A, Yamamoto T, Sakuma H, Takeda K. Abnormal hyperintensity within the subarachnoid space evaluated by fluid-attenuated inversion-recovery MR imaging: a spectrum of central nervous system diseases. *Eur Radiol*. 2003;13 Suppl 4:L192-L201.
53. Mitchell P, Wilkinson ID, Hoggard N, et al. Detection of subarachnoid haemorrhage with magnetic resonance imaging. *J Neurol Neurosurg Psychiatry*. 2001;70(2):205-211.
54. Morris Z, Whiteley WN, Longstreth WT, et al. Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis. *BMJ*. 2009;339:b3016.
55. Nesbitt a. D, Goadsby PJ. Cluster headache. *BMJ*. 2012;344(apr11 1):e2407-e2407.
56. Ozsvath RR, Casey S, Lustrin ES, Alberico R a. Cerebral Venography: of CT and MR Projection. *Am J Roentgenol.* 1997;169(December):1699-1707.
57. Pandor A, Harnan S, Goodacre S, Diagnostic accuracy of clinical characteristics for identifying CT abnormality after minor brain injury: a systematic review and meta-analysis. *J Neurotrauma.* 2012 Mar 20;29(5):707-18.
58. Pierot L, Portefaix C, Rodriguez-Régent C, et al. Role of MRA in the detection of intracranial aneurysm in the acute phase of subarachnoid hemorrhage. *J Neuroradiol*. 2013 Jul;40(3):204-10.
59. Polmear a. Sentinel headaches in aneurysmal subarachnoid haemorrhage: What is the true incidence? A systematic review. *Cephalalgia*. 2003;23(10):935-941.
60. Rozenfeld MN, Ansari SA, Shaibani A, Russell EJ, Mohan P, Hurley MC. Should patients with autosomal dominant polycystic kidney disease be screened for cerebral aneurysms? *AJNR Am J Neuroradiol.* 2014;35(1):3-9.
61. Sailer AMH, Wagemans BAJM, Nelemans PJ, de Graaf R, van Zwam WH. Diagnosing intracranial aneurysms with MR angiography: systematic review and meta-analysis. *Stroke*. 2014;45(1):119-126.
62. Sandrini G, Friberg L, Coppola G, et al. Neurophysiological tests and neuroimaging procedures in non-acute headache (2nd edition). *Eur J Neurol*. 2011;18(3):373-381.
63. Schaafsma JD, Koffijberg H, Buskens E, Velthuis BK, van der Graaf Y, Rinkel GJE. Cost-effectiveness of magnetic resonance angiography versus intra-arterial digital subtraction angiography to follow-up patients with coiled intracranial aneurysms. *Stroke*. 2010;41(8):1736-1742.
64. Schankin CJ, Ferrari U, Reinisch VM, Birnbaum T, Goldbrunner R, Straube a. Characteristics of brain tumour-associated

headache. *Cephalalgia*. 2007;27(8):904-911.

65. Secretariat. MA. Neuroimaging for the Evaluation of Chronic Headaches: An Evidence-Based Analysis. *Ont Health Technol Assess Ser*. 2010; 10(26): 1–57.
66. Sharifi S, Nederveen AJ, Booij J et al. Neuroimaging essentials in essential tremor: a systematic review. *Neuroimage Clin.* 2014 May 9;5:217-31.
67. Silvestri GA, Gould MK, Margolis ML, et al. Noninvasive staging of non-small cell lung cancer. ACCP Evidenced-Based Clinical Practice Guidelines (2nd Edition). *Chest*. 2007;132(3suppl):178S-201S.
68. St Martin MB, Hirsch BE. Imaging of hearing loss. *Otolaryngol Clin North Am*. 2008 Feb;41(1):157-178.
69. Stachler RJ, Chandrasekhar SS, Archer SM, et al. Clinical practice guideline: Sudden hearing loss. *Otolaryngol Head Neck Surg.* 2012;146(3 Suppl):S1-35.
70. Stachler RJ, Chandrasekhar SS, Archer SM, Rosenfeld RM, Schwartz SR, Barrs DM, Brown SR, Fife TD, Ford P, Ganiats TG, Hollingsworth DB, Lewandowski CA, Montano JJ, Saunders JE, Tucci DL, Valente M, Warren BE, Yaremchuk KL, Robertson PJ; American Academy of Otolaryngology-Head and Neck Surgery. Clinical practice guideline: sudden hearing loss. *Otolaryngol Head Neck Surg.* 2012 Mar;146(3 Suppl):S1-35.
71. Suchowersky O, Reich S, Quality Standards Subcommittee of the American Academy of Neurology, et al. 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.
72. The Society of Thoracic Surgeons. Choosing Wisely: Five Things Physicians and Patients Should Question. ABIM Foundation; February 21, 2013. Available at www.choosingwisely.org
73. Thompson BG, American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, and Council on Epidemiology and Prevention; American Heart Association; American Stroke Association, et al. Guidelines for the Management of Patients With Unruptured Intracranial Aneurysms: A Guideline for Healthcare Professionals From the American Heart Association/American Stroke Association. *Stroke*. 2015 Aug;46(8):2368-400.
74. Timóteo Â, Inácio N, Machado S, Pinto AA, Parreira E. Headache as the sole presentation of cerebral venous thrombosis: a prospective study. *J Headache Pain*. 2012;13(6):487-490.
75. Tüzün E, Dalmau J. Limbic encephalitis and variants: classification, diagnosis and treatment. *Neurologist*. 2007;13(5):261-271.
76. Vega C, Kwoon JV, Lavine SD. Intracranial aneurysms: current evidence and clinical practice. *Am Fam Physician*. 2002 Aug 15;66(4):601-8.
77. Vos PE, Alekseenko Y, European Federation of Neurological Societies. Mild traumatic brain injury. *Eur J Neurol*. 2012 Feb;19(2):191-84: Harnan SE, Pickering A, Pandor A, Goodacre SW. Clinical decision rules for adults with minor head injury: a systematic review. *J Trauma.* 2011 Jul;71(1):245-51.
78. Wang HZ, Simonson TM, Greco WR, Yuh WT. Brain MR imaging in the evaluation of chronic headache in patients without other neurologic symptoms. *Acad Radiol.* 2001;8(5):405-408.
79. Wiebers DO. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. *Lancet*. 2003;362:103-110.
80. Williams LN, Brown RD Jr. Management of unruptured intracranial aneurysms. *Neurol Clin Pract*. 2013 Apr;3(2):99-108.

CT Angiography (CTA) and MR Angiography (MRA) Head: Cerebrovascular

CPT Codes

70496..... Computed tomographic angiography, head, with contrast material(s), including noncontrast images, if performed, and image postprocessing

70544..... Magnetic resonance angiography, head, without contrast

70545..... Magnetic resonance angiography, head, with contrast

70546..... Magnetic resonance angiography, head, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- CTA or MRA may be performed to assess the major intracranial arteries of the anterior and posterior circulations (including the Circle of Willis) as well as the venous structures (major cerebral veins and dural venous sinuses).
- For specific clinical indications, exams may be tailored to the region of interest.
- MRA of the head includes imaging of the entire arteriovenous system of the brain. Separate requests for concurrent imaging of the arteries and the veins in the head are inappropriate.

Choice of Imaging Study

Advantages of CTA

- Higher sensitivity for detection of mural calcification
- Absence of in-plane flow phenomenon which can exaggerate the degree of stenosis
- Improved detection of surgical clips and stents
- Shorter scan time, resulting in less motion artifact and better quality images

Advantages of MRA

- Provides information about the age of blood
- No need for iodinated contrast material
- No exposure to ionizing radiation

Combination with MRI

- In the majority of clinical situations, appropriateness of a second imaging study is dependent on the results of the lead study. This is particularly true with regard to MRI and MRA of the same anatomic region, as there is considerable overlap in visualizing vascular structures. Therefore, it is prudent to begin with the optimal study for the indication requested.
- When ordered in combination, peer to peer conversation will be required to understand the individual and unique facts that would support the medical necessity of all imaging studies requested.

Common Diagnostic Indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Common Diagnostic Indications

Aneurysm

- **Screening** in asymptomatic high-risk individuals
  - At least two (2) first degree relatives with intracranial aneurysm or subarachnoid hemorrhage
  - Presence of a heritable condition which predisposes to intracranial aneurysm (examples include autosomal dominant polycystic kidney disease and Ehlers-Danlos syndrome type IV)
- **Diagnosis** of suspected aneurysm based on neurologic signs or symptoms (for isolated headache, see **Headache** indication)
- **Management** (including perioperative evaluation) of known (treated or untreated) intracranial aneurysm when associated with new or worsening neurologic symptoms
- **Surveillance** of known aneurysm in the absence of new or worsening symptoms
  - Initial evaluation at 6–12 months following diagnosis, then every 1–2 years
  - Follow-up after treatment with clips, endovascular coil or stenting

Cerebrovascular accident (CVA)

- Evaluation for stenosis or occlusion of the intracranial arteries following confirmation of recent non-hemorrhagic CVA on MRI or CT scan
- Evaluation for a vascular etiology following confirmation of a recent hemorrhagic CVA on MRI or CT scan

Congenital or developmental vascular anomaly

Diagnosis or management (including perioperative or periprocedural management) of a suspected or known cerebrovascular anomaly

Examples include arteriovenous malformation (AVM), cavernous malformation, dural arteriovenous fistula (DAVF).

Dissection

Diagnosis of suspected intracranial artery dissection when suggested by the clinical presentation

Management (including perioperative evaluation) of established dissection

Headache

Evaluation for a vascular etiology when all of the following requirements have been met:

- MRI or CT criteria for imaging of headache are met
- MRI/CT has not determined the etiology of the headache
- Headache is persistent and undifferentiated

Note: *Undifferentiated headache refers to those not meeting criteria for a primary headache disorder (tension-type, migraine or cluster).*

Hemorrhage / hematoma

Diagnosis of suspected hemorrhage (intracranial or subarachnoid) or hematoma

Management (including perioperative evaluation) of known hemorrhage (intracranial or subarachnoid) or hematoma, when imaging is required to direct treatment

Pulsatile tinnitus

- Evaluation for vascular etiology

Stenosis or occlusion of intracranial arteries

- Diagnosis or management of known or suspected steno-occlusive disease

Thromboembolic disease of major intracranial arterial systems

Common Diagnostic Indications

Trauma

- When vascular involvement is known or suspected

Trigeminal neuralgia

- Evaluation for vascular etiology

Tumor (benign or malignant)

- Evaluation of vascular supply to established tumor

Vascular abnormalities associated with sickle cell disease

Vasculitis

Diagnosis or management of vasculitis with known or suspected CNS involvement

Venous thrombosis (including dural venous sinus thrombosis, venous sinus thrombosis, cerebral vein thrombosis)

Diagnosis (requires at least one clinical finding AND one risk factor, OR at least two clinical findings as specified below)

- Clinical findings
  - Abnormal neurological exam
  - Headache
- Risk factors
  - Bechet's disease
  - Coagulopathy (examples: protein S, protein C, antithrombin 3, antiphospholipid antibody)
  - Drugs (including all trans retinoic acid [ATRA])
  - Iron deficiency anemia
  - Known malignancy
  - Meningitis /intracranial infection
  - Oral contraceptive
  - Pregnancy
  - Prior episodes of venous sinus thrombosis
  - Trauma

Management (including perioperative evaluation) of established venous thrombosis

References

1. Agostoni E, Aliprandi A, Longoni M. Cerebral venous thrombosis. *Expert Rev Neurother*. 2009;9(4):553-564.
2. Alberti A, Venti M, Biagini S. Headache and cerebral vein and sinus thrombosis. *Front Neurol Neurosci*. 2008;23:89-95.
3. Alons IME, van den Wijngaard IR, Verheul RJ, et al. The value of CT angiography in patients with acute severe headache. *Acta Neurol Scand*. 2015; 131(3); 164-8.
4. Brown RD Jr, Huston J, Hornung R, et al. Screening for brain aneurysm in the Familial Intracranial Aneurysm study: frequency and predictors of lesion detection. *J Neurosurg*. 2008 Jun;108(6):1132-8.
5. Caranci F, Briganti F, Cirillo L, Leonardi M, Muto M. Epidemiology and genetics of intracranial aneurysms. *Eur J Radiol*. 2013;82(10):1598-1605.
6. Cumurciuc R, Crassard I, Sarov M, Valade D, Bousser MG. Headache as the only neurological sign of cerebral venous thrombosis: A series of 17 cases - Commentary. *Headache*. 2006;46(1):189.
7. Da Rocha AJ, da Silva CJ, Gama HPP, et al. Comparison of magnetic resonance imaging sequences with computed tomography to detect low-grade subarachnoid hemorrhage: Role of fluid-attenuated inversion recovery sequence. *J Comput Assist Tomogr*. 2006; 30(2):295-303.
8. Damak M, Crassard I, Wolff V, Bousser M-G. Isolated lateral sinus thrombosis: a series of 62 patients. *Stroke*. 2009;40(2):476-481.
9. De Falco F a. Sentinel headache. *Neurol Sci*. 2004;25 Suppl 3:S215-S217.
10. Delgado Almandoz JE, Jagadeesan BD, Refai D, et al. Diagnostic yield of computed tomography angiography and magnetic resonance angiography in patients with catheter angiography-negative subarachnoid hemorrhage. *J Neurosurg*. 2012Aug;117(2):309-15.
11. Delgado Almandoz JE, Kelly HR, Schaefer PW, Lev MH, Gonzalez RG, Romero JM. Prevalence of traumatic dural venous sinus thrombosis in high-risk acute blunt head trauma patients evaluated with multidetector CT venography. *Radiology*. 2010;255(2):570-577.
12. Gross BA, Frerichs KU, Du R. Sensitivity of CT angiography, T2-weighted MRI,and magnetic resonance angiography in detecting cerebral arteriovenous malformations and associated aneurysms. *J Clin Neurosci*. 2012 Aug;19(8):1093-5.
13. Hughes PD, Becker GJ. Screening for intracranial aneurysms in autosomal dominant polycystic kidney disease. *Nephrology* (Carlton). 2003 Aug;8(4):163-70.
14. Iurlaro S, Beghi E, Massetto N, et al. Does headache represent a clinical marker in early diagnosis of cerebral venous thrombosis? A prospective multicentric study. *Neurol Sci*. 2004;25 Suppl 3:S298-S299.
15. LeFevre ML, U.S. Preventive Services Task Force. Screening for asymptomatic carotid artery stenosis: U.S. Preventive Services Task Force recommendation. *Ann Intern Med*. 2014;161(5):356-362.
16. Pierot L, Portefaix C, Rodriguez-Régent C, et al. Role of MRA in the detection of intracranial aneurysm in the acute phase of subarachnoid hemorrhage. *J Neuroradiol*. 2013 Jul;40(3):204-10.
17. Sailer AMH, Wagemans BAJM, Nelemans PJ, de Graaf R, van Zwam WH. Diagnosing intracranial aneurysms with MR angiography: systematic review and meta-analysis. *Stroke*. 2014;45(1):119-126.
18. Timóteo Â, Inácio N, Machado S, Pinto AA, Parreira E. Headache as the sole presentation of cerebral venous thrombosis: a prospective study. *J Headache Pain*. 2012;13(6):487-490.
19. Vattoth S, Shah R, Curé JK. A compartment-based approach for the imaging evaluation of tinnitus. *AJNR Am J Neuroradiol*. 2010 Feb;31(2):211-218.
20. Vega C, Kwoon JV, Lavine SD. Intracranial aneurysms: current evidence and clinical practice. *Am Fam Physician*. 2002 Aug 15;66(4):601-8.
21. Weissman JL, Hirsch BE. Imaging of tinnitus: a review. *Radiology*. 2000;216:342-349.
22. Williams LN, Brown RD Jr. Management of unruptured intracranial aneurysms. *Neurol Clin Pract*. 2013 Apr;3(2):99-108.

Magnetic Resonance Imaging (MRI) Head/Brain

CPT Codes

70551..... MRI Head, without contrast

70552..... MRI Head, with contrast

70553..... MRI Head, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- From skull base to vertex, covering the entire calvarium and intracranial contents, including the internal auditory canals
- Scan coverage may vary, depending on the specific clinical indication.

Technology Considerations

- MRI of the head is preferable to CT in most clinical scenarios, due to its superior contrast resolution and lack of beam-hardening artifact adjacent to the petrous bone (which may limit visualization in portions of the posterior fossa and brainstem on CT).
- Exceptions to the use of brain MRI as the neuroimaging procedure of choice and situations where CT is preferred:
  - initial evaluation of recent craniocerebral trauma
  - evaluation of acute intracranial hemorrhage (parenchymal, subarachnoid, subdural, epidural)
  - evaluation of calcified intracranial lesions
  - osseous assessment of the calvarium, skull base and maxillofacial bones, including detection of calvarial and facial bone fractures

Common Diagnostic Indications

This section begins with general indications for MRI Head/Brain, followed by Neurologic Signs and Symptoms and Vascular indications.

General Head/Brain

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Acoustic neuroma

Management of known acoustic neuroma when <u>at least one</u> of the following applies:

- Symptoms suggestive of recurrence or progression
- Following conservative treatment or incomplete resection at 6, 18, 30, and 42 months
- Post resection, baseline imaging and follow up at 12 months after surgery

Congenital or developmental anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital anomaly or developmental condition

Examples *include Chiari malformation, craniosynostosis, macrocephaly, and microcephaly.*

Dementia

- Initial evaluation to exclude a secondary cause of symptoms
- Evaluation of rapidly progressive symptoms

Common Diagnostic Indications

Hearing loss, sensorineural

Diagnosis—detection of acoustic neuroma or other retrocochlear lesion in persons diagnosed with sensorineural hearing loss characterized by any of the following features:

- Idiopathic sudden onset sensorineural loss
- Gradual onset of unilateral or asymmetric hearing loss demonstrated by audiometric testing (15 dB or greater at 2 consecutive frequencies between 0.5 and 3 kHz)
- Hearing loss associated with at least one neurologic sign or symptom known to increase the pretest probability of a retrocochlear lesion

Horner's syndrome

Hydrocephalus/ventricular assessment

Diagnosis of suspected increased intracranial pressure or hydrocephalus

Management of ventricular shunt

Infectious disease

Diagnosis or management (including perioperative evaluation) of infection involving the brain or related structures

Inflammatory disease

Diagnosis or management of inflammatory disease with CNS involvement

Movement disorders

Initial evaluation of the following movement disorders, to exclude an underlying structural lesion

- Hemifacial spasm
- Huntington's disease
- Multiple system atrophy (MSA)
- Parkinson's disease with atypical features
- Progressive supranuclear palsy
- Secondary dystonia
- Other focal or lateralizing movement disorder, such as hemiballismus, athetosis or chorea

Note: *Imaging is generally not indicated for evaluation of typical Parkinson's disease, essential tremor or primary dystonia.*

Multiple sclerosis and other white-matter diseases

Diagnosis of suspected demyelinating disease

Management or surveillance of established disease

Neurocutaneous disorders

Diagnosis or management (including perioperative evaluation) of CNS lesions associated with a known neurocutaneous disorder

Examples *include neurofibromatosis, Sturge-Weber syndrome, tuberous sclerosis, von Hippel-Lindau disease*

Papilledema

Pituitary adenoma

Diagnosis of suspected pituitary adenoma when supported by symptoms and laboratory findings

Management (including perioperative evaluation) of known adenoma

Common Diagnostic Indications

Seizure disorder

- Initial evaluation, to rule out a structural brain lesion as a cause of seizure
- Evaluation of seizures increasing in frequency or severity
- Prior to discontinuation of anticonvulsant therapy in patients who have not been previously imaged

Trauma

Following initial evaluation with CT, when MRI is needed to direct management or inform prognosis

Trigeminal neuralgia and persistent idiopathic facial pain

Evaluation for a structural lesion or demyelinating disease as a cause of symptoms

Tumor (benign or malignant)

Diagnosis of suspected tumor when supported by the clinical presentation

Management (including perioperative evaluation) of established tumor when imaging is required to direct treatment

Surveillance of established tumor

Neurologic Signs & Symptoms

This section contains indications for Bell's palsy, headache, syncope, tinnitus, vertigo/dizziness, and visual disturbance.

Advanced imaging based on nonspecific signs or symptoms is subject to a high level of clinical review.

Appropriateness of imaging depends upon the context in which it is requested. At a minimum, this includes a differential diagnosis and temporal component, along with documented findings on physical exam.

Additional considerations which may be relevant include comorbidities, risk factors, and likelihood of disease based on age and gender.

In general, the utility of structural brain imaging is limited to the following categories, each with a unique set of clinical presentations:

- Identification of a space occupying lesion or other focal abnormality (tumor, CVA)
- Detection of parenchymal abnormalities (atrophy, demyelinating disease, infection, ischemic change)
- Identification of ventricular abnormalities (hydrocephalus)

There are a number of common symptoms or conditions for which the likelihood of an underlying central nervous system process is extremely low. The following indications include specific considerations and requirements which help to determine appropriateness of advanced imaging for these symptoms.

Bell's palsy (peripheral facial weakness)

Evaluation of hemifacial weakness when <u>either</u> of the following is present:

- Additional neurologic findings suggestive of intracranial pathology
- Symptoms persisting beyond six (6) weeks

Common Diagnostic Indications

Headache

New headache

- When associated with one or more red flag features (see **Table** below); **OR**,
- Headache has not improved or has worsened during a course of physician-directed treatment, and the patient has been reevaluated by a clinician following completion of therapy.

Recurrent headache

- When associated with at least one red flag feature (see **Table** below) and advanced imaging (CT or MRI) has not been performed to evaluate the headache; **OR**,
- When CT or MRI has been performed to evaluate the headache, and a red flag feature has developed since the prior imaging study; **OR**,
- Headaches are increasing in frequency and/or severity despite at least four (4) weeks of physician-directed treatment and reevaluation by a clinician following completion of therapy.

Table: Red flag features for headache

Headache Characteristics	Associated clinical features and conditions
• Brought on by exertion or valsalva • Cluster headache not previously evaluated with MRI • Postural/positional • Thunderclap or sentinel headache—sudden onset and severe (worst headache of life) reaching maximal intensity within minutes	• Abnormal neurological exam during the headache episode or in between episodes *(Note: photophobia and nausea are not considered abnormalities on neurologic exam)* • Neck or facial pain (concern for dissection)—see **Dissection** indication in **CTA/MRA Head** guideline • Neck stiffness and fever—see **Infectious disease** and **Inflammatory disease** indications • Risk factors for venous thrombosis—see **Venous thrombosis** indication
Patient Populations	**High-risk vascular patient**
• Age over 50 years with new onset of headache • Known malignancy • Increased genetic risk for intracranial neoplasms (including basal cell nevus syndrome, Gorlin syndrome, Li-Fraumeni syndrome, neurofibromatosis type 1 and type 2, Turcot syndrome, and von Hippel-Lindau syndrome) • Immunodeficiency (including HIV)	• Personal or family history (at least one first-degree relative) of aneurysm, subarachnoid hemorrhage (SAH), or arteriovenous malformation (AVM) • Heritable condition associated with intracranial aneurysm formation, including autosomal dominant polycystic kidney disease, Ehlers-Danlos syndrome, Marfan syndrome, neurofibromatosis type 1 and type 2, and other rare conditions (hereditary hemorrhagic telangiectasia, multiple endocrine neoplasia, pseudoxanthoma elasticum)

Mental status changes, with documented objective evidence from neurologic exam

Syncope

Evaluation for a structural brain lesion when associated with <u>at least one</u> of following:

- Documented abnormality on neurological examination
- Presence of at least one persistent neurological symptom
- Witnessed or highly suspected seizure activity at the time of the episode

Tinnitus

Evaluation for vascular pathology, when tinnitus is pulsatile in quality

Evaluation for retrocochlear pathology, when <u>at least one</u> of the following features is present:

- Abrupt or sudden onset
- Associated neurologic findings
- Unilateral or asymmetric symptoms
  - Abnormality on audiogram or auditory brainstem response is required if present longer than six (6) months

Common Diagnostic Indications

Vertigo and dizziness

Evaluation for a structural lesion when <u>either</u> of the following is present:

- Abnormal audiogram or auditory brainstem response
- Signs or symptoms suggestive of a CNS lesion

Note: Vertigo or dizziness which is clearly related to positional change does not require advanced imaging.

Visual disturbance

Evaluation for central nervous system pathology when suggested by the ophthalmologic exam

Vascular indications

This section contains indications for aneurysm, cerebrovascular accident, congenital/developmental vascular anomalies, hemorrhage/hematoma, vasculitis, and venous thrombosis.

Aneurysm

- **Screening** in asymptomatic high-risk individuals
  - At least two (2) first degree relatives with intracranial aneurysm or subarachnoid hemorrhage
  - Presence of a heritable condition which predisposes to intracranial aneurysm (examples include autosomal dominant polycystic kidney disease and Ehlers-Danlos syndrome type IV)
- **Diagnosis** of suspected aneurysm based on neurologic signs or symptoms (for isolated headache, see **Headache** indication)
- **Management** (including perioperative evaluation) of known (treated or untreated) intracranial aneurysm when associated with new or worsening neurologic symptoms
- **Surveillance** of known aneurysm in the absence of new or worsening symptoms
  - Initial evaluation at 6–12 months following diagnosis, then every 1–2 years
  - Follow-up after treatment with clips, endovascular coil or stenting

Cerebrovascular accident (CVA or stroke) and transient ischemic attack (TIA)

Diagnosis of signs or symptoms suggestive of acute infarction

Note: *CT is preferred for evaluation of acute intracranial hemorrhage. MRI is preferred for evaluation of subacute and chronic hemorrhage.*

Management of CVA when imaging is required to direct treatment

Congenital or developmental vascular anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital vascular anomaly or developmental condition

Examples *include arteriovenous malformation (AVM), cavernous malformation, dural arteriovenous fistula (DAVF).*

Hemorrhage / hematoma

Diagnosis of suspected hemorrhage (intracranial or subarachnoid) or hematoma

Management (including perioperative evaluation) of known hemorrhage (intracranial or subarachnoid) or hematoma, when imaging is required to direct treatment

Vasculitis

Evaluation of vasculitis with known or suspected CNS involvement

Common Diagnostic Indications

Venous thrombosis (including dural venous sinus thrombosis, venous sinus thrombosis, cerebral vein thrombosis)

Diagnosis (requires at least one clinical finding AND one risk factor, OR at least two clinical findings as specified below)

- Clinical findings
  - Abnormal neurological exam
  - Headache
- Risk factors
  - Bechet's disease
  - Coagulopathy (examples: protein S, protein C, antithrombin 3, antiphospholipid antibody)
  - Drugs (including all trans retinoic acid [ATRA])
  - Iron deficiency anemia
  - Known malignancy
  - Meningitis /intracranial infection
  - Oral contraceptive
  - Pregnancy
  - Prior episodes of venous sinus thrombosis
  - Trauma

Management (including perioperative evaluation) of established venous thrombosis

References

1. Agid R, Shelef I, Scott JN, Farb RI. Imaging of the intracranial venous system. Neurologist. 2008;14(1):12-22.
2. Agostoni E, Aliprandi A, Longoni M. Cerebral venous thrombosis. Expert Rev Neurother. 2009;9(4):553-564.
3. Albanese A, Asmus F, Bhatia KP, et al. EFNS guidelines on diagnosis and treatment of primary dystonias. Eur J Neurol. 2011 Jan;18(1):5-18.
4. Alberti A, Venti M, Biagini S. Headache and cerebral vein and sinus thrombosis. Front Neurol Neurosci. 2008;23:89-95.
5. Alons IME, van den Wijngaard IR, Verheul RJ, et al. The value of CT angiography in patients with acute severe headache. Acta Neurol Scand. 2015; 131(3); 164-8.
6. American College of Emergency Physicians. Choosing Wisely: Avoid computed tomography (CT) scans of the head in emergency department patients with minor head injury who are at low risk based on validated decision rules. ABIM Foundation. 2013. http://www.choosingwisely.org. Accessed May 4, 2016
7. Antonini G, Di Pasquale A, Cruccu G, et al. Magnetic resonance imaging contribution for diagnosing symptomatic neurovascular contact in classical trigeminal neuralgia: a blinded case-control study and meta-analysis. Pain. 2014;155(8):1464-1471.
8. Arab AF, Ahmed ME, Ahmed AE, et al. Accuracy of Canadian CT head rule in predicting positive findings on CT of the head of patients after mild head injury in a large trauma centre in Saudi Arabia. Neuroradiol J. 2015 Dec;28(6):591-7.
9. Baguley D, McFerran D, Hall D. Tinnitus. Lancet. 2013 Nov 9;382(9904):1600-1607.
10. Baugh RF, Basura GJ, Ishii LE, et al. Clinical practice guideline: Bell's palsy. Otolaryngol Head Neck Surg. 2013 Nov;149(3 Suppl):S1-S27.
11. Beck J, Raabe A, Szelenyi A, et al. Sentinel headache and the risk of rebleeding after aneurysmal subarachnoid hemorrhage. Stroke. 2006;37(11):2733-2737.
12. Berardelli A, Wenning GK, Antonini A, et al. EFNS/MDS-ES/ENS [corrected] recommendations for the diagnosis of Parkinson's disease. Eur J Neurol. 2013 Jan;20(1):16-34.
13. Bildik F, Aygun D. Clinical warning criteria in evaluation by computed tomography the secondary neurological headaches in adults. Eur J Neurol. 2003;10(4):437-442.
14. Bramley R, Whitehouse RW, Taylor PM. The Canadian CT Head Rule for patients with minor head injury: consequences for radiology departments in the U.K. Clin Radiol. 2002 Feb;57(2):151-2; author reply 152-3.

References

15. Brazilian Association of Otorhinolaringology, Brazilian College of Radiology. Sensorineural hearing loss: radiologic diagnosis. Rev Assoc Med Bras. 2012 Sep-Oct;58(5):519-529.
16. Brown RD Jr, Huston J, Hornung R, et al. Screening for brain aneurysm in the Familial Intracranial Aneurysm study: frequency and predictors of lesion detection. J Neurosurg. 2008 Jun;108(6):1132-8.
17. Caranci F, Briganti F, Cirillo L, Leonardi M, Muto M. Epidemiology and genetics of intracranial aneurysms. Eur J Radiol. 2013;82(10):1598-1605.
18. Cardoso TA, Coan AC, Kobayashi E, Guerreiro CA, Li LM, Cendes F. Hippocampal abnormalities and seizure recurrence after antiepileptic drug withdrawal. Neurology. 2006 Jul 11;67(1):134-136.
19. Christiaans MH, Kelder JC, Arnoldus EPJ, Tijssen CC. Prediction of intracranial metastases in cancer patients with headache. Cancer. 2002;94(7):2063-2068.
20. Cianfoni A, Pravatà E, De Blasi R, Tschuor CS, Bonaldi G. Clinical presentation of cerebral aneurysms. Eur J Radiol. 2013;82(10):1618-1622.
21. Cueva RA. Clinical thresholds for when to test for retrocochlear lesions: pro. Arch Otolaryngol Head Neck Surg. 2010 Jul;136(7):725-7.
22. Cumurciuc R, Crassard I, Sarov M, Valade D, Bousser MG. Headache as the only neurological sign of cerebral venous thrombosis: A series of 17 cases - Commentary. Headache. 2006;46(1):189.
23. Da Rocha AJ, da Silva CJ, Gama HPP, et al. Comparison of magnetic resonance imaging sequences with computed tomography to detect low-grade subarachnoid hemorrhage: Role of fluid-attenuated inversion recovery sequence. J Comput Assist Tomogr. 2006; 30(2):295-303.
24. Damak M, Crassard I, Wolff V, Bousser M-G. Isolated lateral sinus thrombosis: a series of 62 patients. Stroke. 2009;40(2):476-481.
25. Davidson HC. Imaging evaluation of sensorineural hearing loss. Semin Ultrasound CT MR. 2001 Jun;22(3):229-49. Review.
26. Davis T, Ings A; National Institute of Health and Care Excellence. Head injury: triage, assessment, investigation and early management of head injury in children, young people and adults (NICE guideline CG 176). Arch Dis Child Educ Pract Ed. 2015 Apr;100(2):97-100.
27. De Falco F a. Sentinel headache. Neurol Sci. 2004;25 Suppl 3:S215-S217.
28. Delgado Almandoz JE, Jagadeesan BD, Refai D, et al. Diagnostic yield of computed tomography angiography and magnetic resonance angiography in patients with catheter angiography-negative subarachnoid hemorrhage. J Neurosurg. 2012Aug;117(2):309-15.
29. Delgado Almandoz JE, Kelly HR, Schaefer PW, Lev MH, Gonzalez RG, Romero JM. Prevalence of traumatic dural venous sinus thrombosis in high-risk acute blunt head trauma patients evaluated with multidetector CT venography. Radiology. 2010;255(2):570-577.
30. Detsky ME, McDonald DR, Baerlocher MO, Tomlinson G a, McCrory DC, Booth CM. Does this patient with headache have a migraine or need neuroimaging? JAMA. 2006;296(10):1274-1283.
31. Devenney E, Neale H, Forbes RB. A systematic review of causes of sudden and severe headache (Thunderclap Headache): should lists be evidence based? J Headache Pain. 2014;15(1):49.
32. Donington J, Ferguson M,Thoracic Oncology Network of American College of Chest Physicians; Workforce on Evidence-Based Surgery of Society of Thoracic Surgeons, et al. American College of Chest Physicians and Society of Thoracic Surgeons consensus statement for evaluation and management for high-risk patients with stage I non-small cell lung cancer. Chest. 2012 Dec;142(6):1620-35.
33. Edlow JA, Panagos PD, Godwin SA, Thomas TL, Decker WW. Clinical policy: Critical issues in the evaluation and management of adult patients presenting to the emergency department with acute headache. J Emerg Nurs. 2009;35(3):e43-e71.
34. Fischera M, Marziniak M, Gralow I, Evers S. The incidence and prevalence of cluster headache: A meta-analysis of population-based studies. Cephalalgia. 2008;28(6):614-618.
35. Fogang Y, Naeije G, Ligot N. Transient Neurologic Deficits: Can Transient Ischemic Attacks Be Discrimated from Migraine Aura without Headache? J Stroke Cerebrovasc Dis. 2015;24(5):1047-1051.
36. Frishberg BM, Rosenberg JH, Matchar DB, et al. Evidence-based guidelines in the primary care setting: neuroimaging in patients with nonacute headache. Available from Am Acad Neurol [online]. 2000:1-25.
37. Gross BA, Frerichs KU, Du R. Sensitivity of CT angiography, T2-weighted MRI,and magnetic resonance angiography in

References

detecting cerebral arteriovenous malformations and associated aneurysms. J Clin Neurosci. 2012 Aug;19(8):1093-5.

38. Harnan SE, Pickering A, Pandor A. et al. Clinical decision rules for adults with minor head injury: a systematic review. J Trauma. 2011 Jul;71(1):245-51
39. Hawasli AH, Chicoine MR, Dacey RG. Choosing Wisely. Neurosurgery. 2015;76(1):1-6.
40. Honningsvåg L-M, Hagen K, Håberg A, Stovner LJ, Linde M. Intracranial abnormalities and headache: A population based imaging study (HUNT MRI). Cephalalgia. 2015.
41. Hughes PD, Becker GJ. Screening for intracranial aneurysms in autosomal dominant polycystic kidney disease. Nephrology (Carlton). 2003 Aug;8(4):163-70.
42. Iurlaro S, Beghi E, Massetto N, et al. Does headache represent a clinical marker in early diagnosis of cerebral venous thrombosis? A prospective multicentric study. Neurol Sci. 2004;25 Suppl 3:S298-S299.
43. Josephson CB, White PM, Krishan A, Al-Shahi Salman R. Computed tomography angiography or magnetic resonance angiography for detection of intracranial vascular malformations in patients with intracerebral haemorrhage. Cochrane Database Syst Rev. 2014;9:CD009372.
44. Kernick DP, Ahmed F, Bahra A, et al. Imaging patients with suspected brain tumour: Guidance for primary care. Br J Gen Pract. 2008;58(557):880-885.
45. Kesser BW. Clinical thresholds for when to test for retrocochlear lesions: con. Arch Otolaryngol Head Neck Surg. 2010 Jul;136(7):727-9.
46. Kirby S, Purdy RA. Headaches and Brain Tumors. Neurol Clin. 2014;32(2):423-432.
47. Kurth T, Buring JE, Rist PM. Headache, migraine and risk of brain tumors in women: prospective cohort study. J Headache Pain. 2015;16(1).
48. Kuruvilla DE, Lipton RB. Appropriate Use of Neuroimaging in Headache. Curr Pain Headache Rep. 2015 Jun;19(6):490.
49. Lehman VT, Barrick BJ, Pittelkow MR, Peller PJ, Camilleri MJ, Lehman JS. Diagnostic imaging in paraneoplastic autoimmune multiorgan syndrome: retrospective single site study and literature review of 225 patients [published online 2014 Jul 29]. Int J Dermatol. doi: 10.1111/ijd.12603.
50. Loder E, Weizenbaum E, Frishberg B, Silberstein S. Choosing wisely in headache medicine: The american headache society's list of five things physicians and patients should question. Headache. 2013;53(10):1651-1659.
51. Lynch KM, Brett F. Headaches that kill: A retrospective study of incidence, etiology and clinical features in cases of sudden death. Cephalalgia. 2012;32(13):972-978.
52. Maeda M, Yagishita A, Yamamoto T, Sakuma H, Takeda K. Abnormal hyperintensity within the subarachnoid space evaluated by fluid-attenuated inversion-recovery MR imaging: a spectrum of central nervous system diseases. Eur Radiol. 2003;13 Suppl 4:L192-L201.
53. Mitchell P, Wilkinson ID, Hoggard N, et al. Detection of subarachnoid haemorrhage with magnetic resonance imaging. J Neurol Neurosurg Psychiatry. 2001;70(2):205-211.
54. Morris Z, Whiteley WN, Longstreth WT, et al. Incidental findings on brain magnetic resonance imaging: systematic review and meta-analysis. BMJ. 2009;339:b3016.
55. Nesbitt a. D, Goadsby PJ. Cluster headache. BMJ. 2012;344(apr11 1):e2407-e2407.
56. Ozsvath RR, Casey S, Lustrin ES, Alberico R a. Cerebral Venography: of CT and MR Projection. Am J Roentgenol. 1997;169(December):1699-1707.
57. Pandor A, Harnan S, Goodacre S, Diagnostic accuracy of clinical characteristics for identifying CT abnormality after minor brain injury: a systematic review and meta-analysis. J Neurotrauma. 2012 Mar 20;29(5):707-18.
58. Pierot L, Portefaix C, Rodriguez-Régent C, et al. Role of MRA in the detection of intracranial aneurysm in the acute phase of subarachnoid hemorrhage. J Neuroradiol. 2013 Jul;40(3):204-10.
59. Polmear a. Sentinel headaches in aneurysmal subarachnoid haemorrhage: What is the true incidence? A systematic review. Cephalalgia. 2003;23(10):935-941.
60. Rozenfeld MN, Ansari SA, Shaibani A, Russell EJ, Mohan P, Hurley MC. Should patients with autosomal dominant polycystic kidney disease be screened for cerebral aneurysms? AJNR Am J Neuroradiol. 2014;35(1):3-9.
61. Sailer AMH, Wagemans BAJM, Nelemans PJ, de Graaf R, van Zwam WH. Diagnosing intracranial aneurysms with MR angiography: systematic review and meta-analysis. Stroke. 2014;45(1):119-126.
62. Sajisevi M, Weissman JL, Kaylie DM. What is the role of imaging in tinnitus? Laryngoscope. 2014 Mar;124(3):583-584.
63. Sandrini G, Friberg L, Coppola G, et al. Neurophysiological tests and neuroimaging procedures in non-acute headache

References

(2nd edition). Eur J Neurol. 2011;18(3):373-381.

64. Schaafsma JD, Koffijberg H, Buskens E, Velthuis BK, van der Graaf Y, Rinkel GJE. Cost-effectiveness of magnetic resonance angiography versus intra-arterial digital subtraction angiography to follow-up patients with coiled intracranial aneurysms. Stroke. 2010;41(8):1736-1742.
65. Schankin CJ, Ferrari U, Reinisch VM, Birnbaum T, Goldbrunner R, Straube a. Characteristics of brain tumour-associated headache. Cephalalgia. 2007;27(8):904-911.
66. Secretariat. MA. Neuroimaging for the Evaluation of Chronic Headaches: An Evidence-Based Analysis. Ont Health Technol Assess Ser. 2010; 10(26): 1–57.
67. Sharifi S, Nederveen AJ, Booij J et al. Neuroimaging essentials in essential tremor: a systematic review. Neuroimage Clin. 2014 May 9;5:217-31.
68. Silvestri GA, Gould MK, Margolis ML, et al. Noninvasive staging of non-small cell lung cancer. ACCP Evidenced-Based Clinical Practice Guidelines (2nd Edition). Chest. 2007;132(3suppl):178S-201S.
69. St Martin MB, Hirsch BE. Imaging of hearing loss. Otolaryngol Clin North Am. 2008 Feb;41(1):157-178.
70. Stachler RJ, Chandrasekhar SS, Archer SM, Rosenfeld RM, Schwartz SR, Barrs DM, Brown SR, Fife TD, Ford P, Ganiats TG, Hollingsworth DB, Lewandowski CA, Montano JJ, Saunders JE, Tucci DL, Valente M, Warren BE, Yaremchuk KL, Robertson PJ; American Academy of Otolaryngology-Head and Neck Surgery. Clinical practice guideline: sudden hearing loss. Otolaryngol Head Neck Surg. 2012 Mar;146(3 Suppl):S1-35.
71. Suchowersky O, Reich S, Quality Standards Subcommittee of the American Academy of Neurology, et al. 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.
72. The Society of Thoracic Surgeons. Choosing Wisely: Five Things Physicians and Patients Should Question. ABIM Foundation; February 21, 2013. Available at www.choosingwisely.org
73. Timóteo Â, Inácio N, Machado S, Pinto AA, Parreira E. Headache as the sole presentation of cerebral venous thrombosis: a prospective study. J Headache Pain. 2012;13(6):487-490.
74. Tunkel DE, Bauer C a., Sun GH, et al. Clinical Practice Guideline: Tinnitus Executive Summary. Otolaryngol – Head Neck Surg. 2014;151(4):533-541.
75. Tüzün E, Dalmau J. Limbic encephalitis and variants: classification, diagnosis and treatment. Neurologist. 2007;13(5):261-271.
76. Vattoth S, Shah R, Curé JK. A compartment-based approach for the imaging evaluation of tinnitus. AJNR Am J Neuroradiol. 2010 Feb;31(2):211-218.
77. Vega C, Kwoon JV, Lavine SD. Intracranial aneurysms: current evidence and clinical practice. Am Fam Physician. 2002 Aug 15;66(4):601-8.
78. Vos PE, Alekseenko Y, European Federation of Neurological Societies. Mild traumatic brain injury. Eur J Neurol. 2012 Feb;19(2):191-84: Harnan SE, Pickering A, Pandor A, Goodacre SW. Clinical decision rules for adults with minor head injury: a systematic review. J Trauma. 2011 Jul;71(1):245-51.
79. Wang HZ, Simonson TM, Greco WR, Yuh WT. Brain MR imaging in the evaluation of chronic headache in patients without other neurologic symptoms. Acad Radiol. 2001;8(5):405-408.
80. Weissman JL, Hirsch BE. Imaging of tinnitus: a review. Radiology. 2000;216:342-349.
81. Wiebers DO. Unruptured intracranial aneurysms: natural history, clinical outcome, and risks of surgical and endovascular treatment. Lancet. 2003;362:103-110.
82. Williams LN, Brown RD Jr. Management of unruptured intracranial aneurysms. Neurol Clin Pract. 2013 Apr;3(2):99-108.

Functional Magnetic Resonance Imaging (fMRI) Brain

CPT Codes

70554..... Magnetic resonance imaging, brain, functional MRI; including test selection and administration of repetitive body part movement and/or visual stimulation, not requiring physician or psychologist administration

70555..... Magnetic resonance imaging, brain, functional MRI; including test selection and administration of repetitive body part movement and/or visual stimulation, requiring physician or psychologist administration of entire neurofunctional testing

Standard Anatomic Coverage

- From the skull base to vertex, covering the intra-cranial contents
- Scan coverage may vary, depending on the specific clinical indication

Technology Considerations

- Functional MRI of the brain may be used to localize eloquent areas in the brain, prior to resection of neoplasm or medically intractable epileptogenic foci.
- Studies have shown excellent agreement in language localization, when comparing functional brain MRI with the Wada test and direct electrical stimulation.
- Advantages of functional brain MRI over a Wada test include the non-invasive technique (not requiring catheter placement and contrast injection), lack of ionizing radiation, shorter time-requirement, lower cost and quicker post-procedural recovery. Additionally, the Wada test is considered limited in right hemisphere dominance.
- Advantages of functional brain MRI over intraoperative electrocortical stimulation include its non-invasive technique and more extensive anatomic brain mapping. Direct electrical stimulation is an invasive procedure, which usually evaluates only one hemisphere (limiting assessment for partial or bilateral language dominance) and usually identifies only eloquent brain regions on the surface of the brain.
- Functional MRI may successfully map primary brain activities related to motor, sensory and language functions. Examples of tasks which may be used include sentence completion (to map language) and bilateral hand squeeze task (for sensory motor mapping).

Common Diagnostic Indications

Brain tumors

- Preoperative neurosurgical planning, as a replacement for a Wada test or direct electrical stimulation mapping

Seizures refractory to medical treatment

- Preoperative neurosurgical planning, as a replacement for a Wada test or direct electrical stimulation mapping

Positron Emission Tomography (PET) Brain Imaging

CPT Codes

78608..... PET brain, metabolic evaluation

78609..... PET brain, perfusion evaluation

Commonly Used Radiopharmaceuticals

- 2-(fluorine-18) fluoro-2-deoxy-d-glucose (FDG) Scan coverage may vary, depending on the specific clinical indication

Common Diagnostic Indications

Brain tumor

- Diagnosis or staging
- Differentiation of post treatment scarring from residual or recurrent disease

Frontotemporal lobe dementia and Alzheimer's disease

A one-time FDG-PET scan for differentiating between frontotemporal dementia and Alzheimer's disease is medically necessary and appropriate, provided that all of the following conditions are met:

- A recent diagnosis of frontotemporal dementia or Alzheimer's disease has been made by a physician experienced in the evaluation of dementia.
- There is documentation of cognitive decline of at least six (6) months duration.
- A comprehensive clinical evaluation has been performed, including all of the following:
  - History and physical examination, including an assessment of activities of daily living from a well-acquainted informant other than the patient.
  - Cognitive scales or neuropsychological testing
  - Laboratory testing to evaluate for metabolic causes of cognitive impairment
  - Structural imaging of the brain (CT or MRI) to identify a structural cause for cognitive impairment
  - The evaluation has not clearly identified a specific neurodegenerative disease or other cause for the clinical symptoms.
  - Results of the PET scan will help clarify the diagnosis in order to guide future treatment.
  - A brain SPECT has not been obtained for the same indication.

Note: *Documentation of this evaluation, including results of all testing, and a current list of medications are required.*

Refractory seizures / epilepsy

- Pre-surgical evaluation to identify a focus of seizure activity in patients who have failed conventional medical therapy

Computed Tomography (CT) Orbit, Sella Turcica, Posterior Fossa, Temporal Bone, including Mastoids

CPT Codes

70480..... CT of orbit, sella or posterior fossa and outer, middle or inner ear, without contrast

70481..... CT of orbit, sella or posterior fossa and outer, middle or inner ear, with contrast

70482..... CT of orbit, sella or posterior fossa and outer, middle or inner ear, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Anatomic coverage and protocol specifications will vary, depending on the clinical indication. Anatomic evaluation includes the internal auditory canals (IACs), posterior fossa, sella turcica, orbits and temporal bone, with the mastoid air cells.
- Targeted evaluation, such as CT of the temporal bones, involves collimated views through the region of interest, often in two imaging planes: axial images (petrous bones through mastoid tips) and coronal views (temporomandibular joints through temporal bones).

Technology Considerations

- CT is often the preferred study for suspected fracture or follow-up of a known fracture, foreign body detection, assessment of calcified lesions and temporal bone evaluation.
- With capability for high-resolution osseous imaging, CT can provide detailed anatomic depiction of the temporal bone anatomy, including the middle and inner ear structures.
- MRI (unless contraindicated) is usually preferred over CT for evaluation of the sella turcica, internal auditory canal regions and visual pathways, as well as for most soft tissue tumor evaluation.
- Bony changes from a sellar, para-sellar or orbital mass or infectious process are usually well demonstrated by CT.

Common Diagnostic Indications

This section begins with general indications, followed by orbital and otic indications.

General indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Congenital or developmental anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital anomaly or developmental condition of the orbit, temporal bone, sella turcica or posterior fossa (see Standard Anatomic Coverage for detail)

Infectious disease

Diagnosis or management (including perioperative evaluation) of infection involving the orbit, temporal bone, sella turcica or posterior fossa

Inflammatory disease

Diagnosis or management of inflammatory disease known to involve the orbit, temporal bone, sella turcica or posterior fossa

Localized facial pain – when persistent and unexplained

Common Diagnostic Indications

Osseous lesions
Examples *include fibrous dysplasia, Paget's disease and otosclerosis*

Trauma to the orbit, temporal bone, or skull base

Tumor (benign or malignant)
Diagnosis or management (including perioperative evaluation) of benign or malignant tumor of the orbit, temporal bone, sella turcica or posterior fossa

Orbital indications

Diagnosis or management of any of the following:
- Dysconjugate gaze
- Exophthalmos (or proptosis)
- Extraocular muscle weakness
- Nystagmus
- Optic neuritis
- Orbital pseudotumor
- Papilledema
- Strabismus
- Thyroid ophthalmopathy
- Visual field defect

Foreign body in the orbit
- Following non-diagnostic X-ray

Visual disturbance
Evaluation for orbital or optic nerve pathology when suggested by the ophthalmologic exam

Otic indications

Cholesteatoma

Cochlear implant
Preoperative and post-operative evaluation

Conductive hearing loss

Sensorineural hearing loss**
Diagnosis—detection of acoustic neuroma or other retrocochlear pathology in persons diagnosed with sensorineural hearing loss characterized by <u>either</u> of the following features:

- Gradual onset of unilateral or asymmetric hearing loss demonstrated by audiometric testing (15 dB or greater at 2 consecutive frequencies between 0.5 and 3 kHz)
- Hearing loss associated with at least one neurologic sign or symptom known to increase the pretest probability of a retrocochlear lesion

*****requires** contraindication to MRI*

Common Diagnostic Indications

Tinnitus**

Evaluation for vascular pathology when tinnitus is pulsatile in quality

Evaluation for retrocochlear pathology when <u>at least one</u> of following features is present:

- Abrupt or sudden onset
- Associated neurologic findings
- Unilateral or asymmetric symptoms
  - Abnormality on audiogram or auditory brainstem response is required if present longer than six (6) months.

***requires** contraindication to MRI*

Vertigo and dizziness

- Evaluation of signs or symptoms suggestive of a CNS lesion
- Symptoms associated with abnormal audiogram or auditory brainstem response

Note: *Vertigo or dizziness which is clearly related to positional change does not require advanced imaging.*

References

1. Baguley D, McFerran D, Hall D. Tinnitus. *Lancet*. 2013 Nov 9;382(9904):1600-1607.
2. Cueva RA. Clinical thresholds for when to test for retrocochlear lesions: pro. *Arch Otolaryngol Head Neck Surg*. 2010 Jul;136(7):725-7.
3. Davidson HC. Imaging evaluation of sensorineural hearing loss. *Semin Ultrasound CT MR*. 2001 Jun;22(3):229-49. Review.
4. Kesser BW. Clinical thresholds for when to test for retrocochlear lesions: con. *Arch Otolaryngol Head Neck Surg*. 2010 Jul;136(7):727-9.
5. Sajisevi M, Weissman JL, Kaylie DM. What is the role of imaging in tinnitus? *Laryngoscope*. 2014 Mar;124(3):583-584.
6. Stachler RJ, Chandrasekhar SS, Archer SM, Rosenfeld RM, Schwartz SR, Barrs DM, Brown SR, Fife TD, Ford P, Ganiats TG, Hollingsworth DB, Lewandowski CA, Montano JJ, Saunders JE, Tucci DL, Valente M, Warren BE, Yaremchuk KL, Robertson PJ; American Academy of Otolaryngology-Head and Neck Surgery. Clinical practice guideline: sudden hearing loss. *Otolaryngol Head Neck Surg*. 2012 Mar;146(3 Suppl):S1-35.
7. Tunkel DE, Bauer CA, Sun GH, et al. Clinical Practice Guideline: Tinnitus Executive Summary. *Otolaryngol Head Neck Surg*. 2014;151(4):533-541.
8. Weissman JL, Hirsch BE. Imaging of tinnitus: a review. *Radiology*. 2000;216:342-349.

Magnetic Resonance Imaging (MRI) Orbit, Face & Neck (Soft Tissues)

CPT Codes

70540..... MRI orbit, face and neck, without contrast

70542..... MRI orbit, face and neck, with contrast

70543..... MRI orbit, face and neck, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage is dependent on the specific anatomic area of clinical interest, and may include the following:
  - Facial structures
  - Larynx and subglottic regions
  - Nasopharynx, oropharynx and hypopharynx
  - Neck soft tissues, surrounding the airway and glands
  - Optic nerve
  - Orbit
  - Salivary glands
  - Sinuses
  - Thyroid and parathyroid gland

Technology Considerations

- MRI is usually preferred over CT for evaluation of the sella turcica and visual pathways.
- CT is generally the modality of choice for traumatic injury, calcified lesions, localized infection (for example, orbital extension of an adjacent complicated sinusitis), and foreign body evaluation following initial radiographic evaluation for a radiopaque foreign body.
- CT is preferred for visualization of soft tissue structures in the neck.
- MRI of the orbit, face and neck is not indicated for imaging the internal auditory canals (see MRI brain, CPT codes 70551–70553).

Common Diagnostic Indications

This section begins with general indications, followed by nasal, neck, and orbital indications.

General indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Congenital anomalies

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital anomaly of the orbit, maxillofacial area, or soft tissue structures of the neck (see Standard Anatomic Coverage for detail)

Horner's syndrome

Infectious disease (excluding sinusitis)

Diagnosis or management (including perioperative evaluation) of infection involving the orbit, maxillofacial area, or soft tissue of the neck

Note: *For sinus infection, see CT Paranasal Sinus and Maxillofacial Area*

Common Diagnostic Indications

Inflammatory disease

Diagnosis or management of inflammatory disease known to involve the orbit, maxillofacial area, or soft tissue structures of the neck

Example *includes Wegener's granulomatosis (granulomatosis with polyangiitis)*

Osteonecrosis of the jaw

Evaluation following non-diagnostic Panorex/radiographs

Thyroid nodule or thyromegaly (goiter)

- Following thyroid ultrasound or thyroid scintigraphy
- When associated with mass effect on the upper airway or esophagus
- For preoperative evaluation

Trauma to facial structures or soft tissues of the neck

Tumor (primary neoplasm or metastatic disease)

Diagnosis of suspected malignancy based on exam findings or testing abnormalities

Management (including perioperative evaluation) of known malignancy when imaging is required to direct treatment

Exclusion: Advanced imaging is not indicated for surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy.

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Nasal indications

Evaluation of any of the following:

- Anosmia
- Recurrent epistaxis
- Nasal airway obstruction or polyposis refractory to medical therapy

Neck indications

Hoarseness, dysphonia or vocal cord weakness/paralysis

Initial evaluation when <u>at least one</u> of the following applies:

- Following laryngoscopy, when findings suggest recurrent laryngeal nerve dysfunction or identify a suspicious lesion
- Symptoms persisting longer than one month which are unexplained by laryngoscopy
- Presence of **<u>at least one</u>** of the following high risk features:
  - Tobacco use
  - Alcohol abuse
  - Hemoptysis
  - History of radiation therapy
  - Known head and neck malignancy

Laryngeal edema

Lymphadenopathy

- When persistent and unexplained

Common Diagnostic Indications

Neck mass

- Evaluation of a palpable neck mass
- Follow up of a non-palpable neck mass identified on a prior imaging study
- Management (including perioperative evaluation) of known cystic neck mass or other benign tumor

Parathyroid adenoma

- Diagnosis following abnormal parathyroid ultrasound or scintigraphy
- Management following failed parathyroidectomy for localization of residual parathyroid tissue

Stridor / Tracheal stenosis / Upper airway obstruction

- For subacute and chronic stridor, soft tissue radiographs and ENT evaluation are required.

Orbital indications

Diagnosis or management of any of the following:

- Dysconjugate gaze
- Exophthalmos (or proptosis)
- Extraocular muscle weakness
- Nystagmus
- Optic neuritis
- Orbital pseudotumor
- Papilledema
- Strabismus
- Thyroid ophthalmopathy
- Visual field defect

Visual disturbance

Evaluation for orbital or optic nerve pathology when suggested by the ophthalmologic exam

References

1. American Academy of Otolaryngology — Head and Neck Surgery Foundation. Choosing Wisely: Five Things Physicians and Patients Should Question. ABIM Foundation; February 21, 2013. Available at www.choosingwisely.org.
2. Arce K, Assael LA, Weissman JL, Markiewicz MR. Imaging findings in bisphosphonate-related osteonecrosis of jaws. *J Oral Maxillofac Surg*. 2009;67(5 Suppl):75-84.
3. Leite AF, Ogata Fdos S, de Melo NS, Figueiredo PT. Imaging findings of bisphosphonate-related osteonecrosis of the jaws: a critical review of the quantitative studies [published online 2014 Jun 11]. *Int J Dent.* doi: 10.1155/2014/784348.
4. Paul BC, Branski RC, Amin MR. Diagnosis and management of new-onset hoarseness: a survey of the American Broncho-Esophagological Association. *Ann Otol Rhinol Laryngol*. 2012;121(10):629-634.
5. Schwartz SR, Cohen SM, Dailey SH, et al. Clinical practice guideline: hoarseness (dysphonia). *Otolaryngol Head Neck Surg*. 2009;141(3 Suppl 2):S1-S31.

Computed Tomography (CT)
Paranasal Sinus & Maxillofacial Area

CPT Codes

70486..... CT of maxillofacial area, without contrast
70487..... CT of maxillofacial area, with contrast
70488..... CT of maxillofacial area, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Includes the sinuses, facial structures and maxillary regions. Individual scan coverage depends on the specific clinical request, but generally includes images through the entire frontal, ethmoid, maxillary and sphenoid sinuses. Coverage may be extended to include the mandible and temporomandibular joint (TMJ) in select cases and depending on the clinical indication. CT sections may be obtained in one or two (usually coronal and axial) planes.

Common Diagnostic Indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Congenital anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital maxillofacial anomaly when imaging is required to direct treatment

Infectious disease

Diagnosis or management (including perioperative evaluation) of the following:

- Fungal or other complex sinus infections
- Osteomyelitis of the facial bones

Inflammatory disease

Diagnosis or management of inflammatory disease known to involve the maxillofacial region

Examples *include Wegener's granulomatosis (granulomatosis with polyangiitis)*

Osteonecrosis of the jaw

Evaluation following non-diagnostic Panorex/radiographs

Sinus and nasal indications

Diagnosis or management (including perioperative evaluation) of the following:

- Anosmia
- Foreign body in the maxillofacial region
- Mucocoele of paranasal sinuses
- Nasal airway obstruction refractory to medical therapy
- Polyposis
- Recurrent epistaxis

Common Diagnostic Indications

Sinusitis / rhinosinusitis

Acute, Uncomplicated Sinusitis / Rhinosinusitis

- Defined as symptoms that last for less than 4 weeks. Common symptoms include purulent rhinorrhea, postnasal drainage, anosmia, nasal congestion, facial pain, headache, fever, cough, purulent discharge and/or findings of an upper respiratory tract infection.
- No radiographic imaging is usually necessary for immunocompetent patients with acute rhinosinusitis, unless a complication or alternative diagnosis is suspected that requires imaging.
- CT may be performed if symptoms persist beyond 3 – 4 weeks of adequate treatment, which may include antibiotics, nasal steroids and/or decongestants. Under these circumstances, a complication of acute sinusitis/rhinosinusitis or an alternative diagnosis may warrant CT imaging of the paranasal sinuses.

Acute Recurrent Sinusitis / Rhinosinusitis

- Defined as 3 or more separate episodes of sinusitis during the past year
- Imaging used to corroborate the diagnosis and/or investigate for underlying causes of acute recurrent sinusitis.
- Clinicians should assess patients with recurrent acute sinusitis / rhinosinusitis for factors that modify management, such as allergic rhinitis, cystic fibrosis, immunocompromised states, ciliary dyskinesia and anatomic variations.

Chronic Sinusitis / Rhinosinusitis

- Defined as signs and symptoms of sinusitis that last for 12 weeks or longer
- Imaging used to corroborate the diagnosis and/or investigate for underlying causes of chronic sinusitis.
- Clinicians should assess patients with chronic sinusitis / rhinosinusitis for factors that modify management, such as allergic rhinitis, cystic fibrosis, immunocompromised states, ciliary dyskinesia and anatomic variations.

Peri-Orbital Swelling Associated with Sinus Infection

Barosinusitis / Headache Refractory to Antibiotics and Responding only to Decongestants / Oral Steroids

Temporomandibular disease (TMD)

Diagnosis of a temporomandibular joint (TMJ) source of TMD when <u>at least one</u> of the following applies:

- Panorex is inconclusive or not available
- Panorex findings require further characterization
- Panorex is normal but high clinical suspicion for TMJ pathology remains, and the results will change management (including perioperative evaluation)

Note: *Temporomandibular disease is a collective term, which includes disorders of both the masticatory muscles and the TMJ. CT is generally not indicated when a muscular etiology for TMD is suspected. Most TMJ pathology can be evaluated with a Panorex radiograph.*

Trauma to the facial bones

Tumor or mass lesion in the sinus or nasal region

Diagnosis or management (including perioperative evaluation) of benign or malignant tumors

References

1. American Academy of Orofacial Pain. Orofacial Pain: Guidelines for Assessment, Diagnosis, and Management. De Leeuw R, Klasser GD, eds. Chicago: Quintessence Publishing Co., Inc.; 2013.
2. American Association of Oral and Maxillofacial Surgeons (AAOMS). Clinical Paper: Temporomandibular Disorders. Rosemont, IL: AAOMS; 2013.
3. Arce K, Assael LA, Weissman JL, Markiewicz MR. Imaging findings in bisphosphonate-related osteonecrosis of jaws. *J Oral Maxillofac Surg*. 2009;67(5 Suppl):75-84.
4. Leite AF, Ogata Fdos S, de Melo NS, Figueiredo PT. Imaging findings of bisphosphonate-related osteonecrosis of the jaws: a critical review of the quantitative studies [published online 2014 Jun 11]. *Int J Dent*. doi: 10.1155/2014/784348.
5. Scrivani SJ, Keith DA, Kaban LB. Temporomandibular disorders. *N Engl J Med*. 2008;359(25):2693-2705.
6. Setzen G, Ferguson BJ, Han JK, et al. Clinical consensus statement: appropriate use of computed tomography for paranasal sinus disease. *Otolaryngol Head Neck Surg*. 2012;147(5):808-816.

Magnetic Resonance Imaging (MRI) Temporomandibular Joint (TMJ)

CPT Codes

70336..... MRI of the Temporomandibular Joint(s)

Standard Anatomic Coverage

- Bilateral study, including open and closed mouth views, often performed with surface coils
- Images may be obtained in axial, (oblique) sagittal and (oblique) coronal planes.

Common Diagnostic Indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Arthropathy of the temporomandibular joints

Frozen jaw

Temporomandibular joint dysfunction

Evaluation of persistent symptoms when all of the following requirements are met:

- X-ray or Panorex has not provided sufficient information to guide treatment.
- Intervention is being considered.
- Symptoms have not improved with conservative treatment, including NSAIDs or acetaminophen, a short-term trial of soft diet and proper chewing techniques, and an oral appliance (such as a bite block).

Trauma to the temporomandibular joints

- Evaluation of meniscal position and integrity

Note: *Conventional radiographs, Panorex views or CT of the TMJ are preferred for initial evaluation of trauma.*

Computed Tomography (CT) Neck for Soft Tissue Evaluation

CPT Codes

70490..... CT, soft tissue neck, without contrast

70491..... CT, soft tissue neck, with contrast

70492..... CT, soft tissue neck, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Axial images from the skull base to the clavicles

Technology Considerations

- CT is generally the modality of choice for the following indications: detection of sialolithiasis (salivary gland calculi); following trauma to the soft tissues of the neck; and during foreign body evaluation, after initial radiographic assessment for a radiopaque foreign body.

Common Diagnostic Indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Congenital anomaly

Diagnosis or management (including perioperative evaluation) of a suspected or known congenital or developmental anomaly of the soft tissue structures of the neck

Foreign body in the upper aero-digestive tract or surrounding neck tissue

- Following non-diagnostic neck radiograph

Hoarseness, dysphonia, or vocal cord weakness/paralysis

Initial evaluation when at least one of the following applies:

- Following laryngoscopy, when findings suggest recurrent laryngeal nerve dysfunction or identify a suspicious lesion
- Symptoms persisting longer than one month which are unexplained by laryngoscopy
- Presence of at least one of the following high risk features:
  - Tobacco use
  - Alcohol abuse
  - Hemoptysis
  - History of radiation therapy
  - Known head and neck malignancy

Horner's syndrome

Infectious disease

Diagnosis or management (including perioperative evaluation) of infection involving soft tissue structures in the neck

Inflammatory disease

Diagnosis or management of inflammatory disease involving soft tissue structures in the neck

Common Diagnostic Indications

Laryngeal edema

Lymphadenopathy

- When persistent and unexplained

Neck mass

- Evaluation of a palpable neck mass
- Follow up of a non-palpable neck mass identified on a prior imaging study
- Management (including perioperative evaluation) of known cystic neck mass or other benign tumor

Osteonecrosis of the jaw

Evaluation following non-diagnostic X-ray or Panorex

Parathyroid adenoma

- Evaluation of suspected adenoma following abnormal parathyroid ultrasound or scintigraphy
- Localization of residual parathyroid tissue following failed parathyroidectomy
- Preoperative planning in patients with aberrant anatomy

Salivary / parotid gland ductal calculi

Stridor

- For subacute and chronic stridor, soft tissue radiographs and ENT evaluation are required.

Thyroid nodule or thyromegaly (goiter)

- Following thyroid ultrasound or thyroid scintigraphy
- When associated with mass effect on the upper airway or esophagus
- For preoperative evaluation

Tracheal stenosis or upper airway obstruction

Traumatic injury to soft tissues of the neck

Tumor (primary neoplasm or metastatic disease)

Diagnosis of suspected malignancy based on exam findings or testing abnormalities

Management (including perioperative evaluation) of known malignancy when imaging is required to direct treatment

Exclusion: Advanced imaging is not indicated for surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy.

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

References

1. American Academy of Otolaryngology – Head & Neck Surgery Foundation. Choosing Wisely: CT scans or MRIs for hoarseness. Philadelphia, PA: ABIM Foundation; February 21, 2013. Available at www.choosingwisely.org. Accessed August 15, 2016
2. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013 and December 3, 2014. Available at www.choosingwisely.org. Accessed August 15, 2016
3. Arce K, Assael LA, Weissman JL, Markiewicz MR. Imaging findings in bisphosphonate-related osteonecrosis of jaws. *J Oral Maxillofac Surg*. 2009;67(5 Suppl):75-84.
4. Johnson NA, Tublin ME, Ogilvie JB. Parathyroid imaging: technique and role in the preoperative evaluation of primary hyperparathyroidism. *AJR Am J Roentgenol*. 2007 Jun;188(6):1706-1715.
5. Leite AF, Ogata Fdos S, de Melo NS, Figueiredo PT. Imaging findings of bisphosphonate-related osteonecrosis of the jaws: a critical review of the quantitative studies [published online 2014 Jun 11]. *Int J Dent*. doi: 10.1155/2014/784348.
6. Paul BC, Branski RC, Amin MR. Diagnosis and management of new-onset hoarseness: a survey of the American Broncho-Esophagological Association. *Ann Otol Rhinol Laryngol*. 2012;121(10):629-634.
7. Schwartz SR, Cohen SM, Dailey SH, et al. Clinical practice guideline: hoarseness (dysphonia). *Otolaryngol Head Neck Surg*. 2009;141(3 Suppl 2):S1-S31.

CT Angiography (CTA) and MR Angiography (MRA) Neck

CPT Codes

70498..... CTA, neck, with contrast material(s), including noncontrast images, if performed, and image post-processing

70547..... MRA, neck, without contrast

70548..... MRA, neck, with contrast

70549..... MRA, neck, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- CTA and MRA of the neck involve image acquisitions from the aortic arch to the skull base, to visualize major vessels including the extracranial carotid arteries and vertebral arteries. The major venous structures may also be interrogated with CT and MR angiographic techniques.

Choice of Imaging Study

- Duplex Doppler ultrasound is a first line imaging study for most carotid indications.

Advantages of CTA

- Higher sensitivity for detection of mural calcification
- Absence of in-plane flow phenomenon which can exaggerate the degree of stenosis
- Improved detection of surgical clips and stents
- Shorter scan time, resulting in less motion artifact and better quality images

Advantages of MRA

- Provides information about the age of blood
- No need for iodinated contrast material
- No exposure to ionizing radiation

Common Diagnostic Indications

Abnormal imaging findings

Follow up of abnormal or indeterminate findings on a prior imaging study when required to direct treatment

Aneurysm or dissection of carotid or vertebral arteries

Carotid stenosis or occlusion

Diagnosis or management of known or suspected steno-occlusive disease

- Following abnormal or equivocal duplex Doppler study, unless the diagnosis is supported by clinical exam findings

Note: Screening for carotid disease utilizing advanced imaging is not appropriate.

Congenital or developmental vascular anomaly

Diagnosis or management (including perioperative evaluation) of a vascular anomaly of the carotid or vertebral arteries including arteriovenous malformation (AVM)

Horner's syndrome

Intramural hematoma

Post-operative or post-procedure evaluation

Common Diagnostic Indications

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Exclusions:

- Screening for carotid disease using advanced imaging in preparation for coronary artery bypass graft (CABG) surgery is not considered appropriate.
- MRV (or CTV) in preparation for either a neurosurgical or percutaneous procedure to treat multiple sclerosis is not considered appropriate

Thromboembolic disease of major extracranial arterial and/or venous systems

Traumatic vascular injury to the extracranial carotid and vertebral arteries

Vasculopathy (including fibromuscular dysplasia and vasculitis)

Venous thrombosis or compression

Vertebrobasilar stenosis or occlusion

References

1. American Academy of Family Physicians. Choosing Wisely: Ten Things Physicians and Patients Should Question. ABIM Foundation; Updated February 21, 2013. Available at www.choosingwisely.org.
2. LeFevre ML, U.S. Preventive Services Task Force. Screening for asymptomatic carotid artery stenosis: U.S. Preventive Services Task Force recommendation. *Ann Intern Med*. 2014;161(5):356-362.
3. Wolff T, Guirguis-Blake J, Miller T, Gillespie M, Harris R. Screening for carotid artery stenosis: an update of the evidence for the U.S. Preventive Services Task Force. *Ann Intern Med*. 2007 Dec 18;147(12):860-870.

Computed Tomography (CT) Chest

CPT Codes

71250..... Chest CT without contrast

71260..... Chest CT with contrast

71270..... Chest CT without contrast, followed by re-imaging with contrast

G0297..... Low dose CT scan (LDCT) for lung cancer screening

Standard Anatomic Coverage

- Lung apices through costophrenic sulci
- Scan coverage may vary, depending on the specific clinical indication.

Technology Considerations

- In the majority of clinical situations, chest radiographs should be performed prior to advanced imaging with CT, preferably within 30 days of the chest CT exam request.
- CT chest is not appropriate for cardiac and coronary artery imaging. Please see guidelines for cardiac CT and CCTA.
- When the purpose of the study is imaging of the heart, including the coronary arteries, do not request both a chest CT and a dedicated cardiac/coronary artery CT.

Common Diagnostic Indications

Indications for chest CT are contained in general chest, pulmonary, mediastinal and hilar, pleural, chest wall and diaphragm.

General Chest

Broncho-pleural fistula

Congenital thoracic anomalies

Cough persisting three (3) or more weeks with normal chest X-ray

- Unresponsive to medical treatment and/or after evaluation for other causes (e.g., post-nasal drainage, asthma, gastroesophageal reflux disease and medication effects); **OR**
- Cough in immunosuppressed (e.g. HIV, after organ or bone marrow transplant, on infliximab or other tumor necrosis factor antagonists individual (In these individuals, a higher level of suspicion is warranted); **OR**
- Other etiologies for chronic cough which include, but are not limited to:
  - Smoking
  - Chronic bronchitis
  - Cough-inducing medications (e.g., ACE inhibitors)
  - Exposure to an environmental irritant
  - Respiratory infection
  - Neoplasm

Fever of unknown origin

- Lasting more than three weeks with exceptions for immunocompromised patients
- Following standard work-up to localize the source

Hemoptysis

- Following non-diagnostic chest radiographs

Common Diagnostic Indications

Horner's syndrome

Infectious and inflammatory processes when not otherwise specified

- For initial evaluation and surveillance

Note: *This indication is for evaluation of infectious and inflammatory processes not specifically referenced elsewhere in this guideline (e.g., pneumonia complications, mediastinitis, sternal infection, lung abscess and empyema).*

Lung abscess

Lung cancer screening

- For annual screening of lung cancer **(<u>all</u> of the following)**
  - Patient has no signs or symptoms suggestive of underlying cancer
  - Patient's age is equal to or greater than 55 and less than or equal to 80
  - There is at least a 30 pack-year history of cigarette smoking (and if former smoker, quit date is within previous 15 years)
  - Patient does not have a health problem that substantially limits life expectancy or the ability/willingness to undergo an intervention with curative intent

Note: *One (1) pack-year of smoking equals smoking one pack (20 cigarettes) per day for one year or 7300 cigarettes annually. CT should be performed using a low-dose technique (LDCT).*

Mediastinitis

- Includes:
  - Mediastinal infection/abscess
  - Fibrosing mediastinitis

Paraneoplastic syndrome with unknown primary

Note: *This includes Lambert Eaton syndrome, myasthenia gravis, paraneoplastic cerebellar degeneration, opsoclonus-myoclonus ataxia, positive paraneoplastic panel, anti-GAD antibody syndrome (stiff-person's syndrome), voltage-gated K+ channelopathy (epilepsy syndrome), limbic encephalitis (rapidly progressive dementia syndromes with abnormal lumbar puncture), dermatomyositis/polymyositis, and anti-NMDA*

Persistent pneumonia

- Repeat radiographs show no improvement following at least four (4) weeks of medical treatment
- Recurrent pneumonia in the same location within six months
- Patient is immunosuppressed

Pneumonia, complications

(any <u>one</u> of the following)

- Following non-diagnostic chest radiograph
- Immunosuppressed patient

Note: *Complications of the mediastinum, lung parenchyma, or pleura include abscess, bronchopleural fistula, complicated or loculated parapneumonic effusion, empyema, necrotic pneumonia, and purulent pericarditis*

Positive sputum cytology for malignancy

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Common Diagnostic Indications

Pulmonary embolism (PE)

- PE likely based on modified Wells* (mWells) criteria
- PE unlikely based on mWells* criteria with a positive D-dimer

** mWells criteria: PE likely—greater than 4 points; PE unlikely—less than or equal to 4 points.*[82] *More information available at:* https://www.ncbi.nlm.nih.gov/pubmed/10744147

Sarcoidosis

- Initial evaluation and periodic follow-up

Sternal infection and dehiscence

Note: *Rare complication of cardiothoracic surgery*

Structural abnormalities on chest X–ray, which require further clarification with CT

Trauma

- Injury involving the chest wall, cardiomediastinal structures and/or lungs

Tumor (primary neoplasm or metastatic disease)

Management of biopsy-proven malignancy

- For renal cell carcinoma (where biopsy is contraindicated) when surgical resection is planned, ultrasound or CT findings highly suspicious for cancer may constitute documentation of malignancy

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures).*
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Common Diagnostic Indications

Unexplained weight loss – significant weight loss exceeding 10% of desirable body weight, over a short time interval (6 months or less), after initial evaluation for other causes

Pulmonary

Asbestos-related benign and malignant lesions, involving the lungs and pleura

- Pleural plaques
- Interstitial lung disease
- Malignant mesothelioma
- Pleural effusion
- Lung cancer

Bronchiectasis

- Consider high resolution chest CT (HRCT) technique

Interstitial lung disease / pulmonary fibrosis

- Consider high resolution chest CT (HRCT) technique

Occupational lung disease (pneumoconioses)

- Diagnosis and management of any one of the following:
  - Silicosis
  - Coal workers pneumoconiosis
  - Progressive massive fibrosis
  - Hard metal pneumoconiosis
  - Talcosis
  - Caplan's syndrome (in patients with Rheumatoid Arthritis)

Pulmonary mass or suspicious parenchymal abnormality on recent chest X-ray or other imaging exam

Pulmonary nodule(s) – without a known primary malignancy

A nodule is defined as a rounded or regular opacity measuring up to 3 cm in diameter. Nodules are classified as solid or subsolid. Solid nodules are further classified as calcified or non-calcified. Follow-up recommendations are based on classification, as well as patient risk stratification. For calcified nodules, risk may be correlated with patterns of calcification. Those nodules with benign-appearing calcifications do not generally require follow up.

In patients under the age of 35 years, primary lung cancer is rare, and the risks associated with radiation exposure are increased. Therefore, patients in this age range fall outside of the recommendations established by the Fleischner Society with regard to follow up.

Patients who are immunosuppressed, or who have known or prior malignancy, or who have growing nodules are excluded from Fleischner Society recommendations. In these patients, follow-up imaging is at the discretion of the treating physician.

Follow-up imaging of multiple nodules should be based on the recommendations pertinent to the most suspicious nodule.

An incomplete thoracic CT refers to a CT that includes only a portion of the lung parenchyma such as a CT or CTA of the abdomen, neck or extremity.

Common Diagnostic Indications

Non-calcified nodules

- Age < 35 years:
  - Nodules ≥ 1 cm
  - Nodules with suspicious morphology
- Age 35 years or older:
  - Solid nodules – see Table 1
  - Subsolid nodules – see Table 2

Nodules identified on incomplete thoracic CT

- Less than 6 mm – no follow-up imaging required
- 6 mm to 8 mm – 3- to 12-month follow up with complete chest CT with subsequent follow up per Table 1 or Table 2
- More than 8 mm or suspicious morphology – complete chest CT with subsequent follow up per Table 1 or Table 2

Calcified nodules

- Nodules with benign calcification patterns do not require routine follow up. This includes granulomas and nodules with popcorn calcifications.
- Follow up of nodules with other types of calcification patterns is at the discretion of the ordering provider.

Table 1: Follow-up recommendations for solid non-calcified pulmonary nodules

Solid nodule size	Risk factors	Solitary	Multiple
Less than 6 mm	Low	No follow up	
	High*	Optional follow-up exam at 12 months	
6 mm to 8 mm or Lung-RADS 3	N/A	1) 6 to 12 months 2) 18 to 24 months	1) 3 to 6 months 2) 18 to 24 months
More than 8 mm	N/A	1) 3 months 2) 6 months 3) 18 to 24 months unless diagnostic PET-CT or tissue sampling performed	
Any size when prior imaging has documented 24 months of stability	N/A	No follow up	

***High risk** is defined by any of the following:

- Smoking history (any)
- First-degree relative with lung cancer
- Significant exposure to asbestos, uranium and/or radon, typically through high risk profession

Table 2: Follow-up recommendations for subsolid non-calcified pulmonary nodules

Subsolid nodule size	Solitary ground glass	Solitary part solid	Multiple subsolid
Less than 6 mm	No routine follow up	No routine follow up	1) 3 to 6 months 2) 24 months 3) 48 months
Greater than or equal to 6 mm or Lung-RADS 3	1) 6 to 12 months 2) Every 2 years thereafter for a total of 5 years	1) 3 to 6 months 2) Every year for 5 years	1) 3 to 6 months 2) Follow up based on most suspicious nodule (part solid or ground glass)

Tables 1 and 2, Abbreviation: Lung-RADS™, American College of Radiology Lung CT Screening Reporting and Data System. Adapted from MacMahon H, Naidich DP, Goo JM, et al. Radiology. 2017;284(1):228-243.

Pulmonary sequestration

Common Diagnostic Indications

Mediastinal and Hilar

Hilar enlargement on recent chest X-ray

Hoarseness, dysphonia or vocal cord weakness/paralysis

Initial evaluation when at least one of the following applies:

- Following laryngoscopy, when findings suggest recurrent laryngeal nerve dysfunction or identify a suspicious lesion
- Symptoms persisting longer than one month which are unexplained by laryngoscopy
- Presence of at least one of the following high-risk features:
  - Tobacco use
  - Alcohol abuse
  - Hemoptysis
  - History of radiation therapy
  - Known head and neck malignancy

Known hilar and/or mediastinal lymphadenopathy / mass

- Periodic follow-up

Mediastinal widening on recent chest X-ray

Penetrating atherosclerotic aortic ulcer

Superior vena cava (SVC) syndrome

Thoracic aorta evaluation

Acute aortic syndrome (any one of the following)

- Diagnosis and management
- Periodic surveillance in patients with established acute aortic syndrome undergoing medical management

Note: *Initial diagnosis of acute aortic syndrome is considered a medical emergency. This indication includes aortic rupture, dissection, pseudoaneurysm, mural hematoma, and penetrating ulcer mediastinal hematoma.*

Non-acute thoracic aorta (any one of the following)

- In patients with suspected thoracic aortic aneurysm
- In patients with confirmed thoracic aortic aneurysm with new or worsening signs/symptoms
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm who have not undergone imaging of the thoracic aorta within the preceding six months
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in preoperative planning)
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year
- In patients with confirmed aortic dissection or thoracic aortic aneurysm who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone CTA or MRA of the chest within the preceding 60 days

Note: *See acute aortic syndrome (section above) for complications of aneurysm including aortic dissection.*

Thymoma

- Note that approximately 15% of patients with myasthenia gravis will have a thymoma

Tracheobronchial lesion evaluation

Common Diagnostic Indications

Traumatic aortic injury

Vasculitis of the thoracic aorta or branch vessel

Pleural, Chest Wall and Diaphragm

Abnormal pleural fluid collection, including effusion, hemothorax, empyema and chylothorax

Note: *Ultrasound should be considered as the initial imaging modality and prior to a diagnostic or therapeutic pleural tap.*

Chest wall mass

Diaphragmatic hernia

Pleural mass

Pneumothorax – unexplained or recurrent

Thoracic outlet syndrome

Unexplained diaphragmatic elevation or immobility

References

1. Akira M, Yamamoto S, Inoue Y, Sakatani M. High-resolution CT of asbestosis and idiopathic pulmonary fibrosis. *AJR Am J Roentgenol*. 2003;181(1):163-169.
2. Alkadhi MD, Wildermuth S, Desbiolles L, et al. Vascular emergencies of the thorax after blunt and iatrogenic trauma: multi-detector row CT and three-dimensional imaging. *Radiographics*. 2004;24(5):1239-1255.
3. American Academy of Otolaryngology — Head and Neck Surgery Foundation. Choosing Wisely: CT scans or MRIs for Hoarseness. ABIM Foundation; February 21, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-academy-otolaryngology-head-and-neck-surgery-ct-scans-or-mris-for-hoarseness/. Accessed January 30, 2018.
4. American College of Radiology. ACR-NASCI-SPR Practice Parameter for the Performance AND Interpretation of Cardiac Magnetic Resonance Imaging (MRI). Revised 2016. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/MR-Cardiac.pdf. Accessed January 30, 2018.
5. American College of Radiology. ACR-NASCI-SPR Practice Parameter for the Performance of Body Magnetic Resonance Angiography (MRA). Revised 2015. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-mra.pdf. Accessed January 30, 2018.
6. American College of Radiology. ACR–SCBT-MR–SPR Practice Parameter for the Performance of Thoracic Computed Tomography (CT). Revised 2013. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/CT-Thoracic.pdf. Accessed January 30, 2018.
7. American College of Radiology. ACR-STR Practice Parameter for the Performance of High-Resolution Computed Tomography (HRCT) of the Lungs in Adults. Revised 2015. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/HRCT-Lungs.pdf. Accessed January 30, 2018.
8. American College of Radiology. Choosing Wisely: Imaging for suspected pulmonary embolism without moderate or high pretest probability. ABIM Foundation; April 4, 2012 and June 29, 2017. Available at http://www.choosingwisely.org/clinician-lists/american-college-radiology-imaging-for-suspected-pulmonary-embolism-without-moderate-or-high-pretest-probability/. Accessed January 30, 2018.
9. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. ABIM Foundation; December 4, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-society-hematology-limit-surveillance-ct-scans-following-treatment-for-lymphoma/. Accessed January 30, 2018.
10. American Thoracic Society. Diagnosis and initial management of nonmalignant diseases related to asbestos. *Am J Respir Crit Care Med*. 2004;170(6):691-715.
11. American Urological Association. Choosing Wisely: CT scans for low-risk, localized prostate cancer. ABIM Foundation;

June 11, 2015 and May 26, 2017. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed January 30, 2018.

12. Aquino SL. Imaging of metastatic disease to the thorax. *Radiol Clin N Am*. 2005;43(3):481-495.
13. Bach PB, Kattan MW, Thornquist MD, et al. Variations in lung cancer risk among smokers. *J Natl Cancer Inst.* 2003;95(6):470-478.
14. Bach PB, Mirkin JN, Oliver TK, et al. Benefits and harms of CT screening for lung cancer: a systematic review. *JAMA*. 2012;307(22):2418-2429.
15. Benamore RE, Warakaulle DR, Traill ZC. Imaging of pleural disease. *Imaging.* 2008;20(4):236–225.
16. Carrier M, Righini M, Wells PS, et al. Subsegmental pulmonary embolism diagnosed by computed tomography: incidence and clinical implications. A systematic review and meta-analysis of the management outcome studies. *J Thromb Haemost*. 2010;8(8):1716-22.
17. Center for Medicare and Medicaid Services. *National Coverage Determination (NCD) for Lung Cancer Screening with Low Dose Computed Tomography (LDCT) (210.14)*. Available at http://www.cms.gov/medicare-coverage-database/. Accessibility verified January 30, 2018.
18. Chiles C, Carr JJ. Vascular diseases of the thorax: evaluation with multidetector CT. Radiol Clin N Am. 2005;43(3):543-569.
19. Crawford F, Andras A, Welch K, et al. D-dimer test for excluding the diagnosis of pulmonary embolism. Cochrane Database Syst Rev. 2016(8):CD010864.
20. Cronin P, Sneider MB, Kazerooni SM, et al. MDCT of the left atrium and pulmonary veins in planning radiofrequency ablation for atrial fibrillation. AJR Am J Roentgenol. 2004;183(3):767-778
21. Dyer DS, Mohammed TL, Kirsch J, et al.; American College of Radiology Expert Panel on Thoracic Imaging. ACR appropriateness Criteria® chronic dyspnea: suspected pulmonary origin. *J Thorac Imaging*. 2013;28(5):W64-W66.
22. Fabia Valls MJ, van der Hulle T, den Exter PL, et al. Performance of a diagnostic algorithm based on a prediction rule, D-dimer and CT-scan for pulmonary embolism in patients with previous venous thromboembolism. A systematic review and meta-analysis. *Thromb Haemost*. 2015;113(2):406-13.
23. Fasola G, Belvedere O, Aita M, et al. Low-dose computed tomography screening for lung cancer and pleural mesothelioma in an asbestos-exposed population: baseline results of a prospective, nonrandomized feasibility trial--an Alpe-adria Thoracic Oncology Multidisciplinary Group Study (ATOM 002). Oncologist. 2007;12(10):1215-1224.
24. Fedullo PF, Tapson VF. The evaluation of suspected pulmonary embolism. *N Engl J Med.* 2003;349(13):1247-1256.
25. Fesmire FM, Brown MD, Espinosa JA, et al. Critical issues in the evaluation and management of adult patients presenting to the emergency department with suspected pulmonary embolism. *Ann Emerg Med.* 2011;57(6):628-52.e75.
26. Ghaye B, Szapiro D, Dacher JN, et al. Percutaneous ablation for atrial fibrillation: the role of cross-sectional imaging. *Radiographics*. 2003;23:S19-S33.
27. Gilkeson RC, Ciancibello L, Zahka K. Multidetector CT evaluation of congenital heart disease in pediatric and adult patients. *AJR Am J Roentgenol.* 2003;180(4):973-980.
28. Hansell DM, Bankier AA, MacMahon H, McLoud TC, Müller NL, Remy J. Fleischner Society: glossary of terms for thoracic imaging. *Radiology*. 2008;246(3):697-722.
29. Hartman TE. Radiologic evaluation of the solitary pulmonary nodule. *Radiol Clin N Am*. 2005;43(3):459-465.
30. Heitkamp DE, Albin MM, Chung JH, et al. ACR Appropriateness Criteria® acute respiratory illness in immunocompromised patients. *J Thorac Imaging*. 2015;30(3):W2-5.
31. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
32. Jongbloed MR, Dirksen MS, Bax JJ, et al. Atrial fibrillation: multi-detector row CT of pulmonary vein anatomy prior to radiofrequency catheter ablation–initial experience. *Radiology*. 2005; 234(3): 702-709.
33. Kanne JP, Jensen LE, Mohammed TL, et al.; American College of Radiology Expert Panel on Thoracic Imaging. ACR appropriateness Criteria® radiographically detected solitary pulmonary nodule. *J Thorac Imaging*. 2013;28(1):W1-W3.
34. Kazerooni EA. High-resolution CT of the lungs. *AJR Am J Roentgenol*. 2001;177(3):501-519.
35. Kazerooni EA, Austin JH, Black WC, et al. ACR-STR practice parameter for the performance and reporting of lung cancer screening thoracic computed tomography (CT): 2014 (Resolution 4). *J Thorac Imaging*. 2014;29(5):310-316.
36. Kirsch J, Brown RKJ, Henry TS, et al. ACR Appropriateness Criteria(R) Acute Chest Pain-Suspected Pulmonary Embolism. *J Am Coll Radiol.* 2017;14(5s):S2-s12.
37. Konstantinides SV, Torbicki A, Agnelli G, et al. 2014 ESC guidelines on the diagnosis and management of acute

pulmonary embolism. *Eur Heart J*. 2014;35(43):3033-69, 69a-69k.
38. Kruip MJ, Leclercq MGL, van der Heul C, Prins MH, Büller HR. Diagnostic strategies for excluding pulmonary embolism in clinical outcome studies. *Ann Intern Med*. 2003;138(12):941-951.
39. Lehman VT, Barrick BJ, Pittelkow MR, et al. Diagnostic imaging in paraneoplastic autoimmune multiorgan syndrome: retrospective single site study and literature review of 225 patients. *Int J Dermatol*. 2015;54(4):424-437.
40. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol.* 2011; 29(5):607-614.
41. Low DE, Mazzulli T, Marrie T. Progressive and nonresolving pneumonia. *Curr Opin Pulm Med*. 2005;11(3):247-252.
42. Mabie M, Wunderink RG. Use and limitations of clinical and radiologic diagnosis of pneumonia. *Semin Respir Infect*. 2003;18(2):72-79.
43. MacMahon H, Naidich DP, Goo JM, et al. Guidelines for Management of Incidental Pulmonary Nodules Detected on CT Images: From the Fleischner Society 2017. *Radiology*. 2017;284(1):228-243. (1527-1315 (Electronic)).
44. Macura KJ, Corl FM, Fishman EK, Bluemke DA. Pathogenesis in acute aortic syndromes: aortic aneurysm leak and rupture and traumatic aortic transection. *AJR Am J Roentegenol*. 2003;181(2):303-307.
45. Menéndez R, Perpiñá M, Torres A. Evaluation of nonresolving and progressive pneumonia. *Semin Respir Infect*. 2003;18(2):103-111.
46. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
47. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016;pii: S0302-2838(16):30470-5.
48. Moyer VA. Screening for lung cancer: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2014;160(5):330-338.
49. Munden RF, Bruzzi J. Imaging of non-small cell lung cancer. *Radiol Clin N Am*. 2005;43(3):467-480.
50. Naidich PM, Bankier AA, MacMahon H, et al. Recommendations for the Management of Subsolid Pulmonary Nodules Detected. *Radiology*. 2013;266(1).
51. National Institute for Health and Care Excellence, NICE guideline: Venous thromboembolic diseases: diagnosis, management and thrombophilia testing, (2015) United Kingdom, 26 pgs.
52. National Lung Screening Trial Research Team, Aberle DR, Adams AM, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med*. 2011 Aug 4;365(5):395-409.
53. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 3.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
54. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
55. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
56. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2):e57480.
57. Ost D, Fein AM, Feinsilver SH. The solitary pulmonary nodule. *N Engl J Med*. 2003;348(25):2535-2542.
58. Parker MS, Matheson TL, Rao AV, et al. Making the transition: the role of helical CT in the evaluation of potentially acute thoracic aortic injuries. *AJR Am J Roentgenol*. 2001;176(5):1267-1272.
59. Paul BC, Branski RC, Amin MR. Diagnosis and management of new-onset hoarseness: a survey of the American Broncho-Esophagological Association. *Ann Otol Rhinol Laryngol*. 2012;121(10):629-634.
60. Pipavath S, Godwin JD. Imaging of interstitial lung disease. *Radiol Clin N Am*. 2005;43(3):589-599.
61. Qaseem A, Snow V, Barry P, et al. Current diagnosis of venous thromboembolism in primary care: a clinical practice guideline from the American Academy of Family Physicians and the American College of Physicians. [Reprint in Ann Intern Med. 2007 Mar 20;146(6):454-8; PMID: 17371890]. *Ann Fam Med*. 2007;5(1):57-62.
62. Quiroz R, Kucher N, Zhou KH, et al. Clinical validity of a negative computed tomography scan in patients with suspected pulmonary embolism. *JAMA*. 2005;293(16):2012-2017.
63. Raja AS, Greenberg JO, Qaseem A, et al. Evaluation of Patients With Suspected Acute Pulmonary Embolism: Best Practice Advice From the Clinical Guidelines Committee of the American College of Physicians.[Summary for patients in

Ann Intern Med. 2015 Nov 3;163(9):I34; PMID: 26414918]. *Ann Intern Med*. 2015;163(9):701-11.

64. Ravenel JG, Rosenzweig KE, Kirsch J, et al. ACR Appropriateness Criteria non-invasive clinical staging of bronchogenic carcinoma. *J Am Coll Radiol*. 2014;11(9), 849-856.
65. Raymakers AJ, Mayo J, Marra CA, et al. Diagnostic strategies incorporating computed tomography angiography for pulmonary embolism: a systematic review of cost-effectiveness analyses. *J Thorac Imaging*. 2014;29(4):209-16.
66. Revel MP, Fournier LS, Hennebicque AS, et al. Can CT replace bronchoscopy in the detection of the site and cause of bleeding in patients with large or massive hemoptysis? *AJR Am J Roentgenol*. 2002;179(5):1217-1224.
67. Sadoughi B, Fried MP, Sulica L, Blitzer A. Hoarseness evaluation: a transatlantic survey of laryngeal experts. *Laryngoscope*. 2014;124(1):221-226. doi:10.1002/lary.24178.
68. Schwartz SR, Cohen SM, Dailey SH, et al. Clinical practice guideline: hoarseness (dysphonia). *Otolaryngol Head Neck Surg.* 2009;141(3 Suppl 2):S1-S31.
69. Society of Gynecologic Oncology. Choosing Wisely: Routine Imaging for Surveillance of Gynecologic Cancer. ABIM Foundation; October 31, 2013. Available at http://www.choosingwisely.org/clinician-lists/society-gynecologic-oncology-routine-imaging-for-surveillance-gynecologic-cancer/. Accessed January 30, 2018.
70. Stojanovska J, Carlos RC, Kocher KE, et al. CT Pulmonary Angiography: Using Decision Rules in the Emergency Department. *J Am Coll Radiol*. 2015;12(10):1023-9.
71. Streiff MB, Agnelli G, Connors JM, et al. Guidance for the treatment of deep vein thrombosis and pulmonary embolism. *J Thromb Thrombolysis.* 2016;41(1):32-67.
72. Talti S, Yucel EK, Lipton MJ. CT and MR imaging of the thoracic aorta: current techniques and clinical applications. *Radiol Clin N Am*. 2004;42(3):565-585.
73. Tan BB, Flaherty KR, Kazerooni EA, et al. The solitary pulmonary nodule. *Chest*. 2003;123(1):89S-96S.
74. Tarver RD, Teague SD, Heitkamp DE, Conces DJ Jr. Radiology of community-acquired pneumonia. *Radiol Clin N Am*. 2005;43(3):497-512.
75. Tatli S, Yucel EK, Lipton MJ. CT and MR imaging of the thoracic aorta: current techniques and clinical applications. *Radiol Clin N Am*. 2004;42(3):565-585.
76. Therasse E, Soulez G, Giroux MF, et al. Stent-graft placement for the treatment of thoracic aortic diseases. *Radiographics*. 2005;25(1):157-173.
77. Tunick PA, Krinsky GA, Lee VS, Kronzon I. Diagnostic imaging of thoracic aortic atherosclerosis. *AJR Am J Roentgenol*. 2000;174(4):1119-1125.
78. Tüzün E, Dalmau J. Limbic encephalitis and variants: classification, diagnosis and treatment. *Neurologist*. 2007;13(5):261-271.
79. Uresandi F, Monreal M, Garcia-Bragado F, et al. National Consensus on the Diagnosis, Risk Stratification and Treatment of Patients with Pulmonary Embolism. Spanish Society of Pneumology and Thoracic Surgery (SEPAR). Society Espanola Internal Medicine (SEMI). Spanish Society of Thrombosis and Haemostasis (SETH). Spanish Society of Cardiology (ESC). Spanish Society of Medicine Accident and Emergency (SEMES). Spanish Society of Angiology and Surgery Vascular (SEACV). *Arch Bronconeumol*. 2013;49(12):534-47.
80. van Es J, Beenen LF, Douma RA, et al. A simple decision rule including D-dimer to reduce the need for computed tomography scanning in patients with suspected pulmonary embolism. *J Thromb Haemost.* 2015;13(8):1428-35.
81. van Es N, van der Hulle T, van Es J, et al. Wells Rule and d-Dimer Testing to Rule Out Pulmonary Embolism: A Systematic Review and Individual-Patient Data Meta-analysis. *Ann Intern Med*. 2016;165(4):253-61.
82. Wells PS, Anderson DR, Rodger M, et al. Derivation of a simple clinical model to categorize patients probability of pulmonary embolism: increasing the models utility with the SimpliRED D-dimer. *Thromb Haemost*. 2000;83(3):416-20.
83. Wells PS, Ginsberg JS, Anderson DR, et al. Use of a clinical model for safe management of patients with suspected pulmonary embolism. *Ann Intern Med.* 1998;129(12):997-1005.
84. Yu H. Management of pleural effusion, empyema, and lung abscess. *Semin Intervent Radiol*. 2011;28(1):75-86.

CT Angiography (CTA) Chest (Non-Coronary)

CPT Codes

71275..... CTA of chest (non-coronary), with contrast material(s), including non-contrast images, if performed, and image post-processing

Standard Anatomic Coverage

- Scan coverage varies depending on the clinical indication. This exam does not include cardiac and coronary artery indications.
- Chest CTA may be used for anatomic depiction from the pulmonary apices through the costophrenic sulci.

Technology Considerations

Advantages of CTA:

- Rapidly acquired exam, with excellent anatomic detail afforded by most multidetector CT scanners

Disadvantages of CTA:

- Potential complications from use of intravascular iodinated contrast administration

Biosafety Issues:

- Ordering and imaging providers are responsible for considering safety issues prior to the CTA exam. One of the most significant considerations is the requirement for intravascular iodinated contrast material, which may have an adverse effect on patients with a history of documented allergic contrast reactions or atopy, as well as on individuals with renal impairment, who are at greater risk for contrast-induced nephropathy.

Ordering Issues:

- CTA chest is not appropriate for cardiac and coronary artery imaging. Please review guidelines for cardiac CT and CCTA.
- Pulmonary embolus is rare in the absence of elevated blood D-dimer levels and certain specific risk factors.

Common Diagnostic Indications

Indications for chest CTA are contained in general chest, thoracic aorta and great vessel, and pulmonary artery and vein.

General Chest

Developmental anomalies of the thoracic vasculature

- Examples of congenital thoracic vascular anomalies include but are not limited to the following:
  - Aortic coarctation
  - Double aortic arch
  - Hypoplastic or atretic pulmonary arteries
  - Inferior vena caval interruption
  - Partial anomalous pulmonary venous return
  - Persistent left-sided superior vena cava
  - Right-sided aortic arch
  - Total anomalous pulmonary venous return
  - Truncus arteriosus

Post-traumatic vascular injury

Post-operative or post-procedure evaluation

Common Diagnostic Indications

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Systemic venous thrombosis or occlusion, including superior vena cava (SVC) syndrome

Subclavian steal syndrome

Thoracic outlet syndrome

Vascular involvement from neoplasm in the chest

Thoracic Aorta and Great Vessel

Atheromatous disease

- Evaluation of the thoracic aorta as a source of distal emboli when transthoracic and/or transesophageal echocardiography are non-diagnostic

Hematoma

Post-operative or post-procedure evaluation

Stent graft evaluation, including detection of an endoleak

- Pre-procedure assessment and post-procedure follow-up

Thoracic aorta evaluation

Acute aortic syndrome

(any <u>one</u> of the following)

- Diagnosis and management
- Periodic surveillance in patients with established acute aortic syndrome undergoing medical management

Note: *Initial diagnosis of acute aortic syndrome is considered a medical emergency. This guideline includes aortic rupture, dissection, pseudoaneurysm, mural hematoma, and penetrating ulcer mediastinal hematoma*

Non-acute thoracic aorta

(any <u>one</u> of the following)

- In patients with suspected thoracic aortic aneurysm
- In patients with confirmed thoracic aortic aneurysm with new or worsening signs/symptoms
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm who have not undergone imaging of the thoracic aorta within the preceding six months
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in preoperative planning)
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year
- In patients with confirmed aortic dissection or thoracic aortic aneurysm who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone CTA or MRA of the chest within the preceding 60 days

Note: *See acute aortic syndrome section for complications of aneurysm including aortic dissection*

Vasculitis

Common Diagnostic Indications

Pulmonary Artery and Vein

Pulmonary arterial hypertension

Pulmonary arteriovenous malformation (AVM)

Pulmonary embolism (PE)

- PE likely based on modified Wells* (mWells) criteria
- PE unlikely based on mWells* criteria with a positive D-dimer

** mWells criteria: PE likely—greater than 4 points; PE unlikely—less than or equal to 4 points.*[20] *More information available at:* https://www.ncbi.nlm.nih.gov/pubmed/10744147

Pulmonary sequestration

References

1. American College of Radiology. ACR–NASCI–SIR–SPR Practice Parameter for the Performance and Interpretation of Body Computed Tomography Angiography (CTA). Revised 2016. Available at https://www.acr.org/-/media/ACR/Files/Practice-Parameters/body-cta.pdf. Accessed January 30, 2018.
2. Carrier M, Righini M, Wells PS, et al. Subsegmental pulmonary embolism diagnosed by computed tomography: incidence and clinical implications. A systematic review and meta-analysis of the management outcome studies. *J Thromb Haemost*. 2010;8(8):1716-22.
3. Crawford F, Andras A, Welch K, et al. D-dimer test for excluding the diagnosis of pulmonary embolism. *Cochrane Database Syst Rev*. 2016(8):CD010864.
4. Fabia Valls MJ, van der Hulle T, den Exter PL, et al. Performance of a diagnostic algorithm based on a prediction rule, D-dimer and CT-scan for pulmonary embolism in patients with previous venous thromboembolism. A systematic review and meta-analysis. *Thromb Haemost*. 2015;113(2):406-13.
5. Fesmire FM, Brown MD, Espinosa JA, et al. Critical issues in the evaluation and management of adult patients presenting to the emergency department with suspected pulmonary embolism. *Ann Emerg Med.* 2011;57(6):628-52.e75.
6. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
7. Ketai LH, Mohammed TL, Kirsch J, et al.; American College of Radiology Expert Panel on Thoracic Imaging. ACR Appropriateness Criteria® Hemoptysis. *J Thorac Imaging*. 2014;29(3):W19-W22.
8. Kirsch J, Brown RKJ, Henry TS, et al. ACR Appropriateness Criteria(R) Acute Chest Pain-Suspected Pulmonary Embolism. *J Am Coll Radiol.* 2017;14(5s):S2-s12.
9. Konstantinides SV, Torbicki A, Agnelli G, et al. 2014 ESC guidelines on the diagnosis and management of acute pulmonary embolism. *Eur Heart J*. 2014;35(43):3033-69, 69a-69k.
10. National Institute for Health and Care Excellence, NICE guideline: Venous thromboembolic diseases: diagnosis, management and thrombophilia testing, (2015) United Kingdom, 26 pgs.
11. Qaseem A, Snow V, Barry P, et al. Current diagnosis of venous thromboembolism in primary care: a clinical practice guideline from the American Academy of Family Physicians and the American College of Physicians. [Reprint in Ann Intern Med. 2007 Mar 20;146(6):454-8; PMID: 17371890]. *Ann Fam Med*. 2007;5(1):57-62.
12. Raja AS, Greenberg JO, Qaseem A, et al. Evaluation of Patients With Suspected Acute Pulmonary Embolism: Best Practice Advice From the Clinical Guidelines Committee of the American College of Physicians. [Summary for patients in Ann Intern Med. 2015 Nov 3;163(9):I34; PMID: 26414918]. Ann Intern Med. 2015;163(9):701-11.
13. Raymakers AJ, Mayo J, Marra CA, et al. Diagnostic strategies incorporating computed tomography angiography for pulmonary embolism: a systematic review of cost-effectiveness analyses. *J Thorac Imaging*. 2014;29(4):209-16.
14. Schoepf UJ, Costello P. CT angiography for diagnosis of pulmonary embolism: state of the art. *Radiology*. 2004; 230(2):329-337.
15. Stojanovska J, Carlos RC, Kocher KE, et al. CT Pulmonary Angiography: Using Decision Rules in the Emergency

Department. *J Am Coll Radiol*. 2015;12(10):1023-9.

16. Streiff MB, Agnelli G, Connors JM, et al. Guidance for the treatment of deep vein thrombosis and pulmonary embolism. *J Thromb Thrombolysis.* 2016;41(1):32-67.
17. Uresandi F, Monreal M, Garcia-Bragado F, et al. National Consensus on the Diagnosis, Risk Stratification and Treatment of Patients with Pulmonary Embolism. Spanish Society of Pneumology and Thoracic Surgery (SEPAR). Society Espanola Internal Medicine (SEMI). Spanish Society of Thrombosis and Haemostasis (SETH). Spanish Society of Cardiology (ESC). Spanish Society of Medicine Accident and Emergency (SEMES). Spanish Society of Angiology and Surgery Vascular (SEACV). *Arch Bronconeumol*. 2013;49(12):534-47.
18. van Es J, Beenen LF, Douma RA, et al. A simple decision rule including D-dimer to reduce the need for computed tomography scanning in patients with suspected pulmonary embolism. *J Thromb Haemost.* 2015;13(8):1428-35.
19. van Es N, van der Hulle T, van Es J, et al. Wells Rule and d-Dimer Testing to Rule Out Pulmonary Embolism: A Systematic Review and Individual-Patient Data Meta-analysis. *Ann Intern Med*. 2016;165(4):253-61.
20. Wells PS, Anderson DR, Rodger M, et al. Derivation of a simple clinical model to categorize patients probability of pulmonary embolism: increasing the models utility with the SimpliRED D-dimer. *Thromb Haemost*. 2000;83(3):416-20.
21. Wells PS, Ginsberg JS, Anderson DR, et al. Use of a clinical model for safe management of patients with suspected pulmonary embolism. *Ann Intern Med.* 1998;129(12):997-1005.

Magnetic Resonance Imaging (MRI) Chest

CPT Codes

71550..... MRI chest, without contrast

71551..... MRI chest, with contrast

71552..... MRI chest, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Chest MRI studies are often performed as problem-solving exams, following chest CT. In these circumstances, anatomic coverage will depend on the specific indication for the study.
- MRI of the chest should not be performed for imaging of the heart. For cardiac indications, see Cardiac MRI guideline section and corresponding CPT codes 75557–75563, 75565.

Technology Considerations

Advantages of chest MRI:

- Chest MRI may be helpful after a CT in the following scenarios:
  - Defining mediastinal and hilar lymphadenopathy (particularly after an unenhanced chest CT exam)
  - Determining direct lung tumor invasion into the mediastinum and hilar structures, without the need for iodinated contrast material in CT
  - Assessing spinal canal extension from a postero-medially located thoracic mass
  - Evaluating a suspected Pancoast tumor (also referred to as apical pleuro-pulmonary groove or superior pulmonary sulcus tumors) for direct chest wall extension, given the multiplanar capability of MRI

Disadvantages of chest MRI:

- Lung lesions are usually better imaged with CT when compared with MRI, given the superior spatial resolution of CT.
- MRI should not be performed in patients with certain implanted devices that are not MRI compatible, such as pacemakers.

Ordering issues:

- For initial evaluation of most thoracic lesions, such as pulmonary nodules and masses, chest CT is considered the study of choice.
- Contrast utilization for chest MRI is at the discretion of the ordering and imaging providers.
- For cardiac and coronary artery imaging, see Cardiac MRI guidelines.

Common Diagnostic Indications

Developmental anomalies of the thoracic vasculature

- Examples of congenital thoracic vascular anomalies include but are not limited to the following:
  - Aortic coarctation
  - Double aortic arch
  - Hypoplastic or atretic pulmonary arteries
  - Inferior vena caval interruption
  - Partial anomalous pulmonary venous return
  - Persistent left-sided superior vena cava
  - Right-sided aortic arch
  - Total anomalous pulmonary venous return
  - Truncus arteriosus

Common Diagnostic Indications

Documented malignancy – primary neoplasm and metastatic disease

- For staging and periodic surveillance
- To evaluate the mediastinum, hila, pericardium, heart, chest wall and paraspinal region

Horner's syndrome

Mediastinal and hilar mass lesions – when abnormal findings cannot be thoroughly evaluated with CT

- Particularly in patients who have an allergic history to intravascular iodinated CT contrast material or who have renal insufficiency and thus are at greater risk for contrast-induced nephropathy
- Chest MRI may be helpful in the following circumstances:
  - To differentiate mediastinal and hilar lesions from vascular structures; **OR**
  - To assess vascular invasion by tumor; **OR**
  - To detect spinal extension from a postero-medially located chest mass

Pancoast tumor

- To evaluate for chest wall extension at the superior pulmonary sulcus

Superior vena cava syndrome

Thoracic aorta evaluation

Acute aortic syndrome (any <u>one</u> of the following)

- Diagnosis and management
- periodic surveillance in patients with established acute aortic syndrome undergoing medical management

Note: *Initial diagnosis of acute aortic syndrome is considered a medical emergency. This guideline includes aortic rupture, dissection, pseudoaneurysm, mural hematoma, and penetrating ulcer mediastinal hematoma.*

Non-acute thoracic aorta (any <u>one</u> of the following)

- In patients with suspected thoracic aortic aneurysm
- In patients with confirmed thoracic aortic aneurysm with new or worsening signs/symptoms
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm who have not undergone imaging of the thoracic aorta within the preceding six months
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in preoperative planning)
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year
- In patients with confirmed aortic dissection or thoracic aortic aneurysm who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone CTA or MRA of the chest within the preceding 60 days

Note: *See acute aortic syndrome (section above) for complications of aneurysm including aortic dissection.*

Thoracic outlet syndrome

Thymoma evaluation or history of myasthenia gravis

Note: *Approximately 15% of patients with myasthenia gravis will have a thymoma.*

References

1. American Academy of Otolaryngology — Head and Neck Surgery Foundation. Choosing Wisely: CT scans or MRIs for Hoarseness. ABIM Foundation; February 21, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-academy-otolaryngology-head-and-neck-surgery-ct-scans-or-mris-for-hoarseness/ Accessed August 25, 2016.
2. Ghaye B, Szapiro D, Dacher JN, et al. Percutaneous ablation for atrial fibrillation: the role of cross-sectional imaging. *Radiographics*. 2003;23:S19-S33.
3. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
4. Konen E, Merchant N, Provost Y, et al. Coarctation of the aorta before and after correction: the role of cardiovascular MRI. *AJR Am J Roentgenol*. 2004;182:1333-1339.
5. Kreitner KF, Ley S, Kauczor HU, et al. Chronic thromboembolic pulmonary hypertension: pre- and postoperative assessment with breath-hold MRI imaging techniques. *Radiology*. 2004;232(2):535-543.
6. Kunz RP, Oberholzer K, Kuroczynski W, et al. Assessment of chronic aortic dissection: contribution of different ECGgated breath- hold MRI techniques. *AJR Am J Roentgenol*. 2004;182(5):1319-1326.
7. Munden RF, Bruzzi J. Imaging of non-small cell lung cancer. *Radiol Clin N Am*. 2005;43(3):467-480.
8. Orel SG, Schnall MD. MR imaging of the breast for the detection, diagnosis, and staging of breast cancer. *Radiology*. 2001;220(1):13-30.
9. Ravenel JG, Rosenzweig KE, Kirsch J, et al. ACR Appropriateness Criteria non-invasive clinical staging of bronchogenic carcinoma. *J Am Coll Radiol*. 2014;11(9), 849-856.
10. Talti S, Yucel EK, Lipton MJ. CT and MR imaging of the thoracic aorta: current techniques and clinical applications. *Radiol Clin N Am*. 2004;42(3):565-585.
11. Tan BB, Flaherty KR, Kazerooni EA, et al. The solitary pulmonary nodule. *Chest*. 2003;123(1):89S-96S.
12. Tarver RD, Teague SD, Heitkamp DE, Conces DJ Jr. Radiology of community-acquired pneumonia. *Radiol Clin N Am*. 2005;43(3):497-512.
13. Tatli S, Yucel EK, Lipton MJ. CT and MR imaging of the thoracic aorta: current techniques and clinical applications. *Radiol Clin N Am*. 2004;42(3):565-585.
14. Tunick PA, Krinsky GA, Lee VS, Kronzon I. Diagnostic imaging of thoracic aortic atherosclerosis. *AJR Am J Roentgenol*. 2000;174(4):1119-1125.

MR Angiography (MRA) Chest

CPT Codes

71555..... MRA of chest (excluding the myocardium) without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage varies depending on the clinical indication
- Chest MRA may be used for vascular anatomic depiction, from the pulmonary apices through the costophrenic sulci.

Technology Considerations

Advantages of Chest MRA:

- Use of MR imaging is advantageous over CT in avoiding ionizing radiation and allowing for direct multiplanar imaging.

Disadvantages of Chest MRA:

- With MRA, artifact due to patient motion may have a particularly significant impact on exam quality.
- MRA cannot be performed in patients with certain implanted devices that are not MRI compatible, such as pacemakers.

Common Diagnostic Indications

Chest MRA indications are contained in common chest MRA, thoracic aorta and great vessel, and pulmonary artery and vein.

Common Chest MRA

Developmental anomalies of the thoracic vasculature

- Examples of congenital thoracic vascular anomalies include but are not limited to the following:
  - Aortic coarctation
  - Double aortic arch
  - Hypoplastic or atretic pulmonary arteries
  - Inferior vena caval interruption
  - Partial anomalous pulmonary venous return
  - Patent ductus arteriosus
  - Persistent left-sided superior vena cava
  - Right-sided aortic arch
  - Total anomalous pulmonary venous return
  - Transposition of the great vessels
  - Truncus arteriosus

Post-traumatic vascular injury

Subclavian steal

Systemic venous thrombosis or occlusion, including superior vena cava (SVC) syndrome

Thoracic outlet syndrome

Vascular involvement from neoplasm in the chest

Common Diagnostic Indications

Thoracic Aorta and Great Vessel

Atheromatous disease

(All of the following)

- When CT is contraindicated
- Evaluation of the thoracic aorta as a source of distal emboli when transthoracic and/or transesophageal echocardiography are non-diagnostic

Post-operative or post-procedure evaluation

Stent graft evaluation, including detection of an endoleak

- Pre-procedure assessment and post-procedure follow-up

Thoracic aorta evaluation

Acute aortic syndrome (any one of the following)

- Diagnosis and management
- periodic surveillance in patients with established acute aortic syndrome undergoing medical management

Note: *Initial diagnosis of acute aortic syndrome is considered a medical emergency. This guideline includes aortic rupture, dissection, pseudoaneurysm, mural hematoma, and penetrating ulcer mediastinal hematoma*

Non-acute thoracic aorta (any one of the following)

- In patients with suspected thoracic aortic aneurysm
- In patients with confirmed thoracic aortic aneurysm with new or worsening signs/symptoms
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm who have not undergone imaging of the thoracic aorta within the preceding six months
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in preoperative planning)
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year
- In patients with confirmed aortic dissection or thoracic aortic aneurysm who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone CTA or MRA of the chest within the preceding 60 days

Note: *See acute aortic syndrome (section above) for complications of aneurysm including aortic dissection.*

Vasculitis

Pulmonary Artery and Vein

Pulmonary arterial hypertension

Pulmonary arteriovenous malformation (AVM)

Pulmonary sequestration

References

1. Ho VB, Corse WR, Hood MN, Rowedder AM. Magnetic resonance angiography of the thoracic vessels. *Semin Ultrasound CT MR*. 2003 Aug;24(4):192-216.
2. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
3. Maki DD, Siegelman ES, Roberts DA, Baum RA, Gefter WB. Pulmonary arteriovenous malformations: three-dimensional gadolinium-enhanced MR angiography-initial experience. Radiology. 2001;219(1):243-246.
4. Pereles FS, McCarthy RM, Baskaran V, et al. Thoracic aortic dissection and aneurysm: evaluation with nonenhanced true FISP MR angiography in less than 4 minutes. *Radiology*. 2002;223(1):270-274.
5. Sonnet S, Buitrago-Téllez CH, Scheffler K, et al. Dynamic time-resolved contrast-enhanced two-dimensional MR projection angiography of the pulmonary circulation: standard technique and clinical applications. *AJR Am J Roengenol.* 2002;179(1):159-165.
6. Wu C, Zhang J, Ladner CJ, et al. Subclavian steal syndrome: diagnosis with perfusion metrics from contrast-enhanced MR angiographic bolus-timing examination – initial experience. *Radiology*. 2005;235(3):927-933.

Magnetic Resonance Imaging (MRI) Breast Also referred to as MR Mammography (MRM)

CPT Codes

77058..... MRI of breast, without and/or with contrast material(s); unilateral

77059..... MRI of breast, without and/or with contrast material(s); bilateral

Technology Considerations

Technique:

- It is strongly recommended that breast MRI examinations be performed with a dedicated breast coil.

Limitations:

- Breast MRI is not recommended as a screening technique in patients with average-risk for breast cancer.
- Breast MRI is not recommended to assess suspicious breast lesions in order to avoid a biopsy.
- Breast MRI should not be used to differentiate cysts from solid lesions, which is well evaluated with ultrasound.

Additional Comments:

- A bilateral MRI study of the breast is correctly coded to CPT 77059. Requesting two unilateral studies (77058) to perform a bilateral exam is inappropriate. Billing 77058 two times for the same date of service or separately over subsequent days in order to describe a bilateral procedure fragments the service into its component parts and is not allowed.

Common Diagnostic Indications

Breast MRI indications are contained in diagnostic evaluation and annual screening with breast carcinoma diagnosis and breast implant rupture not requiring a breast carcinoma diagnosis.

For Breast Carcinoma: Diagnostic Evaluation

BI-RADS category 3 findings

- A single follow-up MRI may be performed at 6 months following a breast MRI with BI-RADS category 3 findings

Differentiation of palpable mass(es) from surgical scar tissue

- Following breast surgery, breast reconstruction or radiation therapy

Invasion of breast cancer deep to fascia

- MRI evaluation of breast prior to surgical treatment may be useful in both mastectomy and breast conservation candidates to define the relationship of the tumor to the fascia and its extension into the pectoralis major, serratus anterior, and/or intercostal muscles

Invasive carcinoma and ductal carcinoma in situ (DCIS)

- To determine the extent of disease and the presence of multifocality and multicentricity

Lesion characterization

- When other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer, and biopsy could not be performed (e.g., possible distortion on only one mammographic view without a sonographic correlate)

Common Diagnostic Indications

Metastatic cancer

- Primary is unknown and suspected to be of breast origin.
- In patients presenting with metastatic disease and/or axillary adenopathy and no mammographic or physical findings of primary breast carcinoma.

Neoadjuvant chemotherapy

- MR mammography may be performed before, during and after chemotherapy to assess response to treatment and extent of residual disease, prior to surgery.

Post-lumpectomy with positive margins

- To evaluate for residual disease in patients whose pathology specimens demonstrate close or positive margins for residual disease

Post-operative tissue reconstruction

- To evaluate suspected cancer recurrence in patients with tissue transfer flaps (rectus, latissimus, dorsi, and gluteal)

Recurrence of breast cancer

- In women with a prior history of breast cancer and suspicion of recurrence when clinical, mammographic, and/or sonographic findings are inconclusive

For Breast Carcinoma: Annual Screening

Individuals who received radiation to the chest between ages 10 and 30 years

Individuals with a genetic predisposition to breast cancer, in either themselves or a first degree relative, which may include any of the following:

- Bannayan-Riley-Ruvalcaba syndrome
- BRCA1 and BRCA2
- Cowden syndrome
- Li-Fraumeni syndrome

Individuals known to have any of the following genetic mutations:

- ATM
- CDH1
- CHEK2
- PALB2

History of lobular carcinoma in situ (LCIS), atypical ductal hyperplasia (ADH) or atypical lobular hyperplasia (ALH) on biopsy

Lifetime risk ~ 20% or greater

- As defined by BRCAPRO or other models that are largely dependent on family history

For Breast Implant Rupture: Not Requiring Breast Carcinoma Diagnosis

Breast MRI is indicated to screen for asymptomatic rupture of a silicone breast implant beginning 3 years after implantation and every other year thereafter

Evaluation of symptomatic patients with breast implants, for detection of implant rupture

References

1. Afonso N, Bouwman D. Lobular carcinoma in situ. *Eur J Cancer Prev*. 2008;17(4):312-316.
2. Alberta Provincial Breast Tumour Team, Magnetic resonance imaging for breast cancer screening, pre-operative assessment, and follow-up. Edmonton (Alberta): Alberta Health Services, Cancer Care; 2012 Jan. 19 p. (Clinical practice guideline; no. BR-007).
3. American College of Radiology. ACR Practice Guideline for the Performance of Contrast-Enhanced Magnetic Resonance Imaging (MRI) of the Breast. Updated 2013. Available at http://www.acr.org/~/media/ACR/Documents/PGTS/guidelines/ MRI_Breast.pdf. Accessed August 25, 2016
4. Bahrs SD, Baur A, Hattermann V, et al. BI-RADS 3 lesions at contrast-enhanced breast MRI: is an initial short-interval follow-up necessary? *Acta Radiol*. 2014;55(3):260-265.
5. Berg WA, Gutierrez L, NessAiver MS, et al. Diagnostic accuracy of mammography, clinical examination, US, and MR imaging in preoperative assessment of breast cancer. *Radiology*. 2004;233(3), 830-849.
6. Boisserie-Lacroix M, Ziade C, Hurtevent-Labrot G, et al. Is a one-year follow-up an efficient method for better management of MRI BI-RADS® 3 lesions? *Breast*. 2016;27:1-7.
7. Cardoso F, Loibl S, Pagani O, et al. The European Society of Breast Cancer Specialists recommendations for the management of young women with breast cancer. *Eur J Cancer*. 2012;48(18):3355-3377.
8. Chikarmane SA, Birdwell RL, Poole PS, et al. Characteristics, Malignancy Rate, and Follow-up of BI-RADS Category 3 Lesions Identified at Breast MR Imaging: Implications for MR Image Interpretation and Management. *Radiology*. 2016;280(3):707-15.
9. Degnim AC, Visscher DW, Berman HK, et al. Stratification of breast cancer risk in women with atypia: a Mayo cohort study. *J Clin Oncol*. 2007;25(19):2671-2677.
10. Fancellu A, Turner RM, Dixon JM, et al. Meta-analysis of the effect of preoperative breast MRI on the surgical management of ductal carcinoma in situ. *Br J Surg*. 2015;102(8):883-893.
11. Hlawatsch A, Teifke A, Schmidt M, Thelan M. Preoperative assessment of breast cancer: sonography versus MR imaging. *AJR Am J Roengenol*. 2002;179(6):1493-1501.
12. Huang W, Fisher PR, Dulaimy K, et al. Detection of breast malignancy: diagnostic MR protocol for improved specificity. *Radiology*. 2004;232(2):585-591.
13. IKNL (Comprehensive Cancer Centre the Netherlands) and the Knowledge Institute of Medical Specialists (KiMS). (2012). Breast Cancer - Imaging BI-RADS: Reporting in relation to the Breast Imaging Reporting and Data System (breast cancer): Richtlijnen. Available at http://richtlijnendatabase.nl/en/richtlijn/breast_cancer/diagnostics/imaging/bi-rads.html Accessed August 30, 2016
14. Kriege M, Brekelmans CT, Boetes C, et al. Efficacy of MRI and mammography for breast-cancer screening in women with a familial or genetic predisposition. *N Engl Med*. 2004;351(5):427-437.
15. Kuhl CK. Current status of breast MR imaging. Part 2. clinical applications. *Radiology*. 2007;244(3):672-691.
16. Lee CH, Dershlaw DD, Kopans D, et al. Breast cancer screening with imaging: recommendations from the Society of Breast Imaging and the ACR on the use of mammography, breast MRI, breast ultrasound, and other technologies for the detection of clinically occult breast cancer. *J Am Coll Radiol*. 2010;7(1):18-27.
17. Lee CH. Problem solving MR imaging of the breast. *Radiol Clin N Am*. 2004;42(5):919-934.
18. Lee JM, Orel SG, Czerniecki BJ, Solin LJ, Schnall MD. MRI before reexcision surgery in patients with breast cancer. *AJR Am J Roengenol*. 2004;182(2):473-480.
19. Lee SG, Orel SG, Woo IJ, et al. MR imaging screening of the contralateral breast in patients with newly diagnosed breast cancer: preliminary results. *Radiology*. 2003;226(3):773-778.
20. Schnall M, Orel S. Breast MR imaging in the diagnostic setting. *Magn Reson Imaging Clin N Am*. 2006;14(3):329-337.
21. Song JW, Kim HM, Bellfi LT, Chung KC. The effect of study design biases on the diagnostic accuracy of magnetic resonance imaging for detecting silicone breast implant ruptures: a meta-analysis. *Plast Reconstr Surg*. 2011;127(3):1029-1044.
22. U.S. Food and Drug Administration (FDA). Update on the safety of silicone gel-filled breast implants. Executive Summary. June 2011. Available at http://www.fda.gov/downloads/MedicalDevices/ProductsandMedicalProcedures/ImplantsandProsthetics/BreastImplants/UCM260090.pdf Accessed August 26, 2016
23. Willey SC, Cocilovo C. Screening and follow-up of the patient at high risk for breast cancer. *Obstet Gynecol*. 2007;110(6):1404-1416.
24. Zhou WB, Xue DQ, Liu XA, et al. The influence of family history and histological stratification on breast cancer risk in women with benign breast disease: a meta-analysis. *J Cancer Res Clin Oncol*. 2011 Jul;137(7):1053-60.

Nuclear Cardiology
Myocardial Perfusion Imaging

CPT Codes

78451..... Myocardial perfusion imaging, tomographic (SPECT) (including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); single study, at rest or stress (exercise or pharmacologic)

78452..... Myocardial perfusion imaging, tomographic (SPECT) (including attenuation correction, qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); multiple studies, at rest and/or stress (exercise or pharmacologic) and/or redistribution and/or rest reinjection

78453..... Myocardial perfusion imaging, planar (including qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); single study, at rest or stress (exercise or pharmacologic)

78454..... Myocardial perfusion imaging, planar (including qualitative or quantitative wall motion, ejection fraction by first pass or gated technique, additional quantification, when performed); multiple studies, at rest and/or stress (exercise or pharmacologic) and/or redistribution and/or rest reinjection

Commonly Used Radiopharmaceuticals

- Thallium-201 Chloride
- Technetium-99m Sestamibi
- Technetium-99m Tetrofosmin

Uses of Myocardial Perfusion Imaging (MPI)

- The primary use of MPI is in the diagnosis, exclusion or evaluation of obstructive coronary artery disease (CAD).
- MPI is also used for management of established coronary artery disease.
- MPI may be used for assessment of myocardial viability in patients who have had myocardial infarction.

Imaging Considerations

- A recent EKG is strongly recommended, preferably within 30 days of request for a Myocardial Perfusion Imaging exam. The findings on the resting EKG may be important in determining the need for imaging, the selection of the appropriate imaging protocol and may also show evidence of ischemia at rest or interval myocardial infarction.
- Age, gender and the character of the chest pain provide useful predictors of CAD, as stratified in Table 1 below.

Table 1*: Pre-Test Probability of Coronary Artery Disease by Age, Gender and Symptoms

Very Low < 5% Low Probability < 10%	Intermediate probability 10-90% High Probability > 90%

*Reference for Table 1: Gibbons RJ, Balady GJ, Beasley JW, et al. ACC/AHA Guidelines for Exercise Testing: Executive Summary. Circulation. 1997;96:345-354.

Age (yr)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Non-Anginal Chest Pain	Asymptomatic
30-39	Men	Intermediate	Intermediate	Low	Very Low
	Women	Intermediate	Very Low	Very Low	Very Low
40-49	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Low	Very Low	Very Low
50-59	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Intermediate	Low	Very Low
60-69	Men	High	Intermediate	Intermediate	Low
	Women	High	Intermediate	Intermediate	Low

Imaging Considerations

Myocardial Perfusion Imaging and Stress Echocardiography may provide useful information on Coronary Heart Disease. Comparison data on Sensitivity and Specificity are provided in Table 2 below. Due to regional variation in technical expertise and interpretive proficiency, the clinician should use the diagnostic imaging modality that has been proven most accurate in his/her practices.

Table 2**: Comparison of Non-Invasive Diagnostic Imaging

** Reference for Table 2: Zaret BL, Bellar GA. *Clinical Nuclear Cardiology*. 3rd Edition. Philadelphia: Elsevier Mosby Publishers; 2005, page 539

	Nuclear Imaging Sensitivity (%)	Stress Echo Sensitivity (%)	Nuclear Imaging Specificity (%)	Stress Echo Specificity (%)
Exercise (7 studies)	83%	78%	83%	91%
Dobutamine (8 studies)	86%	80%	73%	86%
Adenosine (3 studies)	89%	63%	73%	86%
Dipyridamole (4 studies)	83%	68%	88%	89%

Several clinical indications listed for Myocardial Perfusion Imaging include standard methods of risk assessment, such as the SCORE (Systematic Coronary Risk Evaluation) or the Framingham risk score calculation. These risk calculation systems include consideration of the following factors:

Age	Sex
Abnormal Lipid Profile	Hypertension
Diabetes Mellitus (always = high risk)	Cigarette Smoking

Other coronary risk factors such as family history of premature CAD, coronary artery calcification, C reactive protein levels, obesity, etc., are not included in the standard methods of risk assessment but are thought to contribute to CAD risk.

- Selection of the optimal diagnostic work-up for evaluation or exclusion of coronary artery disease should be made within the context of available studies (which include treadmill stress test, stress myocardial perfusion imaging, stress echocardiography, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.
- Occasionally, it may be appropriate to do a second non-invasive test for diagnosis or exclusion of CAD when the initially selected test is technically suboptimal and the diagnosis of CAD cannot be established or excluded.
- In order to optimize image quality, imaging protocols may need to be modified in specific patient populations. Thus, patients who are obese may benefit from 2 day imaging protocols and/or prolonged image acquisition times. Similarly, imaging in the prone position may improve accuracy in patients who are obese and women with high likelihood of breast attenuation artifact. Patients whose baseline EKG demonstrates left bundle branch block, may be better suited to pharmacologic stress imaging than to exercise stress protocols.
- Rarely, absolute or relative contraindications to MPI will be encountered. MPI should not be used in pregnant or lactating women. Patients who are unable to remain motionless for several minutes or comprehend simple instructions are not suitable candidates for MPI. Image quality in morbidly obese patients (BMI >40) is usually suboptimal such that consideration should be given to other imaging modalities. If imaging studies using other radioactive tracers have been recently performed, adequate time must elapse to allow for clearance of activity from the heart and surrounding regions.
- For patients who are unable to walk on a treadmill for non-cardiac reasons (orthopedic limitations, claudication, neurological conditions, advanced lung disease, etc.), exercise stress testing is not an option. These patients will require pharmacological testing with echo or nuclear imaging.
- It is anticipated that the evaluation of patients with acute chest pain will occur in the emergency room or in an inpatient setting and MPI performed in these locations is not included in the AIM preauthorization program.

Common Diagnostic Indications

Suspected coronary artery disease in asymptomatic patients

- Patients with high-risk of CAD (SCORE) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with moderate or high risk of CAD (SCORE) who have a high risk occupation that would endanger others in the event of a myocardial infarction, for example: airline pilot, law-enforcement officer, firefighter, mass transit operator, bus driver) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with diseases/conditions with which coronary artery disease commonly coexist and who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency or renal failure; **OR**
- Patients who have undergone cardiac transplantation and have had no evaluation for coronary artery disease within the preceding one (1) year; **OR**
- Patients in whom a decision has been made to treat with interleukin 2
- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Suspected coronary artery disease in symptomatic patients who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding sixty (60) days

- Chest pain
  - With intermediate or high pretest probability of CAD (Table 1); **OR**
  - With low or very low pretest probability of CAD (Table 1) and high risk of CAD (SCORE)
- Atypical symptoms: syncope, shortness of breath (dyspnea), neck, jaw, arm, epigastric or back pain, or sweating (diaphoresis)
  - With moderate or high risk of CAD (SCORE)
- Other symptoms; palpitation, dizziness, lightheadedness, near syncope, nausea, vomiting, anxiety, weakness, fatigue, etc.
  - With high risk of CAD (SCORE)
- Patients with any cardiac symptom who have diseases/conditions with which coronary artery disease commonly coexists such as:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency or renal failure; **OR**
- Patients who have undergone cardiac transplantation; **OR**
- Patients in whom a decision has been made to treat with Interleukin 2; **OR**
- Patients awaiting solid organ transplantation

Established coronary artery disease in asymptomatic patients

- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Common Diagnostic Indications

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have new or worsening symptoms

Note: *If symptoms are typical of myocardial ischemia cardiac catheterization may be more appropriate than MPI*

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have not undergone revascularization and have no symptoms or stable symptoms

- No evaluation of CAD (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years
- No evaluation of CAD (MPI, cardiac PET, stress echo, coronary CTA or cardiac catheterization) within the preceding one (1) year in a patient who has undergone cardiac transplantation and has been found to have CAD since transplantation

Established coronary artery disease in patients who have undergone revascularization

- For evaluation of new or worsening cardiac symptoms
  - If symptoms are typical of myocardial ischemia cardiac catheterization may be more appropriate than MPI; **OR**
- For evaluation of stable patients who have undergone coronary artery bypass grafting more than five (5) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past two (2) years
  - Stable patients whose revascularization has been incomplete may undergo MPI three (3) years following the procedure and every three (3) years thereafter; **OR**
- For evaluation of stable patients who have undergone percutaneous coronary intervention(PCI) more than three (3) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past three (3) years when **any of the following** applies
  - The patient has undergone PCI of the left main (LM) coronary artery or the proximal left anterior descending (LAD) coronary artery
  - The patient has undergone PCI of more than one coronary artery
  - The patient has chronic total occlusion of a coronary artery and the vessel on which PCI was performed is supplying collateral flow to the occluded vessel
  - The patient is known to have only one patent coronary artery.
  - Left ventricular ejection fraction LVEF is <35%

Established coronary artery disease in patients who have had myocardial infarction (ST elevation or non-ST elevation) or unstable angina within the preceding ninety (90) days provided that:

- The patient did not undergo coronary angiography at the time of the acute event; **AND**
- The patient is currently clinically stable

Established Kawasaki Disease with Coronary Artery Involvement

- Every two year evaluation for confirmed small to medium coronary artery aneurysm
- Annual evaluation for confirmed large (giant) coronary artery aneurysm, multiple or complex aneurysms or coronary artery obstruction confirmed by angiography

Common Diagnostic Indications

Patients with new onset arrhythmias (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD

- Patients with sustained (lasting more than 30 seconds) or non-sustained (more than 3 beats but terminating within 30 seconds) ventricular tachycardia; **OR**
- Patients with atrial fibrillation or flutter and high or moderate risk of CAD (SCORE); **OR**
- Patients with atrial fibrillation or flutter and established CAD; **OR**
- Patients who have frequent premature ventricular contractions (PVC) defined as more than thirty (30) PVCs per hour on ambulatory EKG (Holter) monitoring
    - It is not clinically indicated to perform MPI for evaluation of infrequent premature atrial or ventricular depolarizations

Patients with new onset congestive heart failure or recently recognized left ventricular systolic dysfunction (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD

For patients in this category whose CAD risk (SCORE) is high, cardiac catheterization may be more appropriate than non-invasive evaluation

- Provided that new or worsening CAD has not been excluded as the cause of LV dysfunction/ CHF by any of the following tests: MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization

Patients with abnormal exercise treadmill test (performed without imaging)

This guideline applies to patients with suspected or established CAD

- Abnormal findings on an exercise treadmill test include (chest pain, ST segment change, abnormal BP response or complex ventricular arrhythmias)

Patients who have undergone recent (within the past 60 days) stress echocardiography

- When the stress echocardiogram is technically suboptimal, technically limited, inconclusive, indeterminate, or equivocal, such that myocardial ischemia cannot be adequately excluded
    - It is not appropriate to perform MPI on patients who have had a recent normal or abnormal stress echocardiogram
    - A stress echocardiogram is deemed to be abnormal when there are echocardiographic abnormalities. Electrocardiographic abnormalities without echocardiographic evidence of ischemia are considered to be normal studies

Patients with abnormal findings on cardiac CT / coronary CTA

Symptomatic Patients:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis on coronary CTA

Note: *If symptoms are typical of myocardial ischemia cardiac catheterization may be more appropriate than MPI*

Asymptomatic patients who have not had MPI, stress echo, cardiac PET or cardiac catheterization within the preceding three (3) years:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis coronary CTA

Patients with abnormal findings on cardiac catheterization

- To determine flow limiting significance of intermediate coronary stenosis

Common Diagnostic Indications

Myocardial viability evaluation

MPI may be used to evaluate myocardial viability in patients who

- Have established coronary artery disease; **AND**
- Have left ventricular systolic dysfunction (Left Ventricular Ejection Fraction <55%); **AND**
- Are candidates for revascularization

Note: *Pharmacologic stress echocardiography with a drug such as dobutamine that increases myocardial contractility is the preferred protocol*

Pre-operative cardiac evaluation of patients undergoing non-cardiac surgery

This guideline applies to patients undergoing non-emergency surgery

It is assumed that those who require emergency surgery will undergo inpatient pre-operative evaluation

- Patients with active cardiac conditions such as unstable coronary syndromes (unstable angina), decompensated heart failure (NYHA function of class IV, worsening or new onset heart failure), significant arrhythmias (third degree AV block Mobitz II AV block, uncontrolled supraventricular arrhythmia, symptomatic ventricular arrhythmias, ventricular tachycardia), symptomatic bradycardia or severe stenotic valvular lesions. It is recommended that these conditions be evaluated and managed per ACC/AHA guidelines prior to considering elective surgery. That evaluation may include MPI

Low-risk surgery (endoscopic procedures, superficial procedures, cataract surgery, breast surgery, ambulatory surgery)

- Provided that there are no active cardiac conditions (as outlined above), MPI prior to low-risk surgery is considered not medically necessary

Intermediate risk surgery (including but not limited to intraperitoneal and intrathoracic surgery, carotid endarterectomy, head and neck surgery, orthopedic surgery, prostate surgery, gastric bypass surgery) or **High-risk surgery** (including but not limited to aortic and other major vascular surgery, peripheral vascular surgery) when

- The patient has not had a normal coronary angiogram, SE, MPI, CCTA, Cardiac PET perfusion study or revascularization procedure within the previous one (1) year; **AND**
- At least one of the following applies:
  - Patient has established CAD (prior MI, prior PTCA, stent, or CABG) or presumed CAD (Q waves on EKG, abnormal MPI, SE or cardiac PET); **OR**
  - Patient has compensated heart failure or prior history of heart failure (CHF); **OR**
  - Patient has diabetes mellitus; **OR**
  - Patient has chronic renal insufficiency or renal failure; **OR**
  - Patient has a history of cerebrovascular disease (TIA, CVA or documented carotid stenosis requiring carotid endarterectomy); **OR**
  - Patient is unable to walk on a treadmill for reasons other than obesity

Abnormal EKG findings

Some patients have resting EKG findings which would render the interpretation of an exercise EKG test difficult or impossible. In these situations patients who, in the absence of the EKG abnormality, would not meet approval criteria for MPI, may be approved for MPI because exercise EKG testing without imaging would provide little clinically useful data. Patients with the following resting EKG abnormalities are included this category:

- Left bundle branch block; **OR**
- Ventricular paced rhythm; **OR**
- Left ventricular hypertrophy with repolarization abnormality; **OR**
- Digoxin effect; **OR**
- 1 mm ST depression or more on a recent EKG (within the past 30 days); **OR**
- Pre-excitation syndromes (E.G. WPW syndrome)

Unable to walk on a treadmill for reasons other than obesity

Nuclear Cardiology: Cardiac Blood Pool Imaging Blood Pool Imaging includes MUGA (Multi-Gated Acquisition) & First Pass Radionuclide Ventriculography

CPT Codes

78472..... Gated equilibrium; planar, single study, wall motion plus ejection fraction

78473..... Gated equilibrium; planar, multiple studies, wall motion study plus ejection fraction

78481..... First pass technique; single study, wall motion study plus ejection fraction

78483..... First pass technique; multiple studies, wall motion study plus ejection fraction

78494..... Gated equilibrium: SPECT, at rest, wall motion study plus ejection fraction

78496..... This code is an add-on code to be used in conjunction with 78472. As such, this code does not require separate review.

Commonly Used Radiopharmaceuticals

- Technetium-99m

Imaging Considerations

- Primarily used to evaluate global and regional ventricular function and to determine ejection fraction(s)
- May be used in the evaluation of intracardiac shunting or diastolic function
- First-pass studies display initial transit of the radiotracer bolus passing through the cardiopulmonary and central systemic circulations. Right and/or left ventricular function may be evaluated.
- Equilibrium studies display gated data (MUGA) which is acquired over many cardiac cycles, using a blood pool radiotracer. Both right and left ventricles may be evaluated.
- First pass studies should be acquired on a high count-rate camera in order that images have sufficient temporal resolution. High count-rate cameras are not required for MUGA.
- Studies may be performed at rest and/or during exercise.
- MUGA studies are technically more difficult in patients with irregular heart rhythms. Imaging times may have to be prolonged to acquire adequate data.
- Selection of the optimal diagnostic imaging for cardiac evaluation should be made within the context of other available studies (which include transthoracic echocardiography, transesophageal echocardiography, stress myocardial perfusion imaging, stress echocardiography, cardiac MRI, cardiac CT, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.
- Some disease states and medications interfere with red blood cell labeling. These should be taken into account when selecting the optimal imaging modality.
- In interpretation of this document, the term “clinically stable” is taken to mean that the patient has no new or worsening cardiac symptoms and there are no changes on cardiovascular examination.

Common Diagnostic Indications

Evaluation of left ventricular function

Note: *It is assumed that left ventricular function will be evaluated using a single imaging modality. Thus, if left ventricular function has been evaluated recently by echocardiography reevaluation using blood pool imaging is not necessary*

- Initial evaluation of known or suspected heart failure; **OR**
- Reevaluation of patients with known LV dysfunction (systolic or diastolic) in a patient with a deterioration in clinical status; OR
- Evaluation of patients with resting EKG abnormalities (LBBB, RBBB with left anterior or posterior hemiblock, LVH, RVH, Q waves suggestive of prior infarction); **OR**
- Reevaluation of patients with known heart failure (systolic or diastolic) in a patient with a change in clinical status; **OR**
- Baseline and serial reevaluation in patients undergoing, planning to undergo or who have undergone therapy with cardiotoxic agents (examples including but not limited to some chemotherapeutic agents for cancer, Novantrone [mitoxantrone] for multiple sclerosis); **OR**
- Screening study for left ventricular dysfunction every two (2) years in clinically stable and first-degree relatives of patients with inherited cardiomyopathy; **OR**
- Evaluation of suspected restrictive, infiltrative or genetic cardiomyopathy; **OR**
- Evaluation of patients with diagnosed or suspected myocarditis; **OR**
- Evaluation of LV function in a patient with known cardiomyopathy being considered for cardiac resynchronization therapy (CRT), implantable defibrillator (AICD) or ventricular assist device (VAD); **OR**
- Initial evaluation for cardiac resynchronization therapy (CRT) device optimization following implantation; **OR**
- Evaluation of a patient being treated with cardiac resynchronization therapy (CRT) with new or persistent signs or symptoms of heart failure for device optimization; **OR**
- Blood pool imaging is indicated for optimization of device settings in patients with ventricular assist device (VAD); **OR**
- When left ventricular dysfunction is suggested by other testing (chest x-ray, elevated BNP) and LV function has not been evaluated by another modality since that testing was performed; **OR**
- Where a clinically significant discrepancy that might influence patient management exists in the evaluation of left ventricular dysfunction by two other imaging modalities, MUGA/First Pass can be used as an arbiter; **OR**
- Pre and post cardiac transplantation

Evaluation of right ventricular function

- In patients suspected of having right ventricular dysfunction based on history and/or physical examination; **OR**
- Reevaluation of patients with established right ventricular dysfunction in patients with a change in clinical status; **OR**
- Evaluation of right ventricular function in patients with pulmonary hypertension; **OR**
- Evaluation of right ventricular function in patients with diagnoses known to cause right ventricular dysfunction including but not limited to coronary artery disease, valvular heart disease, left ventricular dysfunction, congenital heart disease, morbid obesity, sleep apnea syndrome, advanced lung disease, pulmonary thromboembolic disease, and right ventricular dysplasia; **OR**
- Evaluation of right ventricular function in patients with myocardial infarction where right ventricular involvement is suspected; **OR**
- Evaluation of right ventricular function in patients who are being evaluated for or have undergone cardiac or lung transplantation

Common Diagnostic Indications

Coronary artery disease (CAD) (applies to patients with established coronary artery disease)

- Recent (less than 3 weeks) acute coronary syndrome (myocardial infarction or unstable angina) for initial assessment of LV function
  - This study is usually done prior to discharge
  - Not required if left ventricular function has been assessed using another imaging modality; **OR**
- Prior acute coronary syndrome (myocardial infarction or unstable angina) for reevaluation of ventricular function during recovery phase (up to six [6] months following acute coronary syndrome); **OR**
- Prior acute coronary syndrome (myocardial infarction or unstable angina) for reevaluation of ventricular function after the recovery phase (more than six [6] months) in patients who develop new signs or symptoms suggestive of heart failure; **OR**
- Prior myocardial infarction for reevaluation of LV function in patients being considered for AICD or cardiac resynchronization therapy (CRT)

Congenital heart disease

- For detection and localization of shunts (ventricular septal defect [VSD], atrial septal defect [ASD], patent ductus arteriosus [PDA], anomalous pulmonary venous drainage)
  - Echocardiography is generally considered to be a preferable imaging modality in this clinical situation
- For evaluation of RV and/or LV function in a patient with established complex congenital heart disease

Valvular heart disease

- Established valvular heart disease in patients with new or worsening signs or symptoms
  - In patients with suspected valvular heart disease echocardiography is the appropriate initial imaging modality; **OR**
- Patients with severe asymptomatic aortic regurgitation to assist in optimal timing of aortic valve replacement
  - Rest and stress studies are appropriate in this clinical situation

Nuclear Cardiology
Infarct Imaging

CPT Codes

78466..... Planar, infarct avid; qualitative or quantitative

78468..... Planar, infarct avid; with ejection fraction by first pass technique

78469..... SPECT, infarct avid; with or without quantification

Radiopharmaceuticals

- Technetium-99m Pyrophosphate

Imaging Considerations

- Infarct imaging is typically optimal at 48-72 hours post-event
- False positive findings have been attributed to the following conditions:
  - Amyloidosis
  - Cardiac valvular and pericardial calcification
  - Cardiomyopathy
  - Doxorubicin (Adriamycin) Treatment
  - Myocarditis and Pericarditis
  - Prior myocardial infarction, that remains persistently positive
  - Radiation Therapy
  - Ventricular aneurysm
- Selection of the optimal diagnostic imaging for cardiac evaluation should be made within the context of other available studies (which include treadmill stress test, stress myocardial perfusion imaging, stress echocardiography, cardiac MRI, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.

Common Diagnostic Indications

Suspected acute myocardial infarction, which likely occurred within the last 7 days

- Including interrogation of the following:
  - Negative (past expected peak) cardiac enzymes
  - Abnormal baseline ECG, due to prior myocardial infarction
  - Left bundle branch block

Differentiation of subendocardial (non-Q-wave) infarction versus ischemia

Post-cardioversion

Following significant chest trauma or major surgical procedure, with chest pain

Cardiac Echocardiography
Stress Echocardiography (SE)

CPT Codes

93350..... Echocardiography, transthoracic during rest and cardiovascular stress test using treadmill, bicycle exercise and/or pharmacologically induced stress, with interpretation and report

93351..... Echocardiography, transthoracic during rest and cardiovascular stress test using treadmill, bicycle exercise and/or pharmacologically induced stress, with interpretation and report; including performance of continuous electrocardiographic monitoring with physician supervision

93320..... This code is an add-on code to be used in conjunction with 93350, 93351. As such, this code does not require separate review

93321..... This code is an add-on code to be used in conjunction with 93350, 93351. As such, this code does not require separate review

93325..... This code is an add-on code to be used in conjunction with 93350, 93351. As such, this code does not require separate review

93352..... This code is an add-on code to be used in conjunction with 93350, 93351. As such, this code does not require separate review

Uses of Stress Echocardiography (SE)

- The primary use of SE is in the diagnosis or exclusion of obstructive coronary artery disease (CAD).
- SE is also used for management of established coronary artery disease.
- SE may be used for assessment of myocardial viability in patients who have had myocardial infarction.
- SE is occasionally used in the evaluation of valvular heart disease, and for the detection and management of occult pulmonary hypertension.

Imaging Considerations

- A recent EKG is strongly recommended, preferably within 7 days of request for stress echocardiogram. The findings on the resting EKG may help to determine the need for imaging and may also show evidence of ischemia at rest or interval myocardial infarction.
- Unlike MPI, stress echocardiography does not expose the patient to ionizing radiation.
- Age, gender and the character of the chest pain provide useful predictors of CAD, as stratified in Table 1 below.

Table 1*: Pre-Test Probability of Coronary Artery Disease by Age, Gender and Symptoms

Very Low < 5% Low Probability < 10%	Intermediate probability 10-90% High Probability > 90%

*Reference for Table 1: Gibbons RJ, Balady GJ, Beasley JW, et al. ACC/AHA Guidelines for Exercise Testing: Executive Summary. Circulation. 1997;96:345-354.

Age (yr)	Gender	Typical/Definite Angina Pectoris	Atypical/Probable Angina Pectoris	Non-Anginal Chest Pain	Asymptomatic
30-39	Men	Intermediate	Intermediate	Low	Very Low
	Women	Intermediate	Very Low	Very Low	Very Low
40-49	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Low	Very Low	Very Low
50-59	Men	High	Intermediate	Intermediate	Low
	Women	Intermediate	Intermediate	Low	Very Low
60-69	Men	High	Intermediate	Intermediate	Low
	Women	High	Intermediate	Intermediate	Low

Imaging Considerations

Myocardial Perfusion Imaging and Stress Echocardiography may provide useful information on Coronary Heart Disease. Comparison data on Sensitivity and Specificity are provided in Table 2 below. Due to regional variation in technical expertise and interpretive proficiency, the clinician should use the diagnostic imaging modality that has been proven most accurate in his/her practices.

Table 2**: Comparison of Non-Invasive Diagnostic Imaging

** Reference for Table 2: Zaret BL, Bellar GA. *Clinical Nuclear Cardiology*. 3rd Edition. Philadelphia: Elsevier Mosby Publishers; 2005, page 539

	Nuclear Imaging Sensitivity (%)	Stress Echo Sensitivity (%)	Nuclear Imaging Specificity (%)	Stress Echo Specificity (%)
Exercise (7 studies)	83%	78%	83%	91%
Dobutamine (8 studies)	86%	80%	73%	86%
Adenosine (3 studies)	89%	63%	73%	86%
Dipyridamole (4 studies)	83%	68%	88%	89%

Several clinical indications listed for Stress Echo include standard methods of risk assessment, such as the SCORE (Systematic Coronary Risk Evaluation) or the Framingham risk score calculation. These risk calculation systems include consideration of the following factors:

Age	Sex
Abnormal Lipid Profile	Hypertension
Diabetes Mellitus (always = high risk)	Cigarette Smoking

Other coronary risk factors such as family history of premature CAD, coronary artery calcification, C reactive protein levels, obesity etc. are not included in the standard methods of risk assessment but are thought to contribute to coronary artery disease risk.

- Selection of the optimal diagnostic work-up for evaluation or exclusion of coronary artery disease should be made within the context of available studies (which include treadmill stress test, stress myocardial perfusion imaging, stress echocardiography, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.
- Occasionally it may be appropriate to do a second non-invasive test for diagnosis or exclusion of CAD when the initially selected test is technically suboptimal and the diagnosis of CAD cannot be established or excluded.
- SE may be performed using either physical or pharmacologic stress. If physical stress is used, the choice rests between treadmill exercise test and bicycle exercise test. While it is possible to acquire images during exercise in patients undergoing bicycle exercise testing, image quality during treadmill exercise is suboptimal. In this situation, the “stress” images are actually acquired immediately following peak exercise. Thus, the laboratory must be set up in a manner that allows imaging to be completed within 45 to 60 seconds after peak exercise.
- Some patients may not be suitable candidates for SE. Image quality is frequently suboptimal in morbidly obese patients and in those with advanced lung disease. If image quality at rest is inadequate, the test should be canceled and consideration given to an alternative imaging modality.
- For patients who are unable to walk on a treadmill for non-cardiac reasons (orthopedic limitations, claudication, neurological conditions, advanced lung disease, etc. exercise stress testing is not an option. These patients will require pharmacological testing with echo or nuclear imaging.
- It is anticipated that the evaluation of patients with acute chest pain will occur in the emergency room or in an inpatient setting and stress echo performed in these locations is not included in the AIM preauthorization program.

Common Diagnostic Indications

Suspected coronary artery disease in asymptomatic patients

- Patients with high-risk of CAD (SCORE) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with moderate or high risk of CAD (SCORE) who have a high risk occupation that would endanger others in the event of a myocardial infarction (for example: airline pilot, law-enforcement officer, firefighter, mass transit operator, bus driver) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with diseases/conditions with which coronary artery disease commonly coexists and who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency; **OR**
- Patients who have undergone cardiac transplantation and have had no evaluation for coronary artery disease within the preceding one (1) year; **OR**
- Patients in whom a decision has been made to treat with Interleukin 2; **OR**
- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Suspected coronary artery disease in symptomatic patients who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding sixty (60) days

- Chest pain
  - With intermediate or high pretest probability of CAD (Table 1); **OR**
  - With low or very low pretest probability of CAD (Table 1) and high risk of CAD (SCORE)
- Atypical symptoms: syncope, shortness of breath (dyspnea), neck, jaw, arm, epigastric or back pain, sweating (diaphoresis)
  - With moderate or high risk of CAD (SCORE)
- Other symptoms: palpitation, dizziness, lightheadedness, near syncope, nausea, vomiting, anxiety, weakness, fatigue, etc.
  - With high risk of CAD (SCORE)
- Patients with any cardiac symptom who have diseases/conditions with which coronary artery disease commonly coexists such as:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency or renal failure; **OR**
- Patients who have undergone cardiac transplantation; **OR**
- Patients in whom a decision has been made to treat with Interleukin 2; **OR**
- Patients awaiting solid organ transplantation

Established coronary artery disease in asymptomatic patients

- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Common Diagnostic Indications

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have new or worsening symptoms

Note: *If symptoms are typical of myocardial ischemia cardiac catheterization may be more appropriate than SE*

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have not undergone revascularization and have no symptoms or stable symptoms

- No evaluation of CAD (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years
- No evaluation of CAD (MPI, cardiac PET, stress echo, coronary CTA or cardiac catheterization) within the preceding one (1) year in a patient who has undergone cardiac transplantation and has been found to have CAD since transplantation

Established coronary artery disease in patients who have undergone revascularization

- For evaluation of new or worsening cardiac symptoms
  - If symptoms are typical of myocardial ischemia cardiac catheterization may be more appropriate than SE; **OR**
- For evaluation of stable patients who have undergone coronary artery bypass grafting more than five (5) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past two (2) years
  - Stable patients whose revascularization has been incomplete may undergo SE three (3) years following the procedure and every three (3) years thereafter; **OR**
- For evaluation of stable patients who have undergone percutaneous coronary intervention(PCI) more than three (3) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past three (3) years when **any of the following** applies
  - The patient has undergone PCI of the left main (LM) coronary artery or the proximal left anterior descending (LAD) coronary artery
  - The patient has undergone PCI of more than one coronary artery
  - The patient has chronic total occlusion of a coronary artery and the vessel on which PCI was performed is supplying collateral flow to the occluded vessel
  - The patient is known to have only one patent coronary artery.
  - Left ventricular ejection fraction LVEF is <35%

Established coronary artery disease in patients who have had myocardial infarction (ST elevation or non-ST elevation) or unstable angina within the preceding ninety (90) days provided that

- The patient did not undergo coronary angiography at the time of the acute event; **AND**
- The patient is currently clinically stable

Established Kawasaki Disease with Coronary Artery Involvement

- Every two year evaluation for confirmed small to medium coronary artery aneurysm
- Annual evaluation for confirmed large (giant) coronary artery aneurysm, multiple or complex aneurysms or coronary artery obstruction confirmed by angiography

Common Diagnostic Indications

Patients with new onset arrhythmias (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD

- Patients with sustained (lasting more than 30 seconds) or non-sustained (more than 3 beats but terminating within 30 seconds) ventricular tachycardia; **OR**
- Patients with atrial fibrillation or flutter and high or moderate risk of CAD (SCORE); **OR**
- Patients with atrial fibrillation or flutter and established CAD; **OR**
- Patients who have frequent premature ventricular contractions (PVC) defined as more than thirty (30) PVCs per hour on ambulatory EKG (Holter) monitoring
    - It is not appropriate to perform stress echocardiography for evaluation of infrequent premature atrial or ventricular depolarizations

Patients with new onset congestive heart failure or recently recognized left ventricular systolic dysfunction (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD

For patients in this category whose CAD risk (SCORE) is high, cardiac catheterization may be more appropriate than non-invasive evaluation

- Provided that new or worsening CAD has not been excluded as the cause of LV dysfunction/ CHF by any of the following tests: MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization

Patients with abnormal exercise treadmill test (performed without imaging)

This guideline applies to patients with suspected or established CAD

- Abnormal findings on an exercise treadmill test include (chest pain, ST segment change, abnormal BP response or complex ventricular arrhythmias)

Patients who have undergone recent (within the past 60 days) myocardial perfusion imaging (MPI)

- When the MPI is technically suboptimal, technically limited, inconclusive, indeterminate, or equivocal, such that myocardial ischemia cannot be adequately excluded
    - It is not appropriate to perform SE on patients who have had a recent normal or abnormal MPI
    - An MPI is deemed to be abnormal when there are abnormalities on the nuclear imaging portion of the test. Electrocardiographic abnormalities without evidence of ischemia on the nuclear imaging portion of the test are considered to be normal studies

Patients with abnormal findings on cardiac CT / coronary CTA

Symptomatic Patients:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis on coronary CTA

Note: *If symptoms are typical of myocardial ischemia, cardiac catheterization may be more appropriate than stress echo*

Asymptomatic patients who have not had MPI, stress echo, cardiac PET or cardiac catheterization within the preceding three (3) years:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis coronary CTA

Patients with abnormal findings on cardiac catheterization

- To determine flow limiting significance of intermediate coronary stenosis

Common Diagnostic Indications

Myocardial viability evaluation

Stress Echo may be used to evaluate myocardial viability in patients who

- Have established coronary artery disease; **AND**
- Have left ventricular systolic dysfunction (Left Ventricular Ejection Fraction <55%); **AND**
- Are candidates for revascularization

Note: *Pharmacologic stress echocardiography with a drug such as dobutamine that increases myocardial contractility is the preferred protocol*

Pre-operative cardiac evaluation of patients undergoing non-cardiac surgery

This guideline applies to patients undergoing non-emergency surgery

It is assumed that those who require emergency surgery will undergo in-patient pre-operative evaluation

- Patients with active cardiac conditions such as unstable coronary syndromes (unstable angina), decompensated heart failure (NYHA function of class IV, worsening or new onset heart failure), significant arrhythmias (third degree AV block Mobitz II AV block, uncontrolled supraventricular arrhythmia, symptomatic ventricular arrhythmias, ventricular tachycardia), symptomatic bradycardia or severe stenotic valvular lesions. It is recommended that these conditions be evaluated and managed per ACC/AHA guidelines prior to considering elective surgery. That evaluation may include Stress Echo

Low-risk surgery (endoscopic procedures, superficial procedures, cataract surgery, breast surgery, ambulatory surgery)

- Provided that there are no active cardiac conditions (as outlined above) Stress Echo prior to low-risk surgery is considered not medically necessary

Intermediate risk surgery (including but not limited to intraperitoneal and intrathoracic surgery, carotid endarterectomy, head and neck surgery, orthopedic surgery, prostate surgery, gastric bypass surgery) or **High-risk surgery** (including but not limited to aortic and other major vascular surgery, peripheral vascular surgery) when

- The patient has not had a normal coronary angiogram, SE, MPI, CCTA, Cardiac PET perfusion study or revascularization procedure within the previous one (1) year; **AND**
- At least one of the following applies:
  - Patient has established CAD (prior MI, prior PTCA, stent, or CABG) or presumed CAD (Q waves on EKG, abnormal MPI, SE or cardiac PET); **OR**
  - Patient has compensated heart failure or prior history of heart failure (CHF); **OR**
  - Patient has diabetes mellitus; **OR**
  - Patient has chronic renal insufficiency or renal failure; **OR**
  - Patient has a history of cerebrovascular disease (TIA, CVA or documented carotid stenosis requiring carotid endarterectomy); **OR**
  - Patient is unable to walk on a treadmill for reasons other than obesity

Common Diagnostic Indications

Valvular heart disease

- Stress echocardiography may be used in evaluation of asymptomatic patients with any of the following valvular lesions
  - Severe aortic stenosis
  - Severe aortic regurgitation with normal left ventricular size and function
  - Severe mitral stenosis
  - Severe mitral regurgitation with normal left ventricular size and function; **OR**
- Stress echocardiography may be used in evaluation of symptomatic patients with any of the following valvular lesions
  - Aortic stenosis of uncertain degree (due to the presence of co-existent severe left ventricular systolic dysfunction). Pharmacologic stress echocardiography with a drug such as dobutamine that increases myocardial contractility is the preferred protocol
  - Moderate mitral stenosis
  - Moderate mitral regurgitation

Pulmonary hypertension

- For evaluation of patients with suspected pulmonary hypertension whose resting echocardiogram fails to confirm that diagnosis, such that exercise induced pulmonary hypertension needs to be excluded; **OR**
- For evaluation of right and/or left ventricular function during exercise in patients with established exercised induced pulmonary hypertension

Hypertrophic obstructive cardiomyopathy

- For the evaluation of dynamic changes during exercise in patients with an established diagnosis of hypertrophic obstructive cardiomyopathy who do not have a resting outflow tract gradient of 50 mm Hg or more

Abnormal EKG findings

Some patients have resting EKG findings which would render the interpretation of an exercise EKG test difficult or impossible. In these situations patients who, in the absence of the EKG abnormality, would not meet approval criteria for SE, may be approved for SE because exercise EKG testing without imaging would provide little clinically useful data. Patients with the following resting EKG abnormalities are included in this category:

- Left bundle branch block; **OR**
- Ventricular paced rhythm; **OR**
- Left ventricular hypertrophy with repolarization abnormality; **OR**
- Digoxin effect; **OR**
- 1 mm ST depression or more on a recent EKG (within the past 30 days); **OR**
- Pre-excitation syndromes (e.g. WPW syndrome)

Unable to walk on a treadmill for reasons other than obesity

Transesophageal Echocardiography (TEE)

CPT Codes

93312..... TEE real-time with image documentation (2-D) (with or without M-mode recording)
93313..... Placement of transesophageal probe only
93314..... Image acquisition, interpretation and report only
93315..... TEE for congenital cardiac anomalies
93316..... Placement of transesophageal probe only (congenital cardiac anomalies)
93317..... Image acquisition, interpretation and report only (congenital cardiac anomalies)
93320..... This code is an add-on code to be used in conjunction with 93312, 93314, 93315, 93317. As such, this code does not require separate review
93321..... This code is an add-on code to be used in conjunction with 93312, 93314, 93315, 93317. As such, this code does not require separate review
93325..... This code is an add-on code to be used in conjunction with 93312, 93314, 93315, 93317. As such, this code does not require separate review

Standard Anatomic Coverage

- Heart, proximal great vessels, pericardium

Imaging Considerations

- In general, it is assumed that TEE is appropriately used as an adjunct or subsequent test to transthoracic echocardiography (TTE) when suboptimal TTE images preclude obtaining a diagnostic study.
- There are some clinical situations for which TEE is a more appropriate initial imaging test than TTE. These situations are outlined below under Common Diagnostic Indications for TEE.
- Since TEE requires conscious sedation, it should only be performed at locations where cardiac monitoring and appropriate equipment for cardiopulmonary resuscitation are readily available.
- Patients with oropharyngeal or esophageal pathology which contraindicates intubation of the esophagus are not suitable candidates for TEE.
- Intraoperative TEE (93318) is beyond the scope of AIMs diagnostic imaging management program and will not be addressed in this document.

Common Diagnostic Indications

In patients who have had, or are likely to have suboptimal transthoracic imaging

- When image quality is suboptimal such that the clinical question(s) prompting the TEE has/have not been adequately answered; **OR**
- When it is likely that transthoracic imaging will be suboptimal in the following situations:
  - Previous transthoracic echocardiograms were of suboptimal quality
  - In patients with severe abnormalities of thoracic contour (pectus deformities, severe kyphoscoliosis)
  - In patients who have recently had thoracic surgery where post-operative tenderness or the location of dressings or incisions would preclude imaging from the usual transthoracic locations
  - Following severe chest trauma
  - Following extensive burns to the thorax
  - In patients with a cardiac diagnosis made by TEE who require reevaluation, the results of which would lead to a change in therapy (e.g. resolution of an intracardiac thrombus following anticoagulation)

Common Diagnostic Indications

In patients whose clinical situation suggests that TEE may be preferable to transthoracic echocardiography

- In evaluation of suspected acute aortic pathology; **OR**
- In evaluation of valvular structure and function to assess suitability for and assist in planning of surgical or catheter based valvular intervention; **OR**
- To diagnose/manage endocarditis with a moderate or high pretest probability (e.g. bacteremia, especially staph bacteremia or fungemia); **OR**
- To diagnose/manage endocarditis involving prosthetic heart valves; **OR**
- In evaluation of persistent fever in a patient with an intracardiac device to exclude endocarditis; **OR**
- In evaluation of a patient with atrial fibrillation/flutter to facilitate clinical decision-making with regards to anticoagulation and/or cardioversion and/or ablation
    - TEE is not required when the decision has been made to anticoagulate the patient and not perform cardioversion; **OR**
- In evaluation of a patient who has undergone surgical correction of complex congenital heart disease for the exclusion of intracardiac thrombus; **OR**
- In evaluation for cardiovascular source of embolic event when no non-cardiac source has been identified

Resting Transthoracic Echocardiography (TTE)

CPT Codes

93303..... Transthoracic echocardiography or congenital cardiac anomalies; complete

93304..... Transthoracic echocardiography or congenital cardiac anomalies; follow-up or limited study

93306..... Echocardiography, transthoracic, real-time with image documentation (2D), includes M-mode recording, when performed, complete, with spectral Doppler echocardiography, and with color flow Doppler echocardiography

93307..... Transthoracic echocardiography; complete, without spectral Doppler echocardiography, or color flow Doppler echocardiography

93308..... Transthoracic echocardiography; complete, without spectral Doppler echocardiography, or color flow Doppler echocardiography follow-up or limited study

93320..... This code is an add-on code to be used in conjunction with 93303, 93304. As such, this code does not require separate review

93321..... This code is an add-on code to be used in conjunction with 93303, 93304, 93308. As such, this code does not require separate review

93325..... This code is an add-on code to be used in conjunction with 93303, 93304, 93308. As such, this code does require separate review

Standard Anatomic Coverage

- Heart, proximal great vessels, pericardium

Imaging Considerations

Advantages of transthoracic echocardiography:

- No risk to the patient
- Minimal patient discomfort
- Widely available
- Extremely portable
- No exposure to ionizing radiation

Disadvantages of transthoracic echocardiography:

- Image quality suboptimal in some patients
- Less sensitive than transesophageal echocardiography in some clinical situations

Ordering Issues:

- Transthoracic echocardiography should only be acquired on equipment which has the capability to perform Doppler echocardiography (pulsed-wave and continuous wave with spectral display) and color flow velocity mapping.
- In interpretation of this document, the term “clinically stable” is taken to mean that the patient has no new or worsening cardiac symptoms and there are no changes on cardiovascular examination.

Common Diagnostic Indications

Suspected valvular heart disease

- Evaluation of cardiac murmurs when the diagnosis of valvular heart disease has not been established
  - After the diagnosis of valvular heart disease has been established, follow the guidelines for the specific valvular lesion (eg, established aortic stenosis)
- Initial evaluation for mitral valve prolapse when signs or symptoms of mitral valve prolapse are present
- Initial evaluation for bicuspid aortic valve when there is a family history (established diagnosis in a first-degree relative)

Established native valvular stenosis (does not apply to congenital valvular stenosis)

- Changing signs or symptoms; **OR**
- Reevaluation of clinically stable patients with moderate or severe stenosis annually; **OR**
- Reevaluation of clinically stable patients with mild stenosis every three (3) years; **OR**
- Assessment of changes in hemodynamic severity and left ventricular function in patients with known aortic stenosis during pregnancy

Established native valvular regurgitation

- Changing signs or symptoms; **OR**
- Reevaluation of clinically stable patients with moderate or severe regurgitation annually; **OR**
- Reevaluation of clinically stable patients with mild regurgitation every three (3) years

Established bicuspid aortic valve

- Changing signs or symptoms suggesting the development of aortic valve dysfunction; **OR**
- Bicuspid aortic valve and dilated aortic root on prior echo (annual echocardiography is indicated); **OR**
- Bicuspid aortic valve and normal aortic root on prior echo [echo at three (3) yearly intervals is indicated]

Established mitral valve prolapse

- Changing signs or symptoms

Prosthetic cardiac valves (mechanical or bioprosthetic) and patients who have undergone valve repair

This guideline does not apply to valve replacement or repair for correction of congenital heart disease in childhood – see indication **Evaluation of patients with congenital heart disease**.

- Initial post-operative evaluation of valve function (baseline study); **OR**
- Signs and/or symptoms suggesting dysfunction of a repaired or replaced valve; **OR**
- Annual reevaluation of a patient with a prosthetic or repaired heart valve noted on prior imaging study to have moderate or severe dysfunction (stenosis or regurgitation); **OR**
- Evaluation at three (3) yearly intervals of a patient with a prosthetic or repaired heart valve noted on prior imaging study to have mild dysfunction (stenosis or regurgitation); **OR**
- Annual reevaluation of clinically stable adults (age 19 years or older) who have undergone valve repair or implantation of a bioprosthetic valve more than seven (7) years previously
  - This guideline does not apply to patients with a mechanical valve prosthesis; **OR**
- Following transcatheter aortic valve implantation/replacement (TAVI or TAVR), TTE is appropriate in clinically stable patients on one (1) occasion within the first three (3) months, at one (1) year, and annually thereafter.

Common Diagnostic Indications

Evaluation of patients with congenital heart disease

- Evaluation of patients in whom congenital heart disease is suspected based on signs and symptoms (including murmur, cyanosis, unexplained arterial desaturation, abnormal arterial pulses) abnormal EKG, abnormal chest x-ray; **OR**
- Patients with chromosomal abnormalities or major extra cardiac abnormality associated with a high incidence of coexisting cardiac abnormality; **OR**
- Patients with established congenital heart disease (repaired or unrepaired) in whom there is a change in clinical status; **OR**
- Adult patients with a childhood history of congenital heart disease (with or without prior surgical repair) in whom the original diagnosis is uncertain or when the precise nature of the structural abnormalities or hemodynamics is unclear; **OR**
- Annual echocardiography is appropriate in clinically stable patients age six (6) years or older with established complex congenital heart disease (with or without prior surgical repair) in whom surveillance for ventricular function, valvular function or pulmonary artery pressure is important in clinical decision-making
    - This does not include patients with successfully repaired patent ductus arteriosus, small atrial or ventricular septal defects, bicuspid aortic valve or mitral valve prolapse; **OR**
- Echocardiography is appropriate in clinically stable patients age five (5) years or younger with established congenital heart disease (with or without prior surgical repair) in whom surveillance for ventricular function, AV valvular regurgitation or pulmonary artery pressure is important in clinical decision-making; **OR**
- Initial outpatient post-operative evaluation of patients who have undergone surgical or catheter-based procedures to correct congenital heart disease (within 60 days of the procedure); **OR**
- TTE is appropriate every three (3) years in the follow up of patients who have undergone catheter-based closure of atrial or ventricular septal defects; **OR**
- Non adult patients (less than or equal to 18 years old) who are undergoing staged surgical correction of congenital heart disease; **OR**
- Patients in whom a decision to perform surgical or catheter based repair of congenital heart disease has been made and in whom echocardiography will be used to assist with procedural planning

Common Diagnostic Indications

Evaluation of ventricular function

Note: *It is assumed that left ventricular function will be evaluated using a single imaging modality. Thus, if left ventricular function has been evaluated recently by blood pool imaging reevaluation using echocardiography is not necessary.*

Hypertension

- Initial evaluation of patients with an established diagnosis of hypertension; **OR**
- Annual evaluation of non-adult patients (less than or equal to 18 years old) with an established diagnosis of hypertension

Heart Failure / Cardiomyopathy / Left Ventricular Dysfunction

- Initial evaluation of known or suspected heart failure; **OR**
- Reevaluation of patients with known heart failure (systolic or diastolic) in a patient with a deterioration in clinical status; **OR**
- Reevaluation of patients with known LV dysfunction (systolic or diastolic) in a patient with a deterioration in clinical status; **OR**
- Reevaluation of clinically stable non-adult (age 18 years or younger) patients with left ventricular systolic dysfunction (Left Ventricular ejection fraction <60%) at six (6) monthly intervals; **OR**
- Screening study every two (2) years in clinically stable first-degree relatives of patients with inherited cardiomyopathy {see specific indications for hypertrophic obstructive cardiomyopathy (HOCM) below}; **OR**
- Evaluation of suspected restrictive, infiltrative or genetic cardiomyopathy; **OR**
- Initial evaluation of suspected hypertrophic obstructive cardiomyopathy (HOCM) ; **OR**
- Reevaluation of known hypertrophic obstructive cardiomyopathy (HOCM) in a patient with a change in clinical status to guide or evaluate therapy; **OR**
- Annual reevaluation non-adult (age 18 years or younger) first-degree relatives of patients with established hypertrophic obstructive cardiomyopathy (HOCM); **OR**
- Evaluation every five (5) years of adult (age 19 years or older) first-degree relatives of patients with established hypertrophic obstructive cardiomyopathy (HOCM); **OR**
- Annual reevaluation of asymptomatic adult (age 19 years or older) patients with known hypertrophic obstructive cardiomyopathy (HOCM); **OR**
- Reevaluation of asymptomatic non-adult (age 18 years or younger) patients with known hypertrophic obstructive cardiomyopathy (HOCM) at six (6) monthly intervals

Implantable devices

- Evaluation of LV function in a patient with known cardiomyopathy being considered for cardiac resynchronization therapy (CRT), implantable defibrillator (AICD) or ventricular assist device (VAD); **OR**
- Initial evaluation for cardiac resynchronization therapy (CRT) device optimization following implantation; **OR**
- Evaluation of a patient being treated with cardiac resynchronization therapy (CRT) with new or persistent signs or symptoms of heart failure for device optimization; **OR**
- Echocardiography is indicated for optimization of device settings in patients with ventricular assist device (VAD); **OR**
- Echocardiography is indicated for evaluation of signs and/or symptoms suggestive of device related complications in patients with ventricular assist device (VAD)

Abnormalities on other testing

- Evaluation of patients with resting EKG abnormalities (LBBB, RBBB with left anterior or posterior hemiblock, LVH, RVH, Q waves suggestive of prior infarction); **OR**
- When left ventricular dysfunction is suggested by other testing (chest imaging, elevated BNP) and LV function has not been evaluated by another modality since that testing was performed; **OR**
- Where a significant discrepancy (more than would be expected for the range of error of the methods) exists in the evaluation of left ventricular dysfunction by two other imaging modalities, echocardiography can be used as an arbiter

Common Diagnostic Indications

Other

- Pre and post cardiac transplant evaluation; **OR**
- Evaluation of known or suspected myocarditis; **OR**
- Echocardiography to evaluate right ventricular function in patients with disease likely to affect right ventricular function including but not limited to chronic lung diseases and sleep apnea syndrome; **OR**
- Baseline and serial reevaluation in patients undergoing, planning to undergo or who have undergone therapy with cardiotoxic agents (examples including but not limited to some chemotherapeutic agents for cancer, Novantrone® (mitoxantrone) for multiple sclerosis

Evaluation of patients with cardiac arrhythmias

- In patients who have sustained (lasting more than 30 seconds) or nonsustained (more than 3 beats but terminating within 30 seconds) ventricular tachycardia
- In patients who have sustained (lasting more than 30 seconds) or non-sustained (more than 3 beats but terminating within 30 seconds) supraventricular tachycardia (including but not limited to atrial fibrillation, atrial flutter, atrial tachycardia, AV node reentrant tachycardia, etc.
- In patients who have frequent premature ventricular contractions (PVC) defined as more than thirty (30) PVCs per hour on ambulatory EKG (Holter) monitoring
    - It is not clinically indicated to perform echocardiography for evaluation of infrequent premature atrial or ventricular depolarizations

Evaluation of infective endocarditis (native or prosthetic valves)

- Patients with suspected endocarditis (positive blood cultures and/or a new murmur on physical examination)
- Reevaluation of patients with established endocarditis who have any of the following
    - Virulent organism; **OR**
    - Severe hemodynamic lesion; **OR**
    - Aortic involvement; **OR**
    - Persistent bacteremia; **OR**
    - Clinical deterioration

Evaluation of patients with suspected coronary artery disease

- Chest pain
    - Resting echocardiography may suggest a cause for the chest pain other than myocardial ischemia (mitral valve prolapse) and is therefore a reasonable imaging procedure in patients with chest pain
    - If coronary artery disease is a likely diagnosis and if a resting echocardiogram cannot be performed while the patient is experiencing the pain, a provocative test (exercise or pharmacological stress test with or without imaging as appropriate) is preferable
    - Resting echocardiography has no role in screening for coronary artery disease in asymptomatic patients; **OR**
- Echocardiography is appropriate in the evaluation of patients with suspected aberrant or anomalous coronary origins or coronary artery fistula

Common Diagnostic Indications

Evaluation of patients with known coronary artery disease

- Recent (< 3 weeks) acute coronary syndrome (myocardial infarction or unstable angina) and hemodynamic instability or signs or symptoms suggesting a complication of myocardial infarction including but not limited to acute mitral regurgitation, hypoxemia, abnormal chest x-ray, acute ventricular septal rupture, free wall rupture / tamponade, shock, right ventricular involvement, heart failure, or thrombus
  - This study is usually requested on an inpatient; **OR**
- Recent (< 3 weeks) acute coronary syndrome (myocardial infarction or unstable angina) for initial assessment of LV function
  - This study is usually done prior to discharge
  - Not required if left ventricular function has been assessed using a different imaging modality; **OR**
- Prior acute coronary syndrome (myocardial infarction or unstable angina) for reevaluation of ventricular function during recovery phase {up to six (6) months following acute coronary syndrome}; **OR**
- Prior acute coronary syndrome (myocardial infarction or unstable angina) for reevaluation of ventricular function after the recovery phase {more than six (6) months} in patients who develop new symptoms or signs suggestive of heart failure; **OR**
- Prior myocardial infarction for reevaluation of LV function in patients being considered for AICD or cardiac resynchronization therapy (CRT); **OR**
- Annual echocardiography is appropriate in non-adult patients (less than or equal to 18 years old) with an established diagnosis of aberrant or anomalous coronary origins or coronary artery fistula if the findings on echocardiography will impact clinical decision making; **OR**

Evaluation of Kawasaki disease

- Echocardiography is appropriate in the evaluation of patients with suspected Kawasaki disease; **OR**
- Echocardiography is appropriate in patients with an established diagnosis of Kawasaki disease at 2–4 weeks and again at 6-8 weeks following diagnosis whether or not there was coronary artery involvement; **OR**
- Echocardiography is appropriate for periodic surveillance up to one year following diagnosis of Kawasaki disease in patients with persistent fever; **OR**
- Echocardiography is appropriate for periodic surveillance up to one year following diagnosis of Kawasaki disease when previous echocardiograms reveal any of the following:
  - Coronary abnormalities
  - Left ventricular dysfunction
  - Pericardial effusion
  - Valvular regurgitation (other than trace or trivial regurgitation)
  - Aortic dilation; **OR**
- Annual echocardiography is appropriate in patients with an established diagnosis of Kawasaki disease who have small or medium sized coronary artery aneurysms; **OR**
- Semiannual (every six months) echocardiography is appropriate in patients with an established diagnosis of Kawasaki disease who have large or giant coronary artery aneurysms or coronary artery obstruction

Common Diagnostic Indications

Evaluation of signs, symptoms or abnormal testing

- Echocardiography is appropriate in the evaluation of the following newly recognized symptoms {dyspnea, lightheadedness, syncope, palpitations, reduced functional capacity, orthopnea, paroxysmal nocturnal dyspnea, transient ischemic attack (TIA) or cerebrovascular attack (CVA)}; **OR**
- Echocardiography is appropriate in the evaluation of chest pain not thought to be due to myocardial ischemia or infarction. If myocardial ischemia or infarction is thought to be the cause, resting outpatient echocardiography is not appropriate; **OR**
- Echocardiography is appropriate in the evaluation of the following newly recognized signs suggesting structural heart disease (murmur, cyanosis, ankle edema, ascites, elevation of jugular venous pressure, unexplained weight gain, tachycardia, tachypnea, audible third heart sound, lung crackles suggestive of pulmonary edema); **OR**
- Echocardiography is appropriate in the evaluation of patients who are hemodynamically unstable or hypotensive for unknown reasons; **OR**
- Echocardiography is appropriate in further evaluation of abnormal results from other testing which suggests underlying cardiac disease {abnormal chest imaging suggesting cardiac chamber enlargement, valvular or congenital heart disease or congestive heart failure, abnormal EKG suggesting chamber hypertrophy, valvular or congenital heart disease (LBBB, RBBB with anterior or posterior hemiblock, left or right ventricular hypertrophy or Q waves suggestive of prior infarction) or abnormal laboratory results suggesting congestive heart failure such as elevated B-type natriuretic peptide (BNP)}
    - When other cardiac testing raises concerns of underlying coronary artery disease, provocative testing is recommended over resting echocardiography; **OR**
- Echocardiography is appropriate in the evaluation of respiratory failure of unknown cause; **OR**
- Echocardiography is appropriate annually in the evaluation of patients with syndromes which place them at increased risk for the development of acquired myocardial or aortic diseases (for example, Marfan Syndrome, Ehlers-Danlos Syndrome, Turner Syndrome, etc.); **OR**
- Echocardiography is appropriate in the evaluation of suspected acute rheumatic fever

Evaluation of patients with pulmonary embolus

- In patients with known acute pulmonary embolus, echocardiography may be performed as it is useful in guiding initial decision making (thrombectomy, thrombolysis)
    - Echocardiography is not indicated in the initial evaluation of a patient with suspected pulmonary embolism in order to establish the diagnosis; **OR**
- In patients who have had a pulmonary embolus, echocardiography may be performed to evaluate right ventricular function and pulmonary artery pressure. If right ventricular function and pulmonary artery pressure are normal, repeated studies are not necessary

Evaluation of patients with pulmonary hypertension

- Echocardiography is indicated for evaluation of suspected pulmonary hypertension; **OR**
- Echocardiography is indicated in follow-up of pulmonary arterial pressures in patients with pulmonary hypertension to evaluate response to treatment; **OR**
- Echocardiography may be performed annually in clinically stable patients with an established diagnosis of pulmonary hypertension; **OR**
- Echocardiography may be performed to evaluate signs or symptoms which may be attributable to worsened pulmonary hypertension

Common Diagnostic Indications

Evaluation of aortic disease

- Echocardiography is appropriate on one occasion when ascending aortic aneurysm / dilation or dissection is suspected based on symptoms of chest pain or shortness of breath or abnormal physical findings suggesting these diagnoses
  - Although some providers will use transthoracic echocardiography in evaluation of diseases of the thoracic aorta, transesophageal echocardiography (TEE) is often preferable in this situation
- Echocardiography is indicated annually when pathology of the ascending aorta (aneurysm / dilation or dissection) is suspected because the patient has an established diagnosis of a connective tissue disease or genetic condition which predisposes to ascending aortic pathology including but not limited to Marfan syndrome, Ehlers-Danlos syndrome and familial aortic dilation (this guideline does not apply to surveillance of patients with bicuspid aortic valve – see separate guideline for this condition above)
- Echocardiography is appropriate for evaluation of the ascending aorta in patients with a suspected connective tissue disease or genetic condition which predisposes to ascending aortic pathology including but not limited to Marfan syndrome, Ehlers-Danlos syndrome and familial aortic dilation
- Annual echocardiography is appropriate in patients with an established diagnosis of ascending aortic aneurysm or dissection
  - Annual echocardiographic evaluation is usually sufficient in clinically stable patients but more frequent testing may be appropriate in some situations (e.g. in longitudinal follow-up of large or enlarging thoracic aneurysms, in follow-up of recently diagnosed thoracic aneurysms until stability is established)
- Echocardiography is appropriate in patients with an established diagnosis of ascending aortic aneurysm or dissection who develop new symptoms or signs of aortic aneurysm or dissection.

Evaluation of pericardial diseases

- Echocardiography is indicated in the evaluation of suspected pericardial conditions including but not limited to pericardial effusion, pericardial mass, constrictive pericarditis, effusive-constrictive conditions, patients post cardiac surgery or suspected pericardial tamponade
- Echocardiography is indicated in the evaluation of established pericardial conditions including but not limited to moderate and large pericardial effusion, pericardial mass, constrictive pericarditis, effusive-constrictive conditions, patients post cardiac surgery or suspected pericardial tamponade
  - Routine surveillance of known small pericardial effusions with no change in clinical status is not appropriate

Evaluation of cardiac masses or cardiac source of embolus

- Echocardiography is indicated in the diagnosis or exclusion of a cardiac source of embolus in a patient who has had or appears to have had a systemic embolic event (although transesophageal echocardiography (TEE) is often preferable in this situation)
- Echocardiography is indicated in the pre- and post-treatment evaluation of cardiac masses (tumor or thrombus)
  - Annual echocardiographic evaluation is usually sufficient in clinically stable patients with cardiac masses (tumors or thrombus) but more frequent testing may be appropriate in some situations (e.g. in longitudinal follow-up of enlarging masses or in follow-up of recently diagnosed masses until stability is established)

Computed Tomography (CT) Cardiac (Structure)

CPT Codes

75572..... Computed tomography, heart, with contrast material, for evaluation of cardiac structure and morphology (including 3-D image post-processing, assessment of cardiac function, and evaluation of venous structures if performed)

75573..... Computed tomography, heart, with contrast material, for evaluation of cardiac structure and morphology in the setting of congenital heart disease (including 3-D post-processing, assessment of left ventricular cardiac function, right ventricular structure and function and evaluation of venous structures, if performed)

Standard Anatomic Coverage

- Heart and great vessels within the thorax

Imaging Considerations

Advantages of Cardiac CT:

- Rapidly acquired exams, with excellent anatomic detail afforded by most multi-detector CT scanners with 64 or more active detector rows

Disadvantages of Cardiac CT include:

- Potential complications from use of intravascular iodinated contrast administration (see biosafety issues, below)
- Exposure to ionizing radiation
- Potential factors that may limit the image quality during acquisition of Cardiac CT such as:
  - Uncontrolled atrial or ventricular arrhythmias
  - Inability to image at a desired heart rate, which may occur despite beta blocker administration
  - Inability of the patient to comply with the requirements of scanning (patient motion during image acquisition, inability to comply with breath hold requirements, inability to lie supine, claustrophobia)
  - Because of the radiation exposure issues careful consideration should be given to other imaging modalities in pregnant women and children

Biosafety Issues:

- Ordering and imaging providers are responsible for considering safety issues prior to the cardiac CT exam. One of the most significant considerations is the requirement for intravascular iodinated contrast material, which may have an adverse effect on patients with a history of documented allergic contrast reactions or atopy, as well as on individuals with renal impairment, who are at greater risk for contrast-induced nephropathy. In addition, radiation safety issues including cumulative exposure to ionizing radiation should be considered.

Ordering Issues:

- This guideline does not apply to coronary CT angiography (CPT 75574).
- This guideline does not apply to Cardiac CT for quantitation of coronary artery calcification (CPT 75571).
- Selection of the optimal diagnostic work-up for cardiac evaluation should be made within the context of other available studies (which include transthoracic and transesophageal echocardiography and cardiac MRI), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.
- There are uncommon circumstances when both Cardiac CT and Cardiac MRI should be ordered for the same clinical presentation. The specific rationale must be delineated at the time of request.
- In general, follow-up Cardiac CT exams should be performed only when there is a clinical change, with new signs or symptoms, or specific finding(s) requiring imaging surveillance.

Common Diagnostic Indications

Congenital heart disease

- For evaluation of suspected or established congenital heart disease in patients whose echocardiogram is technically limited or non-diagnostic; **OR**
- For further evaluation of patients whose echocardiogram suggests a new diagnosis of complex congenital heart disease; **OR**
- For evaluation of complex congenital heart disease in patients who are less than one year post surgical correction; **OR**
- For evaluation of complex congenital heart disease in patients who have new or worsening symptoms and/or a change in physical examination; **OR**
- To assist in surgical planning for patients with complex congenital heart disease; **OR**
- For surveillance in asymptomatic patients with complex congenital heart disease who have not had cardiac MRI or cardiac CT within the preceding year
    - Cardiac MRI or transesophageal echocardiography may be preferable to cardiac CT in order to avoid radiation exposure

Cardiomyopathy

- Evaluation of patients with suspected arrhythmogenic right ventricular dysplasia; **OR**
- To assess LV function in patients with suspected or established cardiomyopathy when all other non-invasive imaging is not feasible or technically suboptimal
    - Other modalities providing non-invasive evaluation of LV function include transthoracic and transesophageal echocardiography, blood pool imaging (MUGA or First pass) and cardiac MRI; **OR**
- To assess RV function in patients with suspected RV dysfunction when all other non-invasive imaging is not feasible or technically suboptimal
    - Other modalities providing non-invasive evaluation of RV function include transthoracic and transesophageal echocardiography, blood pool imaging (MUGA or First pass) and cardiac MRI

Valvular heart disease

- Evaluation of suspected dysfunction of native or prosthetic cardiac valves when all other cardiac imaging options are not feasible or technically suboptimal
    - Other modalities providing non-invasive evaluation of native or prosthetic valves include transthoracic and transesophageal echocardiography, and cardiac MRI
- Evaluation of established dysfunction of native or prosthetic cardiac valves when all other cardiac imaging options are not feasible or technically suboptimal
    - Other modalities providing non-invasive evaluation of native or prosthetic valves include transthoracic and transesophageal echocardiography, and cardiac MRI

Evaluation of patients with established coronary artery disease

- Non-invasive localization of coronary bypass grafts or potential grafts (including internal mammary artery) and/or evaluation of retrosternal anatomy in patients undergoing repeat surgical revascularization

Intra-cardiac and para-cardiac masses and tumors

- In patients with a suspected cardiac or para-cardiac mass (thrombus, tumor, etc.) suggested by transthoracic echocardiography, transesophageal echocardiography, blood pool imaging or contrast ventriculography who have not undergone cardiac CT or cardiac MRI within the preceding 60 days; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who are clinically unstable; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who are clinically stable and have not undergone cardiac CT or cardiac MRI within the preceding year; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who have undergone treatment (chemotherapy, radiation therapy, thrombolysis, anticoagulation or surgery) within the preceding year and have not had cardiac CT or cardiac MRI within the preceding 60 days

Common Diagnostic Indications

Cardiac aneurysm and pseudoaneurysm

Evaluation of pericardial conditions (pericardial effusion, constrictive pericarditis, or congenital pericardial diseases)

- In patients with suspected pericardial constriction; **OR**
- In patients with suspected congenital pericardial disease; **OR**
- In patients with suspected pericardial effusion who have undergone echocardiography deemed to be technically suboptimal in evaluation of the effusion; **OR**
- In patients whose echocardiogram shows a complex pericardial effusion (loculated, containing solid material)

Evaluation of cardiac venous anatomy

- For localization of the pulmonary veins in patients with chronic or paroxysmal atrial fibrillation/flutter who are being considered for ablation; **OR**
- Coronary venous localization prior to implantation of a biventricular pacemaker

Evaluation of the thoracic aorta

- In patients with suspected thoracic aortic aneurysm / dilation who have not undergone CT or MRI of the thoracic aorta within the preceding 60 days; **OR**
- In patients with confirmed thoracic aortic aneurysm / dilation with new or worsening signs/symptoms; **OR**
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm / dilation who have not undergone surgical repair and have not had imaging of the thoracic aorta within the preceding six months; **OR**
- In patients with suspected aortic dissection; **OR**
- In patients with confirmed aortic dissection who have new or worsening symptoms; **OR**
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in preoperative planning); **OR**
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year; **OR**
- In patients with confirmed aortic dissection or thoracic aortic aneurysm / dilation who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months; **OR**
- In patients who have sustained blunt chest trauma, penetrating aortic trauma or iatrogenic trauma as a result of aortic instrumentation; **OR**
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone cardiac CT or cardiac MRI within the preceding 60 days

Coronary CT Angiography (CCTA) and CT Derived Fractional Flow Reserve (FFR-CT)

CPT Codes

75574..... Computed tomographic angiography, heart, coronary arteries and bypass grafts (where present), with contrast material, including 3-D image post-processing (including evaluation of cardiac structure and morphology, assessment of cardiac function, and evaluation of venous structures, if performed)

0501T ..... Noninvasive estimated coronary fractional flow reserve (FFR) derived from coronary computed tomography angiography data using computation fluid dynamics physiologic simulation software analysis of functional data to assess the severity of coronary artery disease; data preparation and transmission, analysis of fluid dynamics and simulated maximal coronary hyperemia, generation of estimated FFR model, with anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report

0502T ..... Data preparation and transmission

0503T ..... Analysis of fluid dynamics and simulated maximal coronary hyperemia, and generation of estimated FFR model

0504T ..... Anatomical data review in comparison with estimated FFR model to reconcile discordant data, interpretation and report

Note: Codes 0501T–0504T are effective January 1, 2018. These codes should be reported if FFR is estimated from CCTA data.

Scope of this Guideline

The guideline addresses the appropriate application of CCTA and FFR-CT in the evaluation and management of outpatients. It does not address the use of CCTA and FFR-CT in the emergency room or inpatient settings.

Guideline Interpretation

This guideline does not supersede the enrollee's health plan medical policy specific to CCTA and FFR-CT.

Preamble

CCTA provides direct images of the coronary arteries (anatomical imaging); as such, it differs from more established noninvasive approaches to evaluation of the coronary arteries. Both myocardial perfusion imaging (MPI) and stress echocardiography (SE), for example, do not directly image the coronary arteries, but instead evaluate a parameter which is thought to reflect coronary blood flow to the myocardium and thereby infer the presence (or absence) of coronary stenosis (physiological imaging). In the case of MPI, myocardial uptake of an isotope is evaluated; whereas, with SE, decreased myocardial contractile reserve is assumed to be ischemic and therefore indicative of coronary stenosis.

CCTA has been compared to SE and MPI and has been found to be non-inferior, or superior, depending on the study and the endpoints evaluated. CCTA offers advantages over older approaches including shorter patient throughput times and lower radiation exposure (in the case of MPI). Furthermore, the negative predictive value of CCTA is very high (93%–100%). CCTA also has limitations including the need to use iodinated contrast agents (which may limit use in patients with renal impairment) and the reduction of image quality in morbidly obese patients, those with heavy coronary calcium burdens and those with coronary stents. Beta blockers are frequently required to slow heart rate, and claustrophobic patients may have difficulty with scanning protocols.

The ability to measure fractional flow reserve by CT (FFR-CT) has the potential to expand the clinical application of CCTA. FFR-CT adds a physiological dimension to the CCTA such that coronary stenosis can be visualized anatomically and then evaluated for flow limiting significance. Thus, the availability of FFR-CT would be expected to assist with decisions regarding subsequent care including the need for coronary angiography, the likelihood of benefit from revascularization, etc. FFR-CT cannot be performed as a stand-alone service, but rather is available (if indicated) to patients who have undergone CCTA. Currently, FFR-CT calculations are performed at a location physically removed from the imaging site following electronic transmission of the imaging data. Results are usually available within 24 hours, but shorter turnaround times are feasible on request.

Recent literature comparing CCTA combined with FFR-CT to traditional noninvasive coronary artery disease (CAD) evaluation has signaled that the former approach is non-inferior in terms of clinical endpoints and may offer advantages in terms of cost of care and radiation exposure.

Common Diagnostic Indications

The use of CT Coronary Angiography (CCTA), with or without Fractional Flow Reserve assessed by CT (FFR-CT), may be covered when accompanied by pre-test considerations as well as supporting clinical data and prerequisite information based on the following diagnostic indications.

For purposes of this guideline, a patient is considered to be "symptomatic" when one of the following (1–4) applies:

1. Chest pain
   - With intermediate or high pretest probability of CAD; **OR**
   - With low or very low pretest probability of CAD and high risk of CAD (SCORE)
2. Atypical symptoms: syncope, shortness of breath (dyspnea), neck, jaw, arm, epigastric or back pain, or sweating (diaphoresis)
   - With moderate or high risk of CAD (SCORE)
3. Other symptoms: palpitation, dizziness, lightheadedness, near syncope, nausea, vomiting, anxiety, weakness, fatigue, etc.
   - With high risk of CAD (SCORE)
4. Patients with any cardiac symptom who have diseases/conditions with which CAD commonly coexists, such as:
   - Abdominal aortic aneurysm; **OR**
   - Chronic renal insufficiency or renal failure; **OR**
   - Diabetes mellitus; **OR**
   - Established and symptomatic peripheral vascular disease; **OR**
   - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%)

Indications where FFR-CT will not be required in conjunction with CCTA

Congenital coronary artery anomalies

- For evaluation of suspected congenital anomalies of the coronary arteries

Indications where FFR-CT may be appropriate but is not a required capability of the performing imaging facility

Congestive heart failure/cardiomyopathy/left ventricular dysfunction

- For exclusion of CAD in patients with left ventricular ejection fraction <55% and low to moderate coronary heart disease risk (using standard methods of risk assessment, such as the SCORE risk calculation) in whom CAD has not been excluded as the etiology of the cardiomyopathy
  - Patients with high coronary heart disease risk should undergo cardiac catheterization

Preoperative evaluation for patients undergoing non-coronary cardiac surgery

- Evaluation of symptomatic or asymptomatic patients at moderate coronary heart disease risk (using standard methods of risk assessment, such as the SCORE risk calculation) to avoid an invasive angiogram, where all the necessary preoperative information can be obtained using cardiac CT
  - Procedures include open and percutaneous valvular procedures or ascending aortic surgery

Suspected coronary artery disease in patients who have had abnormal exercise EKG test (performed without imaging) within the past 60 days

- When both of the following apply
  - Patient is symptomatic
  - During testing the patient had exercise-induced chest pain, ST segment change, abnormal BP response or complex ventricular arrhythmias

Common Diagnostic Indications

Suspected coronary artery disease in patients who have had equivocal MPI or SE within the past 60 days

- When both of the following apply
  - Patient is symptomatic
  - The imaging portion of the study is neither clearly normal nor clearly abnormal

Suspected coronary artery disease in patients who have had abnormal MPI or SE within the past 60 days

- When both of the following apply
  - Patient is symptomatic
  - The imaging portion of the study is abnormal

Indications where FFR-CT may be appropriate and is a required capability of the imaging facility

Suspected coronary artery disease in symptomatic patients who have abnormal resting EKG

- When resting EKG abnormalities (left bundle branch block, electronically paced ventricular rhythm, left ventricular hypertrophy with repolarization abnormalities, resting ST segment depression 1 mm or more, digoxin effect or pre-excitation syndrome) would render an exercise treadmill test (without imaging) uninterpretable

Suspected coronary artery disease in symptomatic patients who have not had recent CAD evaluation

- When no CAD imaging evaluation (MPI, cardiac PET, stress echo, CCTA or coronary angiography) has been performed within the preceding sixty (60) days

References

1. Budoff MJ, Dowe D, Jollis JG, et al. Diagnostic performance of 64-multidetector row coronary computed tomographic angiography for evaluation of coronary artery stenosis in individuals without known coronary artery disease: results from the prospective multicenter ACCURACY (Assessment by Coronary Computed Tomographic Angiography of Individuals Undergoing Invasive Coronary Angiography) trial. *J Am Coll Cardiol*. 2008;52(21):1724-32.
2. Chinnaiyan KM, Peyser P, Goraya T, et al. Impact of a continuous quality improvement initiative on appropriate use of coronary computed tomography angiography. Results from a multicenter, statewide registry, the Advanced Cardiovascular Imaging Consortium. *J Am Coll Cardiol.* 2012;60(13):1185-91.
3. Chinnaiyan KM, Raff GL, Goraya T, et al. Coronary computed tomography angiography after stress testing: results from a multicenter, statewide registry, ACIC (Advanced Cardiovascular Imaging Consortium). *J Am Coll Cardiol* 2012; 59(7):688-95.
4. Dewey M, Rief M, Martus P, et al. Evaluation of computed tomography in patients with atypical angina or chest pain clinically referred for invasive coronary angiography: randomised controlled trial. *BMJ*. 2016; 355:i5441.
5. Douglas PS, De Bruyne B, Pontone G, et al; PLATFORM Investigators. 1-Year Outcomes of FFRCT-Guided Care in Patients With Suspected Coronary Disease: The PLATFORM Study. *J Am Coll Cardiol*. 2016;68(5):435-45.
6. Douglas PS, Hoffmann U, Patel MR, et al; PROMISE Investigators. Outcomes of anatomical versus functional testing for coronary artery disease. *N Engl J Med*. 2015;372(14):1291-300.
7. Douglas PS, Pontone G, Hlatky MA, et al. Clinical outcomes of fractional flow reserve by computed tomographic angiography-guided diagnostic strategies vs. usual care in patients with suspected coronary artery disease: the prospective longitudinal trial of FFR(CT): outcome and resource impacts study. *Eur Heart J*. 2015;36(47):3359-67.
8. ECRI Institute. FFRct Software (HeartFlow, Inc.) for Evaluating Coronary Artery Disease. In: Service. HTAI, editor: ECRI Institute; 2017.
9. Graham TP Jr, Driscoll DJ, Gersony WM, Newburger JW, Rocchini A, Towbin JA. Task Force 2: congenital heart disease. *J Am Coll Cardiol*. 2005;45(8):1326-33.
10. Grani C, Buechel RR, Kaufmann PA, Kwong RY. Multimodality Imaging in Individuals With Anomalous Coronary Arteries.

JACC Cardiovasc Imaging. 2017;10(4):471-81.
11. Halpern EJ, Fischman D, Savage MP, Koka AR, DeCaro M, Levin DC. Decision analytic model for evaluation of suspected coronary disease with stress testing and coronary CT angiography. *Acad Radiol*. 2010;17(5):577-86.
12. Hamilton-Craig C, Fifoot A, Hansen M, et al. Diagnostic performance and cost of CT angiography versus stress ECG--a randomized prospective study of suspected acute coronary syndrome chest pain in the emergency department (CT-COMPARE). *Int J Cardiol.* 2014;177(3):867-73.
13. Hlatky MA, De Bruyne B, Pontone G, et al; PLATFORM Investigators. Quality-of-Life and Economic Outcomes of Assessing Fractional Flow Reserve With Computed Tomography Angiography: PLATFORM. *J Am Coll Cardiol*. 2015;66(21):2315-23.
14. Hoffmann U, Ferencik M, Udelson JE, et al. Prognostic Value of Noninvasive Cardiovascular Testing in Patients With Stable Chest Pain: Insights From the PROMISE Trial (Prospective Multicenter Imaging Study for Evaluation of Chest Pain). *Circulation*. 2017;135(24):2320-32.
15. Hoffmann U, Truong QA, Schoenfeld DA, et al; ROMICAT-II Investigators. Coronary CT angiography versus standard evaluation in acute chest pain. *N Engl J Med.* 2012;367(4):299-308.
16. Jorgensen ME, Andersson C, Norgaard BL, et al. Functional Testing or Coronary Computed Tomography Angiography in Patients With Stable Coronary Artery Disease. *J Am Coll Cardiol*. 2017;69(14):1761-70.
17. Koo BK, Erglis A, Doh JH, et al. Diagnosis of ischemia-causing coronary stenoses by noninvasive fractional flow reserve computed from coronary computed tomographic angiograms. Results from the prospective multicenter DISCOVER-FLOW (Diagnosis of Ischemia-Causing Stenoses Obtained Via Noninvasive Fractional Flow Reserve) study. *J Am Coll Cardiol*. 2011;58(19):1989-97.
18. Levin DC, Parker L, Halpern EJ, Julsrud PR, Rao VM. The lack of growth in use of coronary CT angiography: is it being appropriately used? *AJR Am J Roentgenol*. 2011;196(4):862-7.
19. Litt HI, Gatsonis C, Snyder B, et al. CT angiography for safe discharge of patients with possible acute coronary syndromes. *N Engl J Med.* 2012;366(15):1393-403.
20. Lubbers M, Dedic A, Coenen A, et al. Calcium imaging and selective computed tomography angiography in comparison to functional testing for suspected coronary artery disease: the multicentre, randomized CRESCENT trial. *Eur Heart J*. 2016;37(15):1232-43.
21. Mark DB, Berman DS, Budoff MJ, et al; American College of Cardiology Foundation Task Force on Expert Consensus Documents. ACCF/ACR/AHA/NASCI/SAIP/SCAI/SCCT 2010 expert consensus document on coronary computed tomographic angiography: a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. *Catheter Cardiovasc Interv.* 2010;76(2):E1-42.
22. Marwick TH, Cho I, B OH, et al. Finding the Gatekeeper to the Cardiac Catheterization Laboratory: Coronary CT Angiography or Stress Testing? *J Am Coll Cardiol*. 2015;65(25):2747-56.
23. McEvoy JW, Blaha MJ, Nasir K, et al. Impact of coronary computed tomographic angiography results on patient and physician behavior in a low-risk population. *Arch Intern Med*. 2011;171(14):1260-8.
24. McKavanagh P, Lusk L, Ball PA, et al. A comparison of cardiac computerized tomography and exercise stress electrocardiogram test for the investigation of stable chest pain: the clinical results of the CAPP randomized prospective trial. *Eur Heart J Cardiovasc Imaging.* 2015;16(4):441-8.
25. Meijboom WB, Meijs MF, Schuijf JD, et al. Diagnostic accuracy of 64-slice computed tomography coronary angiography: a prospective, multicenter, multivendor study. *J Am Coll Cardiol*. 2008;52(25):2135-44.
26. Miller JM, Rochitte CE, Dewey M, et al. Diagnostic performance of coronary angiography by 64-row CT. *N Engl J Med*. 2008;359(22):2324-36.
27. Min JK, Leipsic J, Pencina MJ, et al. Diagnostic accuracy of fractional flow reserve from anatomic CT angiography. *JAMA*. 2012;308(12):1237-45.
28. Nagaraja V, Mamas M, Mahmoudi M, Rogers C, Curzen N. Change in angiogram-derived management strategy of patients with chest pain when some FFR data are available: How consistent is the effect? *Cardiovasc Revasc Med*. 2017;18(5):320-7.
29. Nakanishi R, Budoff MJ. Noninvasive FFR derived from coronary CT angiography in the management of coronary artery disease: technology and clinical update. *Vasc Health Risk Manag*. 2016;12:269-78.
30. Nakazato R, Park HB, Berman DS, et al. Noninvasive fractional flow reserve derived from computed tomography angiography for coronary lesions of intermediate stenosis severity: results from the DeFACTO study. *Circ Cardiovasc Imaging*. 2013;6(6):881-9.
31. National Institute for Health and Care Excellence (NICE). HeartFlow FFRct for estimating fractional flow reserve from

coronary CT angiography. Medical technology consultation document (MTG32). London: Royal College of Physicians (UK); National Clinical Guideline Centre; 2017. p. 28.

32. Nielsen LH, Ortner N, Norgaard BL, Achenbach S, Leipsic J, Abdulla J. The diagnostic accuracy and outcomes after coronary computed tomography angiography vs. conventional functional testing in patients with stable angina pectoris: a systematic review and meta-analysis. *Eur Heart J Cardiovasc Imaging*. 2014;15(9):961-71.
33. Norgaard BL, Leipsic J, Gaur S, et al; NXT Trial Study Group. Diagnostic performance of noninvasive fractional flow reserve derived from coronary computed tomography angiography in suspected coronary artery disease: the NXT trial (Analysis of Coronary Blood Flow Using CT Angiography: Next Steps). *J Am Coll Cardiol*. 2014;63(12):1145-55.
34. Patel MR, Peterson ED, Dai D, et al. Low diagnostic yield of elective coronary angiography. *N Engl J Med.* 2010;362(10):886-95.
35. Perk J, De Backer G, Gohlke H, et al. European Guidelines on cardiovascular disease prevention in clinical practice (version 2012). The Fifth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of nine societies and by invited experts). *Eur Heart J*. 2012;33(13):1635-701.
36. Rajani R, Webb J, Marciniak A, Preston R. Comparative efficacy testing - fractional flow reserve by coronary computed tomography for the evaluation of patients with stable chest pain. *Int J Cardiol*. 2015;183:173-7.
37. Rogers IS, Banerji D, Siegel EL, et al. Usefulness of comprehensive cardiothoracic computed tomography in the evaluation of acute undifferentiated chest discomfort in the emergency department (CAPTURE). *Am J Cardiol.* 2011;107(5):643-50.
38. Roifman I, Wijeysundera HC, Austin PC, et al. Comparison of Anatomic and Clinical Outcomes in Patients Undergoing Alternative Initial Noninvasive Testing Strategies for the Diagnosis of Stable Coronary Artery Disease. *J Am Heart Assoc*. 2017;6(7).
39. Ropers D, Moshage W, Daniel WG, Jessl J, Gottwik M, Achenbach S. Visualization of coronary artery anomalies and their anatomic course by contrast-enhanced electron beam tomography and three-dimensional reconstruction. *Am J Cardiol*. 2001;87(2):193-7.
40. SCOT-HEART Investigators. CT coronary angiography in patients with suspected angina due to coronary heart disease (SCOT-HEART): an open-label, parallel-group, multicentre trial. *Lancet*. 2015;385(9985):2383-91.
41. Shreibati JB, Baker LC, Hlatky MA. Association of coronary CT angiography or stress testing with subsequent utilization and spending among Medicare beneficiaries. *JAMA*. 2011;306(19):2128-36.
42. Tonino PA, De Bruyne B, Pijls NH, et al; FAME Study Investigators. Fractional flow reserve versus angiography for guiding percutaneous coronary intervention. *N Engl J Med*. 2009;360(3):213-24.
43. Williams MC, Hunter A, Shah ASV, et al; SCOT-HEART Investigators. Use of Coronary Computed Tomographic Angiography to Guide Management of Patients With Coronary Disease. *J Am Coll Cardiol*. 2016;67(15):1759-68.

Cardiac Computed Tomography (CT) for Quantitative Evaluation of Coronary Calcification

CPT Codes

75571..... Computed tomography, heart, without contrast material, with quantitative evaluation of coronary artery calcium

Standard Anatomic Coverage

- Coronary Artery Imaging

Imaging Considerations

Advantages of cardiac CT for quantitative evaluation of coronary artery calcification:

- Rapidly acquired exams
- Coronary artery calcification has been shown to correlate with the presence of atheromatous coronary artery disease

Disadvantages of cardiac CT for quantitative evaluation of coronary artery calcification:

- Exposure to ionizing radiation
- No role in the evaluation of patients with symptoms potentially due to coronary artery disease
- Not clear that risk stratification data provided by quantitative evaluation of coronary artery calcification impacts patient outcomes

Biosafety issues:

- Ordering and imaging providers are responsible for considering safety issues prior to performing quantitative evaluation of coronary artery calcification

Ordering issues:

- Cardiac CT for quantitative evaluation of coronary artery calcification is not covered by most healthcare insurers as a screening study.
- Selection of the optimal diagnostic work-up for cardiac evaluation should be made within the context of other available studies (which include treadmill stress test, stress myocardial perfusion imaging, stress echocardiography, cardiac MRI, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.
- This guideline pertains to cardiac CT for quantitative evaluation of coronary artery calcification using either Electron Beam CT (EBCT) or Multi-Detector CT (MDCT).
- This guideline does not apply to coronary CT angiography (CPT 75574).
- This guideline does not apply to cardiac CT for evaluation of cardiac structure and function (CPT 75572-75573).

Quantitative Evaluation of Coronary Artery Calcification

The use of cardiac CT for quantitative evaluation of coronary artery calcification has not been conclusively shown to impact patient outcomes and is therefore considered to be not medically necessary in all clinical situations

Magnetic Resonance Imaging (MRI) Cardiac

CPT Codes

75557..... Cardiac MRI for morphology and function, without contrast material
75559..... Cardiac MRI for morphology and function, without contrast material, with stress imaging
75561..... Cardiac MRI for morphology and function, without contrast material, followed by contrast material
75563..... Cardiac MRI for morphology and function, without contrast material, followed by contrast material with stress imaging
75565..... Add-on code to be used in conjunction with 75557, 75559, 75561, and 75563. As such, this code does not require separate review.

Coding Considerations

Only one procedure in the series 75557–75563 is appropriately reported per session.

Imaging Considerations

Patient Compatibility Issues:

- Gating Issues: As with other cardiac imaging modalities, the acquisition of images is frequently gated to the electrocardiogram. Thus, in patients with irregular heart rhythms, image quality may be suboptimal.

Biosafety Issues:

- Ordering and imaging providers are responsible for considering biosafety issues prior to MRI examination, to ensure patient safety. Among the generally recognized contraindications to MRI exam performance are permanent pacemakers (some newer models are MRI compatible) or implantable cardioverter-defibrillators (ICD), intracranial aneurysm surgical clips that are not compatible with MR imaging, as well as other devices considered unsafe in MRI scanners (including certain implanted materials in the patient as well as external equipment, such as portable oxygen tanks).
- Contrast utilization is at the discretion of the ordering and imaging providers.

Ordering Issues:

- Selection of the optimal diagnostic work-up for cardiac evaluation should be made within the context of other available studies (which include treadmill stress test, stress myocardial perfusion imaging, stress echocardiography, cardiac MRI, cardiac PET imaging and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.

Common Diagnostic Indications

Coronary artery disease

Patients who have had a myocardial infarction

- To assess viability of the infarcted myocardium utilizing delayed hyperenhancement (contrast studies) when other studies (myocardial perfusion imaging or stress echocardiography) have yielded equivocal or indeterminate results; **OR**
- To assess LV function post myocardial infarction when there is discordant information from other studies or when other studies are technically suboptimal; **OR**
- To assess mitral valve regurgitation post-myocardial infarction when echocardiography is technically suboptimal; **OR**
- To assess ventricular septal defects post-myocardial infarction when echocardiography is technically suboptimal; **OR**
- To delineate pericardial effusions associated with acute myocardial infarction when echocardiography is technically suboptimal

Patients with suspected coronary artery disease

- For evaluation of patients with suspected congenital coronary anomalies

Common Diagnostic Indications

Myocarditis

- For the evaluation of patients with suspected myocarditis; **OR**
- For follow-up evaluation LV function of patients with an established diagnosis of myocarditis whose transthoracic echocardiogram is technically suboptimal

Cardiomyopathy

- To assess LV function in symptomatic patients with suspected or established cardiomyopathy when there is discordant information from other studies or when other studies are technically suboptimal; **OR**
- Annual evaluation for suspected cardiomyopathy in clinically stable patients with an established diagnosis of a chronic and progressive disease (excluding CAD) which may result in cardiomyopathy when echocardiography fails to exclude cardiomyopathy. This guideline applies to infiltrative cardiomyopathies (e.g. sarcoidosis; amyloidosis; hemochromatosis), hypertrophic obstructive cardiomyopathy (HOCM) and non-compaction cardiomyopathy; **OR**
- Reevaluation of clinically stable patients with cardiomyopathy at yearly intervals when echocardiography is technically suboptimal; **OR**
- Evaluation of patients with suspected arrhythmogenic right ventricular dysplasia; **OR**
- For coronary vein mapping in patients with cardiomyopathy for whom cardiac resynchronization therapy (CRT) is planned

Cardiac aneurysm or pseudoaneurysm

Congenital heart disease

- For evaluation of suspected congenital anomalies of the coronary arteries; **OR**
- For evaluation of suspected or established congenital heart disease in patients whose echocardiogram is technically limited or nondiagnostic; **OR**
- For further evaluation of patients whose echocardiogram suggests a new diagnosis of complex congenital heart disease; **OR**
- For evaluation of complex congenital heart disease in patients who are less than one year post surgical correction; **OR**
- For evaluation of complex congenital heart disease in patients who have new or worsening symptoms and/or a change in physical examination; **OR**
- To assist in surgical planning for patients with complex congenital heart disease; **OR**
- For surveillance in asymptomatic patients with complex congenital heart disease who have not had cardiac MRI or cardiac CT within the preceding year

Valvular heart disease

- Following inconclusive echocardiography or when echocardiography is not feasible; **OR**
- When moderate or severe valvular disease diagnosed using other imaging modalities requires further definition and that information is likely to affect subsequent management of the patient
    - To assess valvular lesions and measure regurgitant volume, regurgitant fraction, ejection fraction and ventricular volumes
    - To help determine the timing for valvular surgery

Intra-cardiac and para-cardiac masses and tumors

- In patients with a suspected cardiac or para-cardiac mass (thrombus, tumor, etc.) suggested by transthoracic echocardiography, transesophageal echocardiography, blood pool imaging or contrast ventriculography who have not undergone cardiac MRI or cardiac CT within the preceding 60 days; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who are clinically unstable; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who are clinically stable and have not undergone cardiac MRI or cardiac CT within the preceding year; **OR**
- In patients with established cardiac or para-cardiac mass (thrombus, tumor, etc.) who have undergone treatment (chemotherapy, radiation therapy, thrombolysis, anticoagulation or surgery) within the preceding year and have not had cardiac MRI or cardiac CT within the preceding 60 days

Common Diagnostic Indications

Evaluation of cardiac venous anatomy

- For localization of the pulmonary veins in patients with chronic or paroxysmal atrial fibrillation/flutter who are being considered for ablation; **OR**
- Coronary venous localization prior to implantation of a biventricular pacemaker

Evaluation of pericardial conditions (pericardial effusion, constrictive pericarditis, or congenital pericardial diseases)

- In patients with suspected pericardial constriction; **OR**
- In patients with suspected congenital pericardial disease; **OR**
- In patients with suspected pericardial effusion (including hemopericardium) who have undergone echocardiography deemed to be technically suboptimal in evaluation of the effusion; **OR**
- In patients whose echocardiogram shows a complex pericardial effusion (loculated, containing solid material)

Evaluation of the thoracic aorta

- In patients with suspected thoracic aortic aneurysm / dilation who have not undergone CT or MRI of the thoracic aorta within the preceding 60 days; **OR**
- In patients with confirmed thoracic aortic aneurysm / dilation with new or worsening signs/symptoms; **OR**
- For ongoing surveillance of stable patients with confirmed thoracic aortic aneurysm / dilation who have not undergone imaging of the thoracic aorta within the preceding six months; **OR**
- In patients with suspected aortic dissection; **OR**
- In patients with confirmed aortic dissection who have new or worsening symptoms; **OR**
- In patients with confirmed aortic dissection in whom surgical repair is anticipated (to assist in pre-operative planning); **OR**
- For ongoing surveillance of stable patients with confirmed aortic dissection who have not undergone imaging of the thoracic aorta within the preceding year; **OR**
- In patients with confirmed aortic dissection or thoracic aortic aneurysm / dilation who have undergone surgical repair within the preceding year and have not undergone imaging of the thoracic aorta within the preceding six months; **OR**
- In patients who have sustained blunt chest trauma, penetrating aortic trauma or iatrogenic trauma as a result of aortic instrumentation; **OR**
- In patients being evaluated for potential transcatheter aortic valve implantation/replacement (TAVI or TAVR) provided that the patient has not undergone cardiac CT or cardiac MRI within the preceding 60 days

Positron Emission Tomography (PET) Myocardial Imaging

CPT Codes

78491..... PET myocardial perfusion, single study

78492..... PET myocardial perfusion, multiple studies

78459..... PET myocardial, metabolic evaluation

Commonly Used Radiopharmaceuticals

- Ammonia (13NH3)
- Rubidium Chloride (82 RbCl)
- 2-(18F) FLURO-2DEOXY-D-GLUCOSE (FDG)

Imaging Considerations

- Perfusion PET imaging, using ammonia or rubidium isotopes, is used to differentiate areas of myocardium with normal coronary blood flow from those with abnormal coronary blood flow.
- Rest and/or pharmacological stress perfusion PET imaging can be performed.
- When non-invasive imaging is required in morbidly obese patients (BMI > or = 40 kg/m2), with suspected or established CAD, perfusion PET imaging may be considered as the initial test (because of a higher likelihood of technically suboptimal image quality on nuclear stress testing and stress echocardiography in this patient subgroup).
- PET perfusion imaging may also be a preferable initial noninvasive test for other patients in whom conventional nuclear perfusion imaging is likely to be suboptimal including those with breast implants, previous mastectomy, pleural or pericardial effusion, chest wall deformity and those with suboptimal prior nuclear imaging due to attenuation artifact.
- Perfusion PET myocardial imaging is not appropriate for screening for coronary artery disease in asymptomatic low-risk patients regardless of age or body habitus. Whenever possible and clinically appropriate, exercise stress testing should be used in preference to pharmacological testing. However, for patients who are unable to exercise or who have baseline EKG abnormalities which make pharmacological testing preferable, PET imaging is preferable to conventional nuclear perfusion imaging or stress echocardiography.
- Metabolic evaluation (to determine myocardial viability) is performed using PET flurodeoxyglucose (FDG) imaging. Metabolic PET imaging has been shown to be useful in identification of patients who are likely to benefit from revascularization.
- PET metabolic imaging of the myocardium provides clinically useful information only when the myocardium is deemed to be nonviable using other imaging modalities (conventional nuclear perfusion imaging or echocardiography) or when such imaging modalities are inconclusive regarding the viability status of the myocardium.
- Perfusion PET imaging and metabolic PET imaging may occasionally be appropriate in the evaluation of myocardial pathologic processes other than coronary artery disease (e.g. sarcoidosis).
- Isotopes used in PET imaging require special handling arrangements because of their short half-lives.
- While rubidium may be produced in a commercially available on-site generator, ammonia requires cyclotron production.
- Cardiac PET perfusion imaging has higher temporal and special resolution than conventional nuclear perfusion imaging.
- Cardiac PET has the ability to quantify regional myocardial blood flow and myocardial flow reserve, and this information may be useful in determining optimal treatment.
- Prognostic information derived from cardiac PET perfusion imaging is enhanced by gated imaging used to provide LV function evaluation.

- Radiation exposure should be considered in selection of the optimal study for evaluation for cardiac disease.
- Selection of the optimal diagnostic imaging for cardiac evaluation should be made within the context of other available modalities (which include treadmill stress test, conventional nuclear perfusion imaging, stress echocardiography, cardiac CT, cardiac MRI and invasive cardiac/coronary angiography), so that the resulting information facilitates patient management decisions and does not merely add a new layer of testing.

Note: *For the purposes of interpretation of this guideline, the term "conventional nuclear perfusion imaging" refers to imaging using Thallium or Technetium isotopes.*

Common Diagnostic Indications for PET Perfusion Imaging

PET perfusion imaging is appropriate as the **initial** noninvasive stress imaging test for suspected or established CAD for patients who have a relative contraindication(s) to conventional nuclear perfusion imaging (Table 1) and/or a contraindication to exercise stress testing (Table 2) who meet any of the indications for stress testing outlined below.

Table 1. Relative contraindications to conventional nuclear perfusion imaging
Morbid obesity (BMI > or = 40 kg/m^2)
Breast implant(s) in situ
Previous suboptimal conventional nuclear perfusion imaging which was suboptimal due to attenuation artifact
Previous conventional nuclear imaging discordant with coronary angiographic findings
Known pericardial or pleural effusion
Prior mastectomy
Chest wall deformity
Table 2. Contraindications to exercise stress testing
1. Resting EKG abnormalities a. Complete left bundle branch block LBBB b. Electronically paced ventricular rhythm c. Resting ST depression > 1mm d. Left ventricular hypertrophy (LVH) with secondary repolarization abnormalities e. Digoxin effect f. Pre-excitation (e.g. Wolfe Parkinson White syndrome) g. Previous false positive EKG stress test
2. Conditions limiting exercise capacity such that target heart rate (HR) is unlikely to be achieved a. Orthopedic or neurological impairment b. Severe COPD c. Severe heart failure d. Severe claudication e. Prior failure to achieve target HR f. Use of negatively chronotropic medications which cannot be temporarily withheld for testing
3. Severe valvular stenosis
4. Presence of an implanted cardioverter-defibrillator (ICD)

Common Diagnostic Indications for PET Perfusion Imaging

Suspected coronary artery disease in asymptomatic patients

- Patients with high-risk of CAD (SCORE) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with moderate or high risk of CAD (SCORE) who have a high risk occupation that would endanger others in the event of a myocardial infarction, for example: airline pilot, law-enforcement officer, firefighter, mass transit operator, bus driver) who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years; **OR**
- Patients with diseases/conditions with which coronary artery disease commonly coexist and who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency or renal failure; **OR**
- Patients who have undergone cardiac transplantation and have had no evaluation for coronary artery disease within the preceding one (1) year; **OR**
- Patients in whom a decision has been made to treat with interleukin 2
- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Suspected coronary artery disease in symptomatic patients who have not had evaluation of coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding sixty (60) days

- Chest pain
  - With intermediate or high pretest probability of CAD (Table 1); **OR**
  - With low or very low pretest probability of CAD (Table 1) and high risk of CAD (SCORE)
- Atypical symptoms: syncope, shortness of breath (dyspnea), neck, jaw, arm, epigastric or back pain, or sweating (diaphoresis)
  - With moderate or high risk of CAD (SCORE)
- Other symptoms; palpitation, dizziness, lightheadedness, near syncope, nausea, vomiting, anxiety, weakness, fatigue, etc.
  - With high risk of CAD (SCORE)
- Patients with any cardiac symptom who have diseases/conditions with which coronary artery disease commonly coexists such as:
  - Diabetes mellitus; **OR**
  - Abdominal aortic aneurysm; **OR**
  - Established and symptomatic peripheral vascular disease; **OR**
  - Prior history of cerebrovascular accident (CVA), transient ischemic attack (TIA) or carotid endarterectomy (CEA) or high grade carotid stenosis (>70%); **OR**
  - Chronic renal insufficiency or renal failure; **OR**
- Patients who have undergone cardiac transplantation; **OR**
- Patients in whom a decision has been made to treat with Interleukin 2; **OR**
- Patients awaiting solid organ transplantation

Established coronary artery disease in asymptomatic patients

- Patients awaiting solid organ transplantation who have not undergone evaluation for coronary artery disease within the preceding one (1) year

Common Diagnostic Indications for PET Perfusion Imaging

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have new or worsening symptoms

Note: *If symptoms are typical of myocardial ischemia, cardiac catheterization may be more appropriate than perfusion PET imaging.*

Established coronary artery disease (diagnosed by previous cardiac catheterization, MPI, cardiac PET, or stress echo) in patients who have not undergone revascularization and have no symptoms or stable symptoms

- No evaluation of CAD (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the preceding three (3) years
- No evaluation of CAD (MPI, cardiac PET, stress echo, coronary CTA or cardiac catheterization) within the preceding one (1) year in a patient who has undergone cardiac transplantation and has been found to have CAD since transplantation

Established coronary artery disease in patients who have undergone revascularization

- For evaluation of new or worsening cardiac symptoms
  - If symptoms are typical of myocardial ischemia, cardiac catheterization may be more appropriate than MPI; **OR**
- For evaluation of stable patients who have undergone coronary artery bypass grafting more than five (5) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past two (2) years
  - Stable patients whose revascularization has been incomplete may undergo MPI three (3) years following the procedure and every three (3) years thereafter; **OR**
- For evaluation of stable patients who have undergone percutaneous coronary intervention (PCI) more than three (3) years previously and who have not had an evaluation for coronary artery disease (MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization) within the past three (3) years when any of the following applies
  - The patient has undergone PCI of the left main (LM) coronary artery or the proximal left anterior descending (LAD) coronary artery
  - The patient has undergone PCI of more than one coronary artery
  - The patient has chronic total occlusion of a coronary artery and the vessel on which PCI was performed is supplying collateral flow to the occluded vessel
  - The patient is known to have only one patent coronary artery.
  - Left ventricular ejection fraction LVEF is <35%

Established coronary artery disease in patients who have had myocardial infarction (ST elevation or non-ST elevation) or unstable angina within the preceding ninety (90) days provided that:

- The patient did not undergo coronary angiography at the time of the acute event; **AND**
- The patient is currently clinically stable

Established Kawasaki disease with coronary artery involvement

- Every two-year evaluation for confirmed small to medium coronary artery aneurysm
- Annual evaluation for confirmed large (giant) coronary artery aneurysm, multiple or complex aneurysms or coronary artery obstruction confirmed by angiography

Common Diagnostic Indications for PET Perfusion Imaging

Patients with new onset arrhythmias (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD.

- Patients with sustained (lasting more than 30 seconds) or non-sustained (more than 3 beats but terminating within 30 seconds) ventricular tachycardia; **OR**
- Patients with atrial fibrillation or flutter and high or moderate risk of CAD (SCORE); **OR**
- Patients with atrial fibrillation or flutter and established CAD; **OR**
- Patients who have frequent premature ventricular contractions (PVC) defined as more than thirty (30) PVCs per hour on ambulatory EKG (Holter) monitoring
    - It is not clinically indicated to perform perfusion PET imaging for evaluation of infrequent premature atrial or ventricular depolarizations

Patients with new onset congestive heart failure or recently recognized left ventricular systolic dysfunction (patient can be symptomatic or asymptomatic)

This guideline applies to patients with suspected or established CAD.

For patients in this category whose CAD risk (SCORE) is high, cardiac catheterization may be more appropriate than non-invasive evaluation.

- Provided that new or worsening CAD has not been excluded as the cause of LV dysfunction/ CHF by any of the following tests: MPI, stress echo, cardiac PET, coronary CTA or cardiac catheterization

Patients with abnormal exercise treadmill test (performed without imaging)

This guideline applies to patients with suspected or established CAD.

- Abnormal findings on an exercise treadmill test include (chest pain, ST segment change, abnormal BP response or complex ventricular arrhythmias)

Patients with abnormal findings on cardiac CT / coronary CTA

Symptomatic Patients:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis on coronary CTA

Note: *If symptoms are typical of myocardial ischemia, cardiac catheterization may be more appropriate than MPI.*

Asymptomatic patients who have not had MPI, stress echo, cardiac PET or cardiac catheterization within the preceding three (3) years:

- With coronary artery calcium score > 400 Agatston units; **OR**
- Intermediate severity coronary stenosis coronary CTA

Patients with abnormal findings on cardiac catheterization

- To determine flow limiting significance of intermediate coronary stenosis

Common Diagnostic Indications for PET Perfusion Imaging

Pre-operative cardiac evaluation of patients undergoing non-cardiac surgery

This guideline applies to patients undergoing non-emergency surgery.

It is assumed that those who require emergency surgery will undergo inpatient preoperative evaluation.

- Patients with active cardiac conditions such as unstable coronary syndromes (unstable angina), decompensated heart failure (NYHA function of class IV, worsening or new onset heart failure), significant arrhythmias (third degree AV block Mobitz II AV block, uncontrolled supraventricular arrhythmia, symptomatic ventricular arrhythmias, ventricular tachycardia), symptomatic bradycardia or severe stenotic valvular lesions. It is recommended that these conditions be evaluated and managed per ACC/AHA guidelines prior to considering elective surgery. That evaluation may include MPI.

Low-risk surgery (endoscopic procedures, superficial procedures, cataract surgery, breast surgery, ambulatory surgery)

- Provided that there are no active cardiac conditions (as outlined above), MPI prior to low-risk surgery is considered not medically necessary.

Intermediate-risk surgery (including but not limited to intraperitoneal and intrathoracic surgery, carotid endarterectomy, head and neck surgery, orthopedic surgery, prostate surgery, gastric bypass surgery) or **High-risk surgery** (including but not limited to aortic and other major vascular surgery, peripheral vascular surgery) when

- The patient has not had a normal coronary angiogram, SE, MPI, CCTA, Cardiac PET perfusion study or revascularization procedure within the previous one (1) year; **AND**
- At least one of the following applies:
  - Patient has established CAD (prior MI, prior PTCA, stent, or CABG) or presumed CAD (Q waves on EKG, abnormal MPI, SE or cardiac PET); **OR**
  - Patient has compensated heart failure or prior history of heart failure (CHF); **OR**
  - Patient has diabetes mellitus; **OR**
  - Patient has chronic renal insufficiency or renal failure; **OR**
  - Patient has a history of cerebrovascular disease (TIA, CVA or documented carotid stenosis requiring carotid endarterectomy)

PET perfusion imaging is appropriate in follow up to other noninvasive stress imaging tests in the following situations:

Patients who have undergone recent (within the past 60 days) stress echocardiography or conventional nuclear perfusion imaging

- When the initial test is technically suboptimal, technically limited, inconclusive, indeterminate, or equivocal, such that myocardial ischemia cannot be adequately excluded
  - It is not appropriate to perform PET perfusion imaging on patients who have had a recent normal or abnormal stress echocardiogram or conventional nuclear perfusion imaging test.
  - An initial stress imaging test is deemed to be abnormal when there are echocardiographic or perfusion abnormalities. Studies with electrocardiographic abnormalities without echocardiographic or perfusion evidence of ischemia are considered to be normal studies.

PET perfusion imaging – sarcoidosis:

PET perfusion imaging is appropriate in the evaluation of patients with suspected or established cardiac sarcoidosis when performed in conjunction with metabolic PET imaging

Common Diagnostic Indications for Metabolic PET Imaging

Metabolic PET imaging for evaluation of myocardial viability – when all four of the following conditions are met:

- The patient has established coronary artery disease; **AND**
- Left ventricular systolic dysfunction; **AND**
- Viability status is not defined by other testing; **AND**
- Revascularization is being considered

Metabolic PET imaging for evaluation of non-coronary cardiac diseases

- Metabolic PET imaging (with or without perfusion imaging) may be used in the diagnosis or management of cardiac sarcoidosis

References

1. Akers SR, Panchal V, Ho VB, et al.; Expert Panel on Cardiac Imaging. ACR Appropriateness Criteria® Chronic Chest Pain-High Probability of Coronary Artery Disease. *J Am Coll Radiol.* 2017;14(5s):S71-S80.
2. Al Moudi M, Sun Z, Lenzo N. Diagnostic value of SPECT, PET and PET/CT in the diagnosis of coronary artery disease: A systematic review. *Biomed Imaging Interv J*. 2011;7(2):e9.
3. Bateman TM, Dilsizian V, Beanlands RS, DePuey EG, Heller GV, Wolinsky DA. American Society of Nuclear Cardiology and Society of Nuclear Medicine and Molecular Imaging Joint Position Statement on the Clinical Indications for Myocardial Perfusion PET. *J Nucl Med.* 2016;57(10):1654-1656.
4. Bateman TM, Heller GV, McGhie AI, et al. Diagnostic accuracy of rest/stress ECG-gated Rb-82 myocardial perfusion PET: comparison with ECG-gated Tc-99m sestamibi SPECT. *J Nucl Cardiol.* 2006;13(1):24-33.
5. Di Carli MF, Murthy VL. Cardiac PET/CT for the evaluation of known or suspected coronary artery disease. *Radiographics*. 2011;31(5):1239-54.
6. Dorbala S, Di Carli MF, Beanlands RS, et al. Prognostic value of stress myocardial perfusion positron emission tomography: results from a multicenter observational registry. *J Am Coll Cardiol.* 2013;61(2):176-84.
7. Heller GV, Beanlands R, Merlino DA, et al. ASNC model coverage policy: Cardiac positron emission tomographic imaging. *J Nucl Cardiol.* 2013;20(5):916-47.
8. Jaarsma C, Leiner T, Bekkers SC, et al. Diagnostic performance of noninvasive myocardial perfusion imaging using single-photon emission computed tomography, cardiac magnetic resonance, and positron emission tomography imaging for the detection of obstructive coronary artery disease: a meta-analysis. *J Am Coll Cardiol*. 2012;59(19):1719-28.
9. Lertsburapa K, Ahlberg AW, Bateman TM, et al. Independent and incremental prognostic value of left ventricular ejection fraction determined by stress gated rubidium 82 PET imaging in patients with known or suspected coronary artery disease. *J Nucl Cardiol.* 2008;15(6):745-53.
10. Machac J. Cardiac positron emission tomography imaging. *Semin Nucl Med*. 2005;35(1):17-36.
11. Mc Ardle BA, Dowsley TF, deKemp RA, Wells GA, Beanlands RS. Does rubidium-82 PET have superior accuracy to SPECT perfusion imaging for the diagnosis of obstructive coronary disease?: A systematic review and meta-analysis. *J Am Coll Cardiol.* 2012;60(18):1828-37.
12. Merhige ME, Breen WJ, Shelton V, Houston T, D'Arcy BJ, Perna AF. Impact of myocardial perfusion imaging with PET and (82)Rb on downstream invasive procedure utilization, costs, and outcomes in coronary disease management. *J Nucl Med*. 2007;48(7):1069-76.
13. Parker MW, Iskandar A, Limone B, et al. Diagnostic accuracy of cardiac positron emission tomography versus single photon emission computed tomography for coronary artery disease: a bivariate meta-analysis. *Circ Cardiovasc Imaging*. 2012;5(6):700-7.

Cardiac Bibliography

1. American College of Cardiology. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; 2012. http://choosingwisely.org/wp-content/uploads/2012/04/5things_12_factsheet_Amer_Coll_Cardio.pdf. Accessed May 15, 2012.
2. American Society of Nuclear Cardiology. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; 2012. http://choosingwisely.org/wp-content/uploads/2012/04/5things_12_factsheet_Amer_Soc_Nuc_Cardio.pdf. Accessed May 15, 2012.
3. Anderson JL, Adams CD, Antman EM, et al. ACC/AHA 2007 guidelines for the management of patients with unstable angina/non-ST-elevation myocardial infarction. *J Am Coll Cardiol*. 2007;50(7):e1-157.
4. Antman EM, Anbe DT, Armstrong PW, et al. ACC/AHA guidelines for the management of patients with ST-elevation myocardial infarction. *J Am Coll Cardiol*. 2004;44(3):671-719.
5. Armstrong W, Zoghbi W. Stress echocardiography-current methodology and clinical applications. *J Am Coll Cardiol*. 2005;45(11):1739-1747.
6. Bacharach SL, Bax JJ, et al. PET myocardial glucose metabolism and perfusion imaging: part 1—guidelines for patient preparation and data acquisition. *J Nucl Cardiol*. 2003;10(5):543-554.
7. Balady GJ, Larson MG, Vasan RS, et al. Usefulness of exercise testing in the prediction of coronary disease risk among asymptomatic persons as a function of the framingham risk score. *Circulation*. 2004:110(14):1920-1925.
8. Bengel FM, Higuchi T, Javadi MS, Lautamäki R. Cardiac positron emission tomography. *J Am Coll Cardiol*. 2009;54(1);1-15.
9. Bomma C, Dalal D, Tandri H, et al. Evolving role of multidetector computed tomography in evaluation of arrhythmogenic right ventricular dysplasia/cardiomyopathy. *Am J Cardiol*. 2007;100(1):99-105.
10. Bonow RO, Carabello BA, Chatterjee K, et al. ACC/AHA 2006 guidelines for the management of patients with valvular heart disease. *J Am Coll Cardiol*. 2006;48(3):e1-148.
11. Botvinick EH. Scintigraphic blood pool and phase image analysis: the optimal tool for evaluation of resynchronization therapy. *J Nucl Cardiol*. 2003;10(4):424-428.
12. Cheitline MD, Armstrong WF, Aurigemma GP, et al. ACC/AHA/ASE 2003 guideline update for the clinical application of echocardiography. *J Am Coll Cardiol*. 2003;42(5):954-970.
13. Chiles C, Carr JJ. Vascular Diseases of the Thorax: Evaluation with Multidetector CT. *Radiol Clin N Am*. 2005;43(3):543-569.
14. Conroy RM, Pyorala K, Fitzgerald AP, et al. Estimation of ten-year risk of fatal cardiovascular disease in Europe: the SCORE project. *Eur Heart J*. 2003;24(11):987-1003.
15. Crean A, Dutka D, Coulden R. Cardiac imaging using nuclear medicine and positron emission tomography. *Radiol Clin N Am*. 2004;42(3):619-634.
16. Datta J, White CS, Gikleson RC, et al. Anomalous coronary arteries in adults: depiction at multi-detector row CT angiography. *Radiology*. 2005;235(3):812-818.
17. Dembo LG, Shifrin RY, Wolff SD. MR imaging in ischemic heart disease. *Radiol Clin N Am*. 2004;42(3):651-673.
18. DePuey EG, Corbett JR, Friedman JD, et al. Imaging guidelines for nuclear cardiology procedures - a report of the American Society of Nuclear Cardiology Quality Assurance Committee. *J Nucl Cardiol*. 2006;13:e21-171.
19. DePuey EG, Port S, Wackers FJ, et al. Non-perfusion applications in nuclear cardiology. *J Nucl Cardiol*. 1998;5(2):218-231.
20. Detrano R, Guerci AD, Carr JJ, et al. Coronary calcium as a predictor of coronary events in four racial or ethnic groups. *N Engl J Med*. 2008;358(13):1336-1345.
21. DiBaise L, Fahmy TS, Wazni OM, et al. Pulmonary vein total occlusion following caheter ablation for atrial fibrillation : clinical implications after long-term follow-up. *J Am Coll Cardiol*. 2006;48(12):2493-2499.
22. DiCarli MF. CT coronary angiography: where does it fit? *J Nucl Med*. 2006;47:1397–1399.
23. Douglas PS, Garcia MJ, Haines DE, et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 appropriate use criteria for echocardiography. *J Am Coll Cardiol*. 2011;57(9):1126-1166.

24. Eagle KA, Berger PB, Calkins H, et al. ACC/AHA guideline update for perioperative cardiovascular evaluation for noncardiac surgery. *J Am Coll Cardiol*. 2002;39(3):542-553.
25. Edelman RR. Contrast-enhanced MR imaging of the heart: overview of the literature. *Radiology*. 2004;232(3):653-668.
26. Ehara M, Kawai M, Surmely JF et al. Diagnostic accuracy of coronary in-stent restenosis using 64-slice computed tomography. *J Am Coll Cardiol*. 2007;49:951-959.
27. Elhendy A, O'Leary E, Xie F, et al. Comparative accuracy of real-time myocardial contrast perfusion imaging and wall motion analysis during dobutamine stress echocardiography for the diagnosis or coronary artery disease. *J Am Coll Cardiol*. 2004:44(11):2185-2191.
28. Fihn SD, Gardin JM, Abrams J, et al. 2012 ACCF/AHA/ACP/AATS/PCNA/SCAI/STS guideline for the diagnosis and management of patients with stable ischemic heart disease: a report of the ACCF/AHA task force on practice guidelines. *Circulation*. 2012;126(25):e354-e471.
29. Fleischmann K, Hunink M, Kuntz K, Douglas PS. Exercise echocardiography or exercise SPECT imaging? *JAMA*. 1998;280(10):913-920.
30. Fleisher LA, Beckman JA, Brown KA, et al. ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery. executive summary. *J Am Coll Cardiol.* 2007;50(17):1707-1732.
31. Froelicher VF, Fearon WF, Ferguson CM, et al. Lessons learned from studies of the standard exercise ECG test. *Chest*. 1999;116(5):1442-1451.
32. Gersh BJ, Maron BJ, Bonow RO et al. 2011 ACCF/AHA guideline for the diagnosis and treatment of hypertrophic cardiomyopathy: a report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2011;58:e212-e260.
33. Gibbons RJ, Balady GJ, Bricker JT, et al. ACC/AHA/ASNC guideline update for exercise testing: a report of the american college of cardiology/american heart association task force on practice guidelines, committee on exercise testing. *Circulation*. 2002;106(14):1883-1892.
34. Gibbons RJ, Carryer D, Liu H, et al. Use of echocardiography in Olmsted County outpatients with chest pain and normal resting electrocardiograms seen at Mayo Clinic Rochester. *Mayo Clin Proc*. 2015;90(11):1492-1498.
35. Gilkeson RC, Ciancibello L, Zahka K. Multidetector CT evaluation of congenital heart disease in pediatric and adult patients. *AJR Am J Roentgenol*. 2003;180(4):973-980.
36. Glockner JF, Johnston DL, McGee KP. Evaluation of Cardiac Valvular Disease with MR Imaging: Qualitative and Quantitative Techniques. *Radiographics*. 2003;23(1);e9.
37. Goo HW, Park IS, Ko JK, et al. CT of congenital heart disease: normal anatomy and typical pathologic conditions. *Radiographics*. 2003;23:S147-S165.
38. Grebenc M, Rosado de Christenson M, Burke A, Green CE, Galvin JR. Primary cardiac and pericardial neoplasms: radiologic-pathologic correlation. *Radiographics*. 2000;20(4):1073-1103.
39. Greenland P, Alpert JS, Beller GA, et al. 2010 ACCF /AHA guideline for assessment of cardiovascular risk in asymptomatic adults: executive summary. *J Am Coll Cardiol*. 2010;56(25):2182-2199.
40. Greenland P, Bonow RO, Brundage BH, et al. ACC/ AHA 2007 clinical expert consensus document on coronary artery calcium scoring by computed tomography in global cardiovascular risk assessment and in evaluation of patients with chest pain. *J Am Coll Cardiol*. 2007;49(3):378-402.
41. Grundy SM, Pasternak R, Greenland P, Smith S Jr, Fuster V. Assessment of cardiovascular risk using multiple-risk-factor assessment equations: a statement for healthcare professionals from the American Heart Association and the American College of Cardiology. *Circulation*. 1999;100(13):1481-1492.
42. Hachamovitch R, Hayes S, Friedman, J, Cohen I, Berman DS. Stress myocardial perfusion single-photon emission computed tomography is clinically effective and cost effective in risk stratification of patients with a high likelihood or coronary artery disease (CAD) but no known CAD. *J Am Coll Cardiol*. 2004;43(2):200-208.
43. Hachamovitch R, Hayes, Friedman J, et al. Determinants of risk and its temporal variation in patients with normal stress myocardial perfusion scans. *J Am Coll Cardiol*. 2003;41(8):1329-1340.
44. Hachamovitch R, Nutter B, Hlatky MA, et al. Patient management after noninvasive cardiac imaging results from SPARC (Study of myocardial perfusion and coronary anatomy imaging roles in coronary artery disease). *J Am Coll Cardiol*. 2012;59(5):462-474.
45. Hendel RC, Abbott BG, Bateman TM et al. The role of radionuclide myocardial perfusion imaging in asymptomatic individuals. *J Nucl Cardiol*. 2011;18(1):3-15.
46. Hendel RC, Berman DS, Di Carli MF, et al. ACCF/ASNC/ACR/ASE/SCCT/SNM 2009 appropriate use criteria for cardiac radionuclide imaging. *J Am Coll Cardiol*. 2009;53(23):2201-2229.

47. Hendel RC, Patel MR, Kramer CM, et al. ACCF/ACR/SCCT/SCMR/ASNC/NASCI/SCAI/SIR appropriateness criteria for cardiac computed tomography and cardiac magnetic resonance imaging. *J Am Coll Cardiol*. 2006;48(7):1475-1497.
48. Higgins CB, de Roos A. *MRI and CT of the Cardiovascular System*. Philadelphia, PA: Lippincott Williams & Wilkins; 2006.
49. Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with thoracic aortic disease. *J Am Coll Cardiol*. 2010;55(14):e27-e129.
50. Hiratzka LF, Bakris GL, Beckman JA, et al. 2010 ACCF/AHA/AATS/ACR/ASA/SCA/SCAI/SIR/STS/SVM guidelines for the diagnosis and management of patients with thoracic aortic disease. *J Am Coll Cardiol.* 2010; 55(14):1509-1544.
51. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012;59(13):1200-54.
52. Hundley WG, Bluemke DA, Finn JP, et al. ACCF/ACR/AHA/NASCI/SCMR 2010 expert consensus document on cardiovascular magnetic resonance. *J Am Coll Cardiol*. 2010;55(23);2614-2662.
53. Hunold P, Schlosser T, Vogt F, et al. Myocardial late enhancement in contrast-enhanced cardiac MRI: distinction between infarction scar and non-infarction-related disease. *AJR Am J Roentgenol*. 2005;184(5):1420-1426.
54. Hunt SA, Abraham WT, Chin MH, et al. 2009 Focused update incorporated into the ACC/AHA 2005 guidelines for the diagnosis and management of heart failure in adults. *J Am Coll Cardiol*, 2009;53(15):e1-90.
55. Kasirajan V, Hertzer NR, Beven EG, O'Hara PJ, Krajewski LP, Sullivan TM. Management of isolated common iliac artery aneurysms. *Cardiovasc Surg*. 1998;6(2):171.
56. Kim KP, Einstein AJ, Berrington de Gonzalez A. Coronary artery calcification screening–estimated radiation dose and cancer risk. *Arch Intern Med*. 2009;169(13):1188-1194.
57. Kim SC, Adams SC, Hendel RC. Role of nuclear cardiology in the evaluation of acute coronary syndromes. *Ann Emerg Med*. 1997;30(2):210-218.
58. Klein AL, Murray RD, Grimm RA. Role of transesophageal echocardiography-guided cardioversion of patients with atrial fibrillation. *J Am Coll Cardiol.* 2001;37(3):691-704.
59. Klocke FJ, Baird MG, Bateman TM, et al. ACC/AHA/ASNC guidelines for the clinical use of cardiac radionuclide imaging: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines, ACC/AHA/ASNC Committee To Revise the 1995 guideline for the clinical use of cardiac radionuclide imaging. *Circulation*. 2003;108(11):1404-1418.
60. Koh AS, Flores JL, Keng FY, Tan RS, Chua TS. Correlation between clinical outcomes and appropriateness grading for referral to myocardial perfusion imaging for preoperative evaluation prior to non-cardiac surgery. *J Nucl Cardiol*. 2012;19(2):277-284.
61. Kohli P, Gulati M. Exercise stress testing in women: going back to the basics. *Circulation*. 2010 Dec 14;122(24):2570-2580.
62. Krupski WC, Selzman CH, Floridia R, Strecker PK, Nehler MR, Whitehill TA. Contemporary management of isolated iliac aneurysms. *J Vasc Surg.* 1998;28(1):1.
63. Maganti K, Rigolin V. Stress echocardiography versus myocardial SPECT for risk stratification of patients with coronary artery disease. *Curr Opin Cardiol*. 200318(6):486-493.
64. Marcus FI, McKenna WJ, Sherrill D, et al. Diagnosis of arrhythmogenic right ventricular cardiomyopathy/dysplasia: proposed modification of the task force criteria. *Circulation*. 2010;121(13):1533-1541.
65. Mark DB, Berman DS, Budoff MJ, et al. ACCF/ACR/AHA/NASCI/SAIP/SCAI/SCCT 2010 expert consensus document on coronary computed tomographic angiography: a report of the American College of Cardiology Foundation Task Force on Expert Consensus Documents. *J Am Coll Cardiol*. 2010;55(23);2663-2699.
66. Marwick T, Williams MJ, Haluska B, et al. Exercise echocardiography is an accurate and cost-efficient technique for detection of coronary artery disease in women. *J Am Coll Cardiol*. 1995;26(2):355-341.
67. Marwick TH, Zuchowski C, Lauer MS, et al. Functional status and quality of life in patients with heart failure undergoing coronary bypass surgery after assessment of myocardial viability. *J Am Coll Cardiol*. 1999;33(3):750-758.
68. Mehta D, Lubitz SA, Frankel Z, et al. Cardiac involvement in patients with sarcoidosis: diagnostic and prognostic value of outpatient testing. *Chest*. 2008;133(6);1426-1435.
69. Meyer T, Martinoff S, Hadamitsky M, et al. Improved noninvasive assessment of coronary artery bypass grafts with 64-slice computed tomographic angiography in an unselected patient population. *J Am Coll Cardiol*. 2007;49:946-950.
70. Mieres JH, Shaw LJ, Arai A, et al. Role of noninvasive testing in the clinical evaluation of women with suspected coronary artery disease. *Circulation*. 2005;111(5);682-696.

71. Newberger JW, Takahashi M, Gerber MA, 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, endorsed by the American Academy of Pediatrics. *Circulation*. 2004;110(17):2747-2771.
72. Nishimura RA, Otto CM, Bonow RO, et al. 2014 AHA/ACC Guideline for the Management of Patients With Valvular Heart Disease: A Report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2014;63(22):e57-e185.
73. Olmos L, Dakik H, Gordon R, et al. Long-term prognostic value of exercise echocardiography compared with exercise 201Tl, ECG, and clinical variables in patients evaluated for coronary artery disease. *Circulation*. 1998; 98(24):2679-2686.
74. Otto CM. Valvular aortic stenosis. disease severity and timing of Intervention. *J Am Coll Cardiol*. 2006;4(11)7:2141-2151.
75. Panjrath GS, Jain D. Monitoring chemotherapy induced cardiotoxicity: role of cardiac nuclear imaging. *J Nucl Cardiol.* 2006;13(3):415-426.
76. Patel MR, White RD, Abbara S, et al. 2013 ACCF/ACR/ASE/ASNC/SCCT/SCMR Appropriate Utilization of Cardiovascular Imaging in Heart Failure: A Joint Report of the American College of Radiology Appropriateness Criteria Committee and the American College of Cardiology Foundation Appropriate Use Criteria Task Force. *J Am Coll Cardiol*. 2013;61(21):2207-2231.
77. Pellikka, PA, Nagueh SF, Elhendy AA, Kuehl CA, Sawada SG. American Society of Echocardiography recommendations for performance, interpretation, and application of stress echocardiography. *J Am Soc Echocardiogr*. 2007;20(9):1021-1041.
78. Pennell D, Sechtem UP, Higgins CB, et al. Clinical indications for cardiovascular magnetic resonance (CMR): Consensus Panel report. *Eur Heart J*. 2004:25(21):1940-1965.
79. Phillips LM, Mieres JH. Noninvasive assessment of coronary artery disease in women: What's next? *Curr Cardiol Rep*. 2010;12(2):147-154.
80. Picano E, Pasanisi E, Brown J, Marwick TH. A gatekeeper for the gatekeeper: inappropriate referrals to stress echocardiography. *Am Heart J*. 2007;154(2):285-290.
81. Picano E, Pibarot P, Lancelotti P, Monin JL, Bonow RO. The Emerging Role of Exercise Testing and Stress Echocardiography in Valvular Heart Disease. *J Am Coll Cardiol*. 2009;54(24):2251-2260.
82. Poornima I, Miller T, Christian T, et al. Utility of Myocardial Perfusion Imaging in Patients with Low-Risk Treadmill Scores. *J Am Coll Cardiol*. 2004;43(2):194-199.
83. Qaseem A, Alguire P, Dallas P, et al. Appropriate use of screening and diagnostic tests to foster high-value, cost-conscious care. *Ann Intern Med*. 2012;156(2):147-149.
84. Rahimi AR, York M, Gheewala N, Markson L, Hauser TH, Manning WJ. Trends in outpatient transthoracic echocardiography: impact of appropriateness criteria publication. *Am J Med*. 2011;124(8):740-746.
85. Redberg RF, Walsh J. Pay now, benefits may follow—the case of cardiac computed tomographic angiography. *N Engl J Med*. 2008;359(22):2309-2311.
86. Richardson JW, Greenfield LJ. Natural history and management of iliac aneurysms. *J Vasc Surg*. 1988;8(2):165.
87. Rienmüller R, Gröll R, Lipton M. CT and MR imaging of pericardial disease. *Radiol Clin N Am*. 2004;42(3):587-601.
88. Santilli SM, Wernsing SE, Lee ES. Expansion rates and outcomes for iliac artery aneurysms. *J Vasc Surg.* 2000;31(1 Pt 1):114.
89. Sato H, Iwasaki T, et al. Prediction of functional recovery after revascularization in coronary artery disease using 18 FDG and 123I BMIPP SPECT. *Chest* 2000;117(1):65.
90. Schelbert HR, Beanlands R, Bengel F. PET myocardial perfusion and glucose metabolism imaging: Part 2—guidelines for interpretation and reporting. *J Nucl Cardiol*. 2003;10(5):557-571.
91. Schinkel, AFL, Bax, JJ, Geleijnse ML, et al. Noninvasive evaluation of ischaemic heart disease: myocardial perfusion imaging or stress echocardiography? *Eur Heart J*. 2003;24(9):789-800.
92. Senior R, Monaghan M, Becher H, et al. Stress echocardiography for the diagnosis and risk stratification of patients with suspected or known coronary artery disease: a critical appraisal. Supported by the British Society of Echocardiography. *Heart*. 2005;91(4):427-436.
93. Shaw LJ, Mieres JH, Hendel RH, et al. Comparative effectiveness of exercise electrocardiography with or without myocardial perfusion single photon emission computed tomography in women with suspected coronary artery disease: results from the What Is the Optimal Method for Ischemia Evaluation in Women (WOMEN) trial. *Circulation*. 2011;124(11):1239-1249.

94. Strauss HW, Miller DD, Wittry MD, et al. Society of Nuclear Medicine Procedure Guideline for Myocardial Perfusion Imaging 3.3. *J Nucl Med Technol*. 2008;36(3):155-161..
95. Taylor AJ, Cerqueira M, Hodgson JM, et al. ACCF/ SCCT/ACR/AHA/ASE/ASNC/SCAI/SCMR 2010 appropriate use criteria for cardiac computed tomography. *J Am Coll Cardiol*. 2010;56(22):1864-1894.
96. Thrall JH, Ziessman HA. *Nuclear Medicine: The Requisites*. 2nd edition. St. Louis: Elsevier Mosby Publishers; 2001:105-109.
97. Tops LF, Krishnan SC, Schuijf JD, Schalij MJ, Bax JJ. Noncoronary applications of cardiac multidetector row computed tomography. *JACC Cardiol Imaging*. 2008;1(1):94–106.
98. Travin MI, Bergmann SR. Assessment of myocardial viability. *Semin Nucl Med*. 2005;35(1):2-16.
99. Vahanian A, Baumgartner H, Bax J, et al. Guidelines on the management of valvular heart disease: the Task Force on the Management of Valvular Heart Disease of the European Society of Cardiology. *Eur Heart J*. 2007;28(2):230-268.
100. Vallejo E, Dione DP, Sinusas AJ, Wackers FJ. Assessment of left ventricular ejection fraction with quantitative gated SPECT: accuracy and correlation with first pass radionuclide angiography. *J Nucl Cardiol*. 2000;7(5):461-470.
101. Vavas E, Hong SN, Rosen SE, Mieres JH. Noninvasive diagnostic techniques for coronary disease in women. *Clin Cardiol*. 2012;35(3):149-155.
102. Wang ZF, Reddy GP, Gotway MB, et al. CT and MR imaging of pericardial disease. *Radiographics*. 2003;23:S167-S180.
103. Warnes CA, Williams RG, Bashore TM, et al. ACC/AHA 2008 guidelines for the management of adults with congenital heart disease. *J Am Coll Cardiol*. 2008;52(23):e143-e263.
104. Weinreb JC, Larson PA, Woodard PK, et al. American College of Radiology clinical statement on noninvasive cardiac imaging. *Radiology*. 2005;235(3):723-772.
105. Willens HJ, Kessler KM. Transesophageal echocardiography in the diagnosis of diseases of the thoracic aorta; part 1. aortic dissection, aortic intramural hematoma, and penetrating atherosclerotic ulcer of the aorta. *Chest*. 1999;116(6):1772-1779. Williams KA. A historical perspective on measurement of ventricular function with scintigraphic techniques: part II - ventricular function with gated techniques for blood pool and perfusion imaging. *J Nucl Cardiol*. 2005;12(2):208-15.
106. Williams KA. Measurement of ventricular function with scintigraphic techniques: part I - imaging hardware, radiopharmaceuticals, and first pass radionuclide angiography. *J Nucl Cardiol*. 2005;12(1):86-95.
107. Wolk MJ, Bailey SR, Doherty JU, et al. ACCF/AHA/ASE/ASNC/HFSA/HRS/SCAI/SCCT/SCMR/STS 2013 Multimodality Appropriate Use Criteria for the Detection and Risk Assessment of Stable Ischemic Heart Disease: A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Heart Association, American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Cardiovascular Computed Tomography, Society for Cardiovascular Magnetic Resonance, and Society of Thoracic Surgeons. *J Am Coll Cardiol.* 2014;63(4):380-406.
108. Yancy CW, Jessup M, Bozkurt B, et al. 2013 ACCF/AHA Guideline for the Management of Heart Failure: Executive Summary: A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2013;62(16):1495-1539.
109. Yao SS, Qureshi E, Sherrid M, Chaudhry FA. Practical applications in stress echocardiography: risk stratification and prognosis in patients with known or suspected ischemic heart disease. *J Am Coll Cardiol*. 2003;42(6):1084-1090.
110. Zaret BL, Bellar GA. *Clinical Nuclear Cardiology*. 3rd Edition. Philadelphia: Elsevier Mosby Publishers; 2005.
111. Zellweger MJ, Lewin HC, Lai S, et al. When to stress patients after coronary artery bypass surgery. *J Am Coll Cardiol*. 2001;37(1):144-152.
112. Zoghbi WA, Enriquez-Sarano M, Foster E, et al. Recommendations for evaluation of the severity of native valvular regurgitation with two-dimensional and Doppler echocardiography. *J Am Soc Echocardiogr*. 2003;16(7):777-802.

Computed Tomography (CT) Abdomen

CPT Codes

74150..... CT abdomen; without contrast

74160..... CT abdomen; with contrast

74170..... CT abdomen; without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Diaphragmatic dome to iliac crests
- Scan coverage may vary, depending on the specific clinical indication

Technology Considerations

- For most gallbladder and hepatobiliary conditions, ascites evaluation and certain renal abnormalities (such as detection of gallstones, hydronephrosis and differentiation of cystic, complex and solid lesions), initial imaging should be considered using ultrasound.
- Verification of cystic lesions in abdominal viscera can usually be well-documented with ultrasound.
- Ultrasound studies may be limited in obese patients.

Common Diagnostic Indications

This section contains general abdominal, hepatobiliary, pancreatic, gastrointestinal, genitourinary, splenic, and vascular indications.

General Abdominal

Abdominal pain

- Unexplained by any of the following:
  - Clinical findings; **OR**
  - Physical examination; **OR**
  - Other imaging studies

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Ascites

- For diagnosis and surveillance, following non-diagnostic ultrasound

Congenital anomaly

Diffuse, unexplained lower extremity edema

Note: *For female patients, to exclude an occult lesion causing mass effect, vascular compression, or intraluminal thrombi, ultrasound should be considered as the initial imaging modality*

Fever of unknown origin

- Lasting more than three weeks with exceptions for immunocompromised patients
- Following standard work-up to localize the source

Hematoma / hemorrhage

Common Diagnostic Indications

Hernia

- For diagnosis of a hernia with suspected complications or presurgical planning including, but not limited to the following types of hernia:
  - Femoral
  - Internal
  - Inguinal
  - Spigelian (through semilunar line, lateral to rectus abdominis muscle)
  - Ventral

Incisional hernia

- For diagnosis of a hernia with suspected complications or presurgical planning

Note: *Ultrasound should be considered as the initial imaging modality*

Infectious or inflammatory process

- Including but not limited to the following:
  - Abscess
  - Diffuse inflammation / phlegmon
  - Fistula

Iron deposition/overload in hemochromatosis

- When MRI is contraindicated; **AND**
- To exclude iron overload in patients with hemochromatosis who are candidates for chelation therapy or phlebotomy

Lymphadenopathy

- For initial detection and follow-up

Palpable abdominal mass

Note: *For pediatric patients, ultrasound should be considered as the initial imaging modality*

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Retroperitoneal abnormality – fibrosis, inflammation and neoplasm

Trauma

- Following significant blunt or penetrating injury to the abdomen

Common Diagnostic Indications

Tumor (primary neoplasm or metastatic disease)

Diagnosis, management or surveillance of known or suspected malignancy

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures).*
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Unexplained weight loss – significant weight loss exceeding 10% of desirable body weight, over short time interval (six months or less), after initial evaluation for other causes

Hepatobiliary

Acute cholecystitis

- Evaluation of suspected complications of acute cholecystitis when abdominal ultrasound is non-diagnostic

Examples include perforation, abscess, gangrenous or hemorrhagic cholecystitis, gallstone ileus and Mirizzi's syndrome

Cirrhosis for evaluation of hepatocellular carcinoma

Common Diagnostic Indications

Elevated liver transaminases

- Including alanine transaminase (ALT) and aspartate transaminase (AST)
- Following an abnormal or inconclusive abdominal ultrasound
- In patients on medications known to cause liver transaminase elevation, such as statins for hyperlipidemia, acetaminophen, non-steroidal anti-inflammatory drugs, Dilantin®, protease inhibitors and sulfonamides. These medications should be stopped whenever possible and liver chemistries repeated before performing advanced imaging
- Other causes for elevated liver transaminases include excessive alcohol intake, cirrhosis, hepatitis, hepatic steatosis as well as other hepatic and non-hepatic disorders. Consider additional diagnostic labs such as hepatitis panel and serum alpha fetoprotein, as appropriate

Focal liver lesions

Indeterminate lesions (not biopsied and not fully characterized by prior imaging)

- **Initial evaluation** of an indeterminate lesion identified on prior imaging when any of the following are present:
  - Size > 1 cm in diameter
  - Multiple lesions
  - Known malignancy
  - Known cirrhosis
  - Chronic hepatitis
  - Sclerosing cholangitis
  - Primary biliary cirrhosis
  - Hemochromatosis
  - Hemosiderosis
  - Oral contraceptive use
  - Anabolic steroid use
- **Follow up or surveillance** at 3 to 6 months when any of the above risk factors are present, or when the lesion is enhancing, poorly defined or increasing in size

Benign lesions (biopsy-proven or fully characterized by imaging)

- Follow up when symptoms suggest a change in size or character
- Periodic evaluation of known adenoma

Hepatomegaly

- For clinically suspected or worsening hepatic enlargement

Note: *Ultrasound should be considered as the initial imaging modality*

Jaundice

- With abnormal liver function tests (transaminases) and unexplained icterus, following an abdominal ultrasound
- CT imaging used to evaluate for diffuse or multifocal parenchymal liver disease as well as biliary obstruction

Pancreatic

Acute pancreatitis

- With suspected complications including:
  - Pancreatic necrosis
  - Abscess
  - Pseudocyst
  - Peri-pancreatic fluid

Note: *Patients with mild acute, uncomplicated pancreatitis usually do not require cross-sectional imaging, aside from ultrasound identification of gallstones and/or biliary ductal calculi, as a potential cause*

Common Diagnostic Indications

Known pancreatic mass

- CT pancreas with pancreatic protocol is indicated

Note: *MRI pancreas may be performed as an alternative study*

Pancreatic pseudocyst

- With prior history of pancreatitis or pancreatic trauma

Note: *For a patient with a known pancreatic pseudocyst requiring follow-up surveillance, ultrasound should be considered as the initial imaging modality*

Gastrointestinal

Appendiceal or peri-appendiceal mass – unexplained on physical exam and other imaging studies

Appendicitis

Diagnosis

- Male patients or non-pregnant female patients
- Following a non-diagnostic ultrasound in pregnant patients when MRI is contraindicated or unavailable

Management

- Failure of non-operative therapy
- Complications of appendicitis

Bowel obstruction

Diverticulitis

Enteritis and/or colitis

Inflammatory bowel disease (IBD)

Diagnosis

- Evaluation of suspected Crohn's disease following non-diagnostic upper and lower endoscopy

Management

- Evaluation of new or worsening symptoms to confirm exacerbation or evaluate for complications, including stricture, abscess or fistula

Ischemic bowel

Genitourinary

Acute pyelonephritis

- In a patient with any of the following:
  - Diabetes; **OR**
  - History of renal calculi; **OR**
  - History of renal surgery; **OR**
  - Absence of response after 72 hours of therapy

Adrenal lesion

- Following a non-diagnostic ultrasound in neonate patients
- For characterization of an indeterminate adrenal mass identified on prior imaging – such as a benign adenoma versus a metastatic deposit; **OR**
- When there is biochemical evidence of an adrenal endocrine abnormality

Common Diagnostic Indications

Hematuria

Hydronephrosis

- Evaluation for possible obstructing ureteral or urinary bladder lesion
- When ultrasound is non-diagnostic or abnormal and unexplained, requiring further evaluation

Renal cyst

- Following a non-diagnostic ultrasound

Note: *A simple renal cyst which has benign characteristics on ultrasound may not require advanced imaging or surveillance*

Renal lesion

- Characterization of indeterminate lesion, particularly a mass, demonstrated on prior imaging

Note: *For pediatric patients, ultrasound should be considered as the initial imaging modality*

Renal neoplasm

- For diagnosis, initial staging and pre-operative evaluation, re-staging and treatment monitoring

Note: *For pediatric patients, ultrasound should be considered as the initial imaging modality*

Undescended testicle (cryptorchidism)

Urinary tract calculi

Initial evaluation of suspected renal or ureteral calculi in patients with no history of nephrolithiasis

Suspected recurrence

- History of radiolucent calculus
- History of radiopaque calculus and atypical presentation
- History of radiopaque calculus and typical presentation, following non-diagnostic ultrasound

Management and follow up

- In patients planning to undergo treatment with percutaneous nephrolithotomy, ureteroscopy or shock wave lithotripsy, when CT has not been performed within the preceding 30 days
- Symptomatic patients with known radiolucent calculi
- Symptomatic patients with radiopaque calculi, following non-diagnostic KUB or ultrasound
- Asymptomatic patients with known radiolucent calculi, persistent hydronephrosis on ultrasound, and treatment involving either shock wave lithotripsy or ureteroscopic stone extraction

Pregnancy

- Diagnosis or management, following non-diagnostic ultrasound or KUB

Worsening renal function

- Following a non-diagnostic ultrasound

Note: *Non-contrast evaluation is indicated in individuals with worsening renal function, as contrast administration may potentially worsen renal function in these patients.*

Splenic

Indeterminate splenic lesion on prior imaging, such as ultrasound

Note: *Splenic hemangioma is the most common benign splenic tumor and may be followed with splenic ultrasound.*

Splenic hematoma

- Parenchymal
- Subcapsular
- Peri-splenic

Common Diagnostic Indications

Splenomegaly

- For clinically suspected or worsening splenic enlargement

Note: *Ultrasound should be considered as the initial imaging modality*

Vascular

Aneurysm of the abdominal aorta

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the abdominal aorta
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Aortic dissection

- May evaluate with either CT or CTA
  - Usually results from subdiaphragmatic extension of a thoracic aortic dissection

Thrombosis in the systemic and portal venous circulations

- Following initial evaluation with inconclusive Doppler ultrasound

References

1. American Association for the Study of Liver Diseases. Choosing Wisely: CT or MRI to monitor benign focal lesions. ABIM Foundation. June 15, 2014. Available at http://www.choosingwisely.org/clinician-lists/american-association-study-liver-disease-ct-or-mri-to-monitor-benign-focal-lesions/ Accessed on June 28, 2017.
2. American College of Emergency Physicians. Choosing Wisely: CT of abdomen and pelvis for ED patients under 50. ABIM Foundation. October 27, 2014. Available at http://www.choosingwisely.org/clinician-lists/acep-ct-of-abdomen-and-pelvis-for-ed-patients-under-50/ Accessed on Accessed on April 27, 2017.
3. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-society-hematology-limit-surveillance-ct-scans-following-treatment-for-lymphoma/ Accessed on April 27, 2017.
4. American Urological Association. Choosing Wisely: Pelvis CT scans for low-risk, localized prostate cancer. Philadelphia, PA: ABIM Foundation; June 11, 2015. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed on April 27, 2017.
5. Angelucci E, Barosi G, Camaschella C, et al. Italian Society of Hematology practice guidelines for the management of iron overload in thalassemia major and related disorders. *Haematologica*. 2008;93(5):741-752.
6. Arguedas MR, Chen VK, Eloubeidi MA, et al. Screening for hepatocellular carcinoma in patients with hepatitis C cirrhosis: a cost-utility analysis. *Am J Gastroenterol*. 2003;98(3):679-690.
7. Assy N, Nasser G, Djibre A, et al. Characteristics of common solid liver lesions and recommendations for diagnostic workup. *World J Gastroenterol*. 2009;15(26):3217-3227.
8. Beck WC, Holzman MD, Sharp KW, Nealon WH, Dupont WD, Poulose BK. Comparative effectiveness of dynamic abdominal sonography for hernia vs computed tomography in the diagnosis of incisional hernia. *J Am Coll Surg*. 2013 Mar;216(3):447-453.
9. Benter T, Klühs L, Teichgräber U. Sonography of the spleen. J Ultrasound Med. 2011 Sep;30(9):1281-93.
10. Berland LL, Silverman SG, Gore RM, et al. Managing Incidental Findings on Abdominal CT: White Paper of the ACR

Incidental Findings Committee. *J Am Coll Radiol*. 2010;7(10):754-773.

11. Brancatelli G, Federle MP, Grazioli L, et al. Focal nodular hyperplasia: CT findings with emphasis on multiphasic helical CT in 78 patients. *Radiology*. 2001;219(1):61-68.
12. Caturelli E, Pompili M, Bartolucci F, Siena DA, Sperandeo M, Andriulli A, Bisceglia M. Hemangioma-like lesions in chronic liver disease: diagnostic evaluation in patients. *Radiology*. 2001 Aug;220(2):337-342.
13. Chou R, Cuevas C, Fu R, et al. Imaging Techniques for the Diagnosis and Staging of Hepatocellular Carcinoma. Agency for Healthcare Research and Quality (US). Comparative Effectiveness Review Number 143. October 2014. Available at http://www.effectivehealthcare.ahrq.gov/ehc/products/479/1990/liver-cancer-final-141022.pdf Accessed on September 28, 2016.
14. Chung DJ, Huh KC, Choi WJ, Kim JK. CT colonography using 16-MDCT in the evaluation of colorectal cancer. *AJR Am J Roentgenol*. 2005;184(1):98-103.
15. Cristiano A, Dietrich A, Spina JC, et al. Focal nodular hyperplasia and hepatic adenoma: current diagnosis and management. *Updates Surg*. 2014;66(1): 9-21.
16. Dhar M, Denstedt JD. Imaging in diagnosis, treatment, and follow-up of stone patients. *Adv Chronic Kidney Dis*. 2009 Jan;16(1):39-47.
17. Doria AS, Moineddin R, Kellenberger CJ, et al. US or CT for diagnosis of appendicitis in children and adults? A meta-analysis. *Radiology*. 2006 Oct;241(1):83-94.
18. Frauenfelder T, Wildermuth S, Marincel B, Boehm T. Nontraumatic emergent abdominal vascular conditions: advantages of multi-detector row CT and three-dimensional imaging. *Radiographics*. 2004;24(2):481-496.
19. Gore RM, Newmark GM, Thakrar KH, Mehta UK, Berlin JW. Hepatic incidentalomas. *Radiol Clin North Am*. 2011 Mar;49(2):291-322
20. Gore RM, Thakrar KH, Newmark GM, Mehta UK, Berlin JW. Gallbladder imaging. *Gastroenterol Clin North Am*. 2010 Jun;39(2):265-287, ix.
21. Gore RM, Thakrar KH, Wenzke DR, et al. That liver lesion on MDCT in the oncology patient: is it important? *Cancer Imaging.* 2012;12:373-384.
22. Grazioli L, Federle MP, Brancatelli G, et al. Hepatic adenomas: imaging and pathologic findings. *Radiographics*. 2001;21(4):877-892.
23. Halligan S, Altman DG, Taylor SA, et al. CT colonography in the detection of colorectal polyps and cancer: systematic review, meta-analysis, and proposed minimum data set for study level reporting. *Radiology*. 2005;237(3):893-904.
24. Ho PJ, Tay L, Lindeman R, Catley L, Bowden DK. Australian guidelines for the assessment of iron overload and iron chelation in transfusion-dependent thalassaemia major, sickle cell disease and other congenital anaemias. *Intern Med J*. 2011;41(7):516-524.
25. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
26. Jeong YY, Kang HK, Chung TW, et al. Uterine cervical carcinoma after therapy: CT and MR Imaging findings. *Radiographics*. 2003;23(4):969-981.
27. Jung SE. Lee JM, Rha SE, et al. CT and MR Imaging of ovarian tumors with emphasis on differential diagnosis. *Radiographics*. 2002;22(6):1305–1325.
28. Kim AY, Ha HK. Evaluation of suspected mesenteric ischemia: efficacy of radiologic studies. *Radiol Clin North Am*. 2003;41(2):327-342.
29. Kim T, Federie MP, Baron RL, et al. Discrimination of small hepatic hemangiomas from hypervascular malignant tumors smaller than 3 cm with three-phase helical CT. *Radiology*. 2001;219(3):699-706.
30. Kirkpatrick ID, Greenberg HM. Evaluating the CT diagnosis of clostridium difficile colitis: should CT guide therapy? *AJR Am J Roentgenol*. 2001;176(3):635-639
31. Lamba R, Fananapazir G, Corwin MT, et al. Diagnostic imaging of hepatic lesions in adults. *Surg Oncol Clin N Am*. 2014;23(4):789-820.
32. Lang G, Schmiegel W, Nicolas V, et al. Impact of Small Bowel MRI in Routine Clinical Practice on Staging of Crohn's Disease. *J Crohns Colitis*. 2015;9(9):784-794.
33. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol*. 2011;29(5):607-614.
34. Low G, Panu A, Millo N, Leen E. Multimodality imaging of neoplastic and nonneoplastic solid lesions of the pancreas.

Radiographics. 2011 Jul-Aug;31(4):993-1015.

35. Lucey MR, Terrault N, Ojo L, et al. Long-term management of the successful adult liver transplant: 2012 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Liver Transpl*. 2013;19(1):3-26.
36. Mandeville JA, Gnessin E, Lingeman JE. Imaging evaluation in the patient with renal stone disease. *Semin Nephrol*. 2011 May;31(3):254-258.
37. Marrero JA, Ahn J, Rajender Reddy K. American College of Gastroenterology clinical guideline: the diagnosis and management of focal liver lesions. *Am J Gastroenterol*. 2014;109(9):1328-1347.
38. Matsuki M, Kani H, Tatsugami F, et al. Preoperative assessment of vascular anatomy around the stomach by 3D imaging using MDCT before laparoscopy-assisted gastrectomy. *AJR Am J Roentgenol.* 2004;183(1):145-151.
39. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
40. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016; pii: S0302-2838(16)30470-5.
41. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
42. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
43. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
44. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2): e57480.
45. Panes J, Bouzas R, Chaparro M, et al. Systematic review: the use of ultrasonography, computed tomography and magnetic resonance imaging for the diagnosis, assessment of activity and abdominal complications of Crohn's disease. *Aliment Pharmacol Ther*. 2011;34(2):125-145.
46. Pang EH, Harris AC, Chang SD. Approach to the solitary liver lesion: imaging and when to biopsy. *Can Assoc Radiol J*. 2016;67(2):130-148.
47. Sandborn WJ. Crohn's disease evaluation and treatment: clinical decision tool. *Gastroenterology*. 2014;147(3):702-705.
48. World Gastroenterology Organisation. Practice Guideline - Inflammatory Bowel Disease. August 2015. Available at http://www.worldgastroenterology.org/UserFiles/file/guidelines/inflammatory-bowel-disease-english-2015.pdf Accessed on September 28, 2016.
49. Wu LM, Xu JR, Gu HY, et al. Is magnetic resonance imaging a reliable diagnostic tool in the evaluation of active Crohn's disease in the small bowel? *J Clin Gastroenterol.* 2013;47(4):328-338.

Magnetic Resonance Imaging (MRI) Abdomen

CPT Codes

74181..... MRI of abdomen, without contrast

74182..... MRI of abdomen, with contrast

74183..... MRI of abdomen, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication for the abdominal MRI. General landmarks extend from the diaphragmatic dome to the iliac crests

Technology Considerations

- Abdominal MRI studies are usually targeted for further evaluation of indeterminate or questionable findings, identified on more standard imaging exams such as ultrasound and CT.
- For evaluation of vascular abnormalities such as renal artery stenosis and celiac/superior mesenteric artery stenosis (in chronic mesenteric ischemia), Doppler ultrasound, MRA or CTA should be considered as the preferred imaging modalities.
- The CPT code assignment for an MRI procedure is based on the anatomic area imaged. Requests for multiple MRI imaging of the same anatomic area to address patient positional changes, additional sequences or equipment are not allowed. These variations or extra sequences are included within the original imaging request.

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Appendicitis

Diagnosis and management

- In pregnant patients, following a non-diagnostic ultrasound

Note: *This guideline is intended only for pregnant patients*

Congenital anomaly

Contraindication to CT (contrast allergy, renal disease, pregnancy)

- Iodinated contrast risks (i.e., allergy, renal disease)
  - Patient meets appropriateness criteria for CT, and MRI has been shown to have superior diagnostic accuracy to non-contrast CT
- Pregnancy
  - MRI is a reasonable alternative for the requested indication

Diffuse liver disease

- Following an inconclusive or abnormal abdominal ultrasound or CT
- Including the following hepatic disorders:
  - Cirrhosis
  - Chronic hepatitis

Common Diagnostic Indications

Focal liver lesions

Indeterminate lesions (not biopsied and not fully characterized by prior imaging)

- **Initial evaluation** of an indeterminate lesion identified on prior imaging when any of the following are present:
  - Size > 1 cm in diameter
  - Multiple lesions
  - Known malignancy
  - Known cirrhosis
  - Chronic hepatitis
  - Sclerosing cholangitis
  - Primary biliary cirrhosis
  - Hemochromatosis
  - Hemosiderosis
  - Oral contraceptive use
  - Anabolic steroid use
- **Follow up or surveillance** at 3 to 6 months when any of the above risk factors are present, or when the lesion is enhancing, poorly defined or increasing in size

Benign lesions (biopsy-proven or fully characterized by imaging)

- Follow up when symptoms suggest a change in size or character
- Periodic evaluation of known adenoma

Indeterminate abdominal mass

- For further evaluation and characterization of indeterminate lesions arising in the solid abdominal viscera and surrounding anatomic structures, including but not limited to the following anatomic sites:
  - Adrenal – characterization of an adrenal mass, including differentiation of adrenal adenoma from metastasis
  - Assess vascular invasion or compression by pelvic or renal tumor
  - Kidney – evaluation of an indeterminate renal mass
  - Other abdominal and retroperitoneal anatomic structures
  - Pancreas
  - Spleen

Infectious or inflammatory process

- CT is usually the initial imaging modality of choice for infectious and inflammatory conditions
- Including but not limited to the following:
  - Abscess
  - Diffuse inflammation / phlegmon

Inflammatory bowel disease (IBD)

Diagnosis

- Evaluation of suspected Crohn's disease following non-diagnostic upper and lower endoscopy

Management

- Evaluation of new or worsening symptoms to confirm exacerbation or evaluate for complications, including stricture, abscess or fistula

Iron deposition/overload in hemochromatosis

- To exclude iron overload in patients with hemochromatosis who are candidates for chelation therapy or phlebotomy

Common Diagnostic Indications

Lymphadenopathy

- When abdominal CT is non-diagnostic
- May be useful for differentiating enlarged lymph nodes from vascular structures (with flow void on MRI), as follow-up from an unenhanced abdominal CT exam

Tumor (primary neoplasm or metastatic disease)

Management of biopsy-proven malignancy, when MRI is needed to guide treatment in either of the following scenarios:

- CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity)
- Evidence-based literature has shown MRI to have superior diagnostic accuracy to CT.

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures).*
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

References

1. American Association for the Study of Liver Diseases. Choosing Wisely: CT or MRI to monitor benign focal lesions. ABIM Foundation. June 15, 2014. Available at http://www.choosingwisely.org/clinician-lists/american-association-study-liver-disease-ct-or-mri-to-monitor-benign-focal-lesions/ Accessed on June 28, 2017.
2. American College of Emergency Physicians. Choosing Wisely: CT of abdomen and pelvis for ED patients under 50. ABIM Foundation. October 27, 2014. Available at http://www.choosingwisely.org/clinician-lists/acep-ct-of-abdomen-and-pelvis-for-ed-patients-under-50/ Accessed on Accessed on April 27, 2017.
3. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013. Available at http://www.choosingwisely.org/clinician-lists/

american-society-hematology-limit-surveillance-ct-scans-following-treatment-for-lymphoma/ Accessed on April 27, 2017.

4. American Urological Association. Choosing Wisely: Pelvis CT scans for low-risk, localized prostate cancer. Philadelphia, PA: ABIM Foundation; June 11, 2015. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed on April 27, 2017.
5. Angelucci E, Barosi G, Camaschella C, et al. Italian Society of Hematology practice guidelines for the management of iron overload in thalassemia major and related disorders. *Haematologica*. 2008;93(5):741-752.
6. Arguedas MR, Chen VK, Eloubeidi MA, et al. Screening for hepatocellular carcinoma in patients with hepatitis C cirrhosis: a cost-utility analysis. *Am J Gastroenterol*. 2003;98(3):679-690.
7. Assy N, Nasser G, Djibre A, et al. Characteristics of common solid liver lesions and recommendations for diagnostic workup. *World J Gastroenterol*. 2009;15(26):3217-3227.
8. Berland LL, Silverman SG, Gore RM, et al. Managing Incidental Findings on Abdominal CT: White Paper of the ACR Incidental Findings Committee. *J Am Coll Radiol*. 2010;7(10):754-773.
9. Chou R, Cuevas C, Fu R, et al. Imaging Techniques for the Diagnosis and Staging of Hepatocellular Carcinoma. Agency for Healthcare Research and Quality (US). Comparative Effectiveness Review Number 143. October 2014. Available at http://www.effectivehealthcare.ahrq.gov/ehc/products/479/1990/liver-cancer-final-141022.pdf Accessed on September 28, 2016.
10. Cristiano A, Dietrich A, Spina JC, et al. Focal nodular hyperplasia and hepatic adenoma: current diagnosis and management. *Updates Surg*. 2014;66(1): 9-21.
11. Gore RM, Thakrar KH, Wenzke DR, et al. That liver lesion on MDCT in the oncology patient: is it important? *Cancer Imaging.* 2012;12:373-384.
12. Ho PJ, Tay L, Lindeman R, Catley L, Bowden DK. Australian guidelines for the assessment of iron overload and iron chelation in transfusion-dependent thalassaemia major, sickle cell disease and other congenital anaemias. *Intern Med J*. 2011;41(7):516-524.
13. Israel GM, Krinsky GA. MR imaging of the kidneys and adrenal glands. *Radiol Clin North Am*. 2003;41(1):145-159.
14. Jeong YY, Kang HK, Chung TW, et al. Uterine cervical carcinoma after therapy: CT and MR Imaging findings. *Radiographics*. 2003;23(4):969-981.
15. Jung SE. Lee JM, Rha SE, et al. CT and MR Imaging of ovarian tumors with emphasis on differential diagnosis. *Radiographics*. 2002;22(6):1305–1325.
16. Kamel IR, Bluemke DA. MR imaging of liver tumors. *Radiol Clin North Am*. 2003; 41(1): 51-65. 32.
17. Keogan MT, Edelman RR. Technologic advances in abdominal MR imaging. *Radiology*. 2001;220(2):310-320.
18. Kim AY, Ha HK. Evaluation of suspected mesenteric ischemia: efficacy of radiologic studies. *Radiol Clin North Am*. 2003;41(2):327-342.
19. Kinkel K, Lu Y, Mehdizade A, Pelte MF, Hricak H. Intermediate ovarian mass at US: incremental value of second imaging test for characterization–meta-analysis and bayesian analysis. *Radiology*. 2005;236(1):85-94.
20. Lamba R, Fananapazir G, Corwin MT, et al. Diagnostic imaging of hepatic lesions in adults. *Surg Oncol Clin N Am*. 2014;23(4):789-820.
21. Lang G, Schmiegel W, Nicolas V, et al. Impact of Small Bowel MRI in Routine Clinical Practice on Staging of Crohn's Disease. *J Crohns Colitis*. 2015;9(9):784-794.
22. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol*. 2011;29(5):607-614.
23. Lucey MR, Terrault N, Ojo L, et al. Long-term management of the successful adult liver transplant: 2012 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Liver Transpl*. 2013;19(1):3-26.
24. Marrero JA, Ahn J, Rajender Reddy K. American College of Gastroenterology clinical guideline: the diagnosis and management of focal liver lesions. *Am J Gastroenterol*. 2014;109(9):1328-1347.
25. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
26. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016; pii: S0302-2838(16)30470-5.
27. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
28. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National

Comprehensive Cancer Network, 2017.
29. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
30. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2):e57480.
31. Panes J, Bouzas R, Chaparro M, et al. Systematic review: the use of ultrasonography, computed tomography and magnetic resonance imaging for the diagnosis, assessment of activity and abdominal complications of Crohn's disease. *Aliment Pharmacol Ther*. 2011;34(2):125-145.
32. Pang EH, Harris AC, Chang SD. Approach to the Solitary Liver Lesion: Imaging and When to Biopsy. *Can Assoc Radiol J*. 2016;67(2):130-148.
33. Sandborn WJ. Crohn's disease evaluation and treatment: clinical decision tool. Gastroenterology. 2014;147(3):702-705.
34. Sarigianni M, Liakos A, Vlachaki E, et al. Accuracy of magnetic resonance imaging in diagnosis of liver iron overload: a systematic review and meta-analysis. *Clin Gastroenterol Hepatol*. 2015 Jan;13(1):55-63.e5.
35. World Gastroenterology Organisation. Practice Guideline - Inflammatory Bowel Disease. August 2015. Available at http://www.worldgastroenterology.org/UserFiles/file/guidelines/inflammatory-bowel-disease-english-2015.pdf Accessed on September 28, 2016.
36. Wu LM, Xu JR, Gu HY, et al. Is magnetic resonance imaging a reliable diagnostic tool in the evaluation of active Crohn's disease in the small bowel? *J Clin Gastroenterol.* 2013;47(4):328-338.

Magnetic Resonance Cholangiopancreatography (MRCP) Abdomen

CPT Codes

74181..... MRI of abdomen, without contrast

Standard Anatomic Coverage

- Magnetic resonance cholangiopancreatography (MRCP) is used to evaluate the biliary and pancreatic ductal systems non-invasively and is covered under CPT code 74181, abdominal MRI without contrast.

Technology Considerations

- MRCP studies are usually targeted for further evaluation of indeterminate or questionable findings, identified on more standard imaging exams such as ultrasound and CT.
- When magnetic resonance cholangiopancreatography (MRCP) is requested in addition to a MRI of the abdomen, only one MRI abdomen code should be allowed. Additional sequences obtained for MRCP are considered part of the primary procedure.
- MRCP is performed using heavily T2-weighted images to display hyperintense signal from static or slowly-moving fluid-filled structures.
- Advantages of MRCP when compared with ERCP include non-invasive imaging technique, no ionizing radiation, no anesthesia required, often better anatomic visualization proximal to a ductal obstruction, may detect extra-ductal abnormalities not evident by ERCP
- Disadvantages of MRCP when compared with ERCP include limited spatial resolution and therefore less sensitive exam for detection of more subtle abnormalities, only provides diagnostic information compared with ERCP which has both diagnostic and therapeutic capabilities, as a consequence, MRCP may result in a delay for needed therapeutic interventions performed with ERCP (such as sphincterotomy, stone extraction, stent placement), susceptibility artifact on MRI may occur (for example, from metallic foreign bodies/surgical clips in the right upper abdominal quadrant) and result in image degradation.
- MRCP is appropriate in cases of incomplete or failed ERCP or when ERCP cannot be safely performed (e.g., following pancreatic ductal trauma or a significant allergy to iodinated contrast material) or when ERCP is precluded by anatomic considerations such as a biliary-enteric surgical anastomosis.
- Significant upper abdominal ascites and large cystic/fluid-filled structures may impede visualization of the pancreatic and biliary ductal systems with MRCP.

Common Diagnostic Indications

Biliary tract dilatation, biochemical evidence of biliary obstruction and/or unexplained RUQ pain

- Including but not limited to the detection of:
  - Choledocholithiasis
  - Benign stricture
  - Mass lesion (benign or malignant)
  - Fistula

High clinical suspicion for choledocholithiasis in a patient who is post-cholecystectomy

Primary sclerosing cholangitis

Recurrent acute pancreatitis of unknown etiology

- To identify possible causes such as congenitally aberrant ductal anatomy (e.g., choledochal cyst, pancreas divisum and annular pancreas)

Common Diagnostic Indications

Suspected biliary and/or pancreatic ductal abnormalities

References

1. Fayad LM, Kowalski T, Mitchell DG. MR cholangiopancreatography: evaluation of common pancreatic disease. *Radiol Clin North Am*. 2003;41(1):97-114.

CT/MR Angiography (CTA/MRA) Abdomen

CPT Codes

74175..... Computed tomographic angiography, abdomen, with contrast material(s), including non-contrast images, if performed, and image post-processing

74185..... Magnetic resonance angiography, abdomen; without or with contrast

Standard Anatomic Coverage

- Anatomic coverage for CPT codes 74175 (CTA) and 74185 (MRA) includes the major arterial and/or venous structures in the abdomen, from the diaphragmatic dome through the iliac crests.

Technology Considerations

- For CTA of the abdominal aorta and iliofemoral vasculature with lower extremity runoff, use CPT code 75635
- For MRA of the abdominal aorta and iliofemoral vasculature, with lower extremity runoff, use the following CPT codes: CPT 74185 MRA Abdomen x 1 and CPT 73725 MRA Lower Extremities x 2.
- Doppler ultrasound examination is an excellent means to identify a wide range of vascular abnormalities, both arterial and venous in origin. This well-established modality should be considered in the initial evaluation of many vascular disorders listed below.
- CTA of the abdomen is an alternative exam in patients who cannot undergo MRA.

Common Diagnostic Indications

Aneurysm of the abdominal aorta

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the abdominal aorta
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Arteriovenous malformation (AVM) or arteriovenous fistula (AVF)

Note: *For renal or superficial AVM, ultrasound should be considered as the first imaging modality*

Dissection

Of the abdominal aorta and/or branch vessel

Hematoma / hemorrhage

Of the abdominal aorta and/or branch vessel

Mesenteric ischemia

- May have an acute or chronic and progressive (intestinal or abdominal angina) presentation

Portal hypertension

Common Diagnostic Indications

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Prior to resection of pelvic neoplasm

Pseudoaneurysm

Of the abdominal aorta and/or branch vessel

Renal artery stenosis

- Suspected renovascular hypertension from renal artery stenosis with at least **one of the following**
  - Refractory hypertension, in patients receiving therapeutic doses of three (3) or more anti-hypertensive medications with documentation of at least two (2) abnormal serial blood pressure measurements
  - Hypertension with renal failure or progressive renal insufficiency
  - Accelerated or malignant hypertension
  - Abrupt onset of hypertension
  - Hypertension developing in patients younger than 30 years of age
- Deteriorating renal function on angiotensin converting enzyme inhibition
- Abdominal bruit, suspected to originate in the renal artery
- Generalized arteriosclerotic occlusive disease with hypertension
- Unilateral small renal size (greater than 1.5 cm difference in renal size on ultrasound)
- Following an abnormal renal Doppler ultrasound suggestive of renal artery stenosis
- Recurrent, unexplained episodes of “flash” pulmonary edema

Note: *Doppler ultrasound examination of the renal arteries has been shown in the peer-reviewed literature to be efficacious and cost-efficient in detecting renal artery stenosis. However, it is less sensitive than CTA/MRA for detection of renovascular hypertension*

Stenosis or occlusion of the abdominal aorta or branch vessels

- Due to:
  - Atherosclerosis
  - Thromboembolism
  - Other causes

Surgical planning for a kidney donor

Surgical planning for renal tumor resection

Suspected leak following abdominal aortic surgery

Traumatic vascular injury

Unexplained blood loss in the abdomen

Vascular anatomic delineation for other surgical and interventional procedures

- Including but not limited to the following clinical scenarios:
  - For surgical porto-systemic shunt placement or TIPS (transjugular intrahepatic porto-systemic shunt)
  - For hepatic chemo-embolization procedure
  - For vascular delineation prior to operative resection of an abdominal neoplasm
  - For pre- and post-procedure evaluation of bypass grafts, stents and vascular anastomoses

Common Diagnostic Indications

Vascular evaluation of lower extremity claudication

- CPT Coding for abdominal aortic and run-off evaluation, which involves image post-processing for three-dimensional reconstructions, should follow:
  - For CTA: 75635 - CTA of abdominal aorta and bilateral iliofemoral lower extremity run-off without contrast, followed by re-imaging with contrast
  - For MRA: 74185 - abdominal MRA and 73725 - bilateral lower extremity MRAs
- Either CTA or MRA is indicated in a patient with classic presenting symptoms of claudication from peripheral arterial disease, such as diminished/absent peripheral pulses and cramping pain in the legs (particularly in the thighs and calves) when walking, which disappears at rest. Other clinical findings which support non-invasive assessment with CTA or MRA include lower extremity cutaneous ulcers and gangrene.
- In the absence of classic peripheral symptoms of claudication, then obtain a vascular surgical consultation and perform lower extremity non-invasive arterial evaluation, which may include the following: segmental systolic pressure measurements, segmental limb plethysmography, continuous wave Doppler and duplex ultrasonography. Ankle brachial indices (ABI) of < 0.9 may undergo advanced imaging. Rest pain or severe occlusive disease typically occurs with ABI < 0.5

Vascular invasion or compression by an abdominal tumor

Vasculitis

Venous thrombosis or occlusion

Evaluation of suspected thrombosis or occlusion of major abdominal vessels, including portal and systemic venous systems

- Ultrasound is required as the initial study to evaluate the following:
  - Hepatic or portal vein thrombosis
  - Renal vein thrombosis
  - Splenic vein thrombosis

Note: *Ultrasound is not required for suspected thrombosis of the IVC or other venous structures in the abdomen and pelvis.*

Visceral artery aneurysms

- Diagnosis, management, and surveillance of visceral artery aneurysms including:
  - Renal
  - Celiac
  - Splenic
  - Hepatic
  - Superior/inferior mesenteric and their branches

References

1. Anderson JL, Halperin JL, Albert N, et al. Management of Patients With Peripheral Artery Disease (Compilation of 2005 and 2011 ACCF/AHA Guideline Recommendations): A Report of the American College of Cardiology Foundation/ American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2013;61(14):1555-1570.
2. Bolduc JP, Oliva VL, Therasse E. Diagnosis and Treatment of Renovascular Hypertension: A Cost Benefit Analysis. *AJR Am J Roentgenol*. 2005;184:931-937.
3. Cademartiri F, Raaijmakers RHJM, Kuiper JW, et al. Multi-detector row CT angiography in patients with abdominal angina. *Radiographics*. 2001;24(4):969-984.
4. Glockner JF. Three dimensional galdolinium-enhanced MR angiography: applications for abdominal imaging. *Radiographics*. 2001;21(2):357-370
5. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic

valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.

6. Korst MBJM, Joosten FBM, Postma CT, et al. Accuracy of normal-dose contrast-enhanced MR angiography in assessing renal artery stenosis and accessory renal arteries. *AJR Am J Roentgenol*. 2000;174(3):629-634.
7. Leiner T, Kessels,AGH, Nelemans PJ, et al. Peripheral arterial disease: comparison of color duplex US and contrastenhanced MR angiography for diagnosis. *Radiology*. 2005;235(2):699-708.
8. Masunaga H, Takehara Y, Isoda H, et al. Assessment of gadolinium-enhanced time-resolved three dimensional MR angiography for evaluating renal artery stenosis. *AJR Am J Roentgenol*. 2001;176(5):1213-1219.
9. Zhang LJ, Yang GF, Qi J, Shen W. Renal artery aneurysm: diagnosis and surveillance with multidetector-row computed tomography. *Acta Radiol*. 2007;48(3):274-279.

CT Angiography (CTA) Abdominal Aorta and Bilateral Iliofemoral Lower Extremity Run-Off

CPT Codes

75635..... Computed tomographic angiography, abdominal aorta and bilateral iliofemoral lower extremity runoff, with contrast material(s), including non-contrast images, if performed, and image post-processing

Standard Anatomic Coverage

- Anatomic coverage for CPT code 75635 (CTA) includes the abdominal aorta and bilateral iliofemoral vasculature, in addition to lower extremity run-off to the level of the popliteal regions at the knees and often extending through the calf vasculature to the ankle and foot regions.

Technology Considerations

- Doppler ultrasound examination is an excellent means to identify a wide range of vascular abnormalities, both arterial and venous in origin. This well-established modality should be considered in the initial evaluation of many vascular disorders listed below.
- CTA of the abdomen is an alternative exam for patients who cannot undergo MRA.
- Additional, separate requests for a CTA of the pelvis and/or the lower extremities, along with CPT code 75635, are inappropriate.

Common Diagnostic Indications

Aneurysm of abdominal aorta or branch vessel

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the abdominal aorta or branch vessel
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging of the abdomen or pelvis has been performed for this indication within the preceding 60 days

Critical ischemia of lower extremities

- For example, in diabetic vascular disease with ischemic ulcers or gangrene

Dissection

Of the abdominal aorta and/or branch vessel

Hemorrhage

Common Diagnostic Indications

Peripheral arterial disease

- Evaluation of peripheral arterial disease of the lower extremities following non-invasive confirmation (ankle brachial index, toe-brachial index, segmental pressure examination, or duplex ultrasound) in patients with claudication or critical limb ischemia who have no contraindication to revascularization
- Evaluation of peripheral arterial disease of the lower extremities following non-invasive confirmation (ankle brachial index, toe-brachial index, segmental pressure examination, or duplex ultrasound) in patients with ischemic ulceration who have no contraindication to revascularization
- Periodic follow up of patients who have undergone lower extremity revascularization when non-invasive evaluation (ankle brachial index, toe-brachial index, segmental pressure examination, or duplex ultrasound) suggests recurrent stenosis or occlusion
- Following vascular procedures (angiography or revascularization) or trauma involving the lower extremity when non-invasive evaluation suggests a complication (dissection, pseudoaneurysm, external compression, etc.) and CTA will be used to direct subsequent management

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Pseudoaneurysm

Of the abdominal aorta and/or branch vessel

Thromboembolism

Traumatic vascular injury

References

1. Anderson JL, Halperin JL, Albert N, et al. Management of Patients With Peripheral Artery Disease (Compilation of 2005 and 2011 ACCF/AHA Guideline Recommendations): A Report of the American College of Cardiology Foundation/ American Heart Association Task Force on Practice Guidelines. *J Am Coll Cardiol*. 2012;61(14):1555-1570.
2. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
3. Macedo TA, Stanson AW, Oderich GS, et al. Infected aortic aneurysms: imaging findings. *Radiology*. 2004;231(1):250-257.
4. Martin ML, Tay KH, Flak B, et al. Multidetector CT Angiography of the aortoiliac system and lower extremities: a prospective comparison with digital subtraction angiography. *AJR Am J Roentgenol*. 2003;180(4):1085-1091.

Computed Tomography (CT) Pelvis

CPT Codes

72192..... CT of pelvis, without contrast

72193..... CT of pelvis, with contrast

72194..... CT of pelvis without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Iliac crests to ischial tuberosities
- Coverage may vary, depending on the specific clinical indication for the exam

Technology Considerations

- Consider using ultrasound for indications such as differentiation of cystic, complex and solid lesions and initial ascites evaluation.
- Verification of cystic lesions in the pelvis is usually well-established with ultrasound.
- Ultrasound studies may be limited in obese patients.

Common Diagnostic Indications

This section contains general pelvic, intestinal, genitourinary, vascular, and osseous indications.

General Pelvic

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Ascites

- For diagnosis and surveillance, following non-diagnostic ultrasound

Congenital anomaly

Diffuse, unexplained lower extremity edema

Note: *For female patients, to exclude an occult lesion causing mass effect, vascular compression, or intraluminal thrombi, ultrasound should be considered as the initial imaging modality*

Fever of unknown origin

- Lasting more than three weeks with exceptions for immunocompromised patients
- Following standard work-up to localize the source

Hematoma / hemorrhage

Hernia

- For diagnosis of a hernia with suspected complications or presurgical planning including, but not limited to the following types of hernia:
  - Femoral
  - Internal
  - Inguinal
  - Spigelian (through semilunar line, lateral to rectus abdominis muscle)
  - Ventral

Common Diagnostic Indications

Incisional hernia

- For diagnosis of a hernia with suspected complications or presurgical planning

Note: *Ultrasound should be considered as the initial imaging modality*

Infectious or inflammatory process

- Including but not limited to the following:
  - Abscess
  - Diffuse inflammation / phlegmon
  - Fistula
  - Recurrent cystitis (male with at least two episodes or female with failed antibiotic therapy)

Lymphadenopathy

- For initial detection and follow-up

Palpable pelvic mass

- When palpable pelvic mass requires further evaluation following pelvic ultrasound in female patients
- Male patients

Pelvic pain

- For female patients, following non-diagnostic transabdominal and transvaginal pelvic ultrasound
- Unexplained by any of the following:
  - Clinical findings; **OR**
  - Physical examination; **OR**
  - Other imaging studies

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Retroperitoneal abnormality – fibrosis, inflammation and neoplasm

Trauma

- Following significant blunt or penetrating injury to the pelvis

Common Diagnostic Indications

Tumor (primary neoplasm or metastatic disease)

Diagnosis, management or surveillance of known or suspected malignancy

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures).*
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Unexplained weight loss – significant weight loss exceeding 10% of desirable body weight, over short time interval (six months or less) after initial evaluation for other causes

Intestinal

Appendiceal or peri-appendiceal mass – unexplained on physical exam and other imaging studies

Appendicitis

Diagnosis

- Male patients or non-pregnant female patients
- Following a non-diagnostic ultrasound in pregnant patients when MRI is contraindicated or unavailable

Management

- Failure of non-operative therapy
- Complications of appendicitis

Bowel obstruction

Common Diagnostic Indications

Diverticulitis

Enteritis and/or colitis

Inflammatory bowel disease (IBD)

Diagnosis

- Evaluation of suspected Crohn's disease following non-diagnostic upper and lower endoscopy

Management

- Evaluation of new or worsening symptoms to confirm exacerbation or evaluate for complications, including stricture, abscess or fistula

Ischemic bowel

Genitourinary

Hematuria

Hydronephrosis

- Evaluation for possible obstructing ureteral or urinary bladder lesion
- When ultrasound is non-diagnostic or abnormal and unexplained, requiring further evaluation

Undescended testicle (cryptorchidism)

Urinary tract calculi

Initial evaluation of suspected renal or ureteral calculi in patients with no history of nephrolithiasis

Suspected recurrence

- History of radiolucent calculus
- History of radiopaque calculus and atypical presentation
- History of radiopaque calculus and typical presentation, following non-diagnostic ultrasound

Management and follow up

- In patients planning to undergo treatment with percutaneous nephrolithotomy, ureteroscopy or shock wave lithotripsy, when CT has not been performed within the preceding 30 days
- Symptomatic patients with known radiolucent calculi
- Symptomatic patients with radiopaque calculi, following non-diagnostic KUB or ultrasound
- Asymptomatic patients with known radiolucent calculi, persistent hydronephrosis on ultrasound, and treatment involving either shock wave lithotripsy or ureteroscopic stone extraction

Pregnancy

- Diagnosis or management, following non-diagnostic ultrasound or KUB

Common Diagnostic Indications

Vascular

Aneurysm of iliac and femoral vessels

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the iliac or femoral vessels
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual postoperative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Aorto-iliac dissection

- May evaluate with either CT or CTA

Thrombosis in the systemic and portal venous circulations

- Following initial evaluation with inconclusive Doppler ultrasound

Osseous

Acute pelvic trauma, for fracture evaluation

- Radiographs should be performed prior to CT

Hip osteonecrosis

- When the patient is unable to undergo hip MRI or radionuclide bone scintigraphy, which are more sensitive modalities than hip CT, in individuals with normal hip films or inconclusive radiographic evidence of hip osteonecrosis
- In known hip osteonecrosis and femoral head collapse by radiography, CT may help in the preoperative planning, to define the location and extent of disease in patients with painful hips

Osseous tumor evaluation in the pelvis

- MRI or radionuclide bone scintigraphy may be more appropriate for detection of skeletal metastases and primary bone tumors unless otherwise contraindicated

Osteoid osteoma

- Requires negative or inconclusive hip radiographs prior to CT imaging

Sacroiliitis

- Following sacroiliac joint radiographs

Stress / insufficiency fracture in the pelvis

- Radiographs are a required first step before other imaging is performed
  - Subsequent advanced imaging often includes MRI or radionuclide bone scan as the next step

Suspicion of pelvic osteomyelitis or septic arthritis

- When the patient is unable to undergo hip MRI or radionuclide bone scintigraphy

References

1. American College of Emergency Physicians. Choosing Wisely: CT of abdomen and pelvis for ED patients under 50. ABIM foundation. October 27, 2014. Available at http://www.choosingwisely.org/clinician-lists/acep-ct-of-abdomen-and-pelvis-for-ed-patients-under-50/ Accessed on September 28, 2016.
2. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-society-hematology-limit-surveillance-ct-scans-following-treatment-for-lymphoma/ Accessed on April 27, 2017.
3. American Urological Association. Choosing Wisely: Pelvis CT scans for low-risk, localized prostate cancer. Philadelphia, PA: ABIM Foundation; June 11, 2015. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed on April 27, 2017.
4. Beck WC, Holzman MD, Sharp KW, Nealon WH, Dupont WD, Poulose BK. Comparative effectiveness of dynamic abdominal sonography for hernia vs computed tomography in the diagnosis of incisional hernia. *J Am Coll Surg*. 2013 Mar;216(3):447-453.
5. Cannistra SA. Cancer of the ovary. *N Engl J Med*. 2004;351(24):2519-2529.
6. Dhar M, Denstedt JD. Imaging in diagnosis, treatment, and follow-up of stone patients. *Adv Chronic Kidney Dis*. 2009 Jan;16(1):39-47.
7. Doria AS, Moineddin R, Kellenberger CJ, et al. US or CT for diagnosis of appendicitis in children and adults? A meta-analysis. *Radiology*. 2006 Oct;241(1):83-94.
8. Fulgham P, Assimos D, Pearle M, Preminger G. Clinical Effectiveness Protocols for Imaging in the Management of Ureteral Calculous Disease: AUA Technology Assesssment. Linthicum, MD: American Urological Association; 2012. http://www.auanet.org/common/pdf/education/clinical-guidance/Imaging-Assessment.pdf. Accessed September 20, 2013.
9. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
10. Hoppe H, Studer R, Kessler TM, Vock P, Studer UE, Thoeny HC. Alternate or additional findings to stone disease on unenhanced computerized tomography for acute flank pain can impact management. *J Urol*. 2006 May;175(5):1725-30; discussion 1730.
11. Lang G, Schmiegel W, Nicolas V, et al. Impact of Small Bowel MRI in Routine Clinical Practice on Staging of Crohn's Disease. *J Crohns Colitis*. 2015;9(9):784-794.
12. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol*. 2011;29(5):607-614.
13. Lucey MR, Terrault N, Ojo L, et al. Long-term management of the successful adult liver transplant: 2012 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Liver Transpl*. 2013;19(1):3-26.
14. Mandeville JA, Gnessin E, Lingeman JE. Imaging evaluation in the patient with renal stone disease. *Semin Nephrol*. 2011 May;31(3):254-258.
15. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
16. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016; pii: S0302-2838(16)30470-5.
17. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
18. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
19. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
20. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2): e57480.
21. Panes J, Bouzas R, Chaparro M, et al. Systematic review: the use of ultrasonography, computed tomography and magnetic resonance imaging for the diagnosis, assessment of activity and abdominal complications of Crohn's disease.

Aliment Pharmacol Ther. 2011;34(2):125-145.

22. Sandborn WJ. Crohn's disease evaluation and treatment: clinical decision tool. *Gastroenterology*. 2014;147(3):702-705.
23. Smith-Bindman R, Aubin C, Bailitz J, Bengiamin RN, et al. Ultrasonography versus computed tomography or suspected nephrolithiasis. *N Engl J Med.* 2014 Sep 18;371(12):1100-10.
24. World Gastroenterology Organisation. Practice Guideline - Inflammatory Bowel Disease. August 2015. Available at http://www.worldgastroenterology.org/UserFiles/file/guidelines/inflammatory-bowel-disease-english-2015.pdf Accessed on September 28, 2016.
25. Wu LM, Xu JR, Gu HY, et al. Is magnetic resonance imaging a reliable diagnostic tool in the evaluation of active Crohn's disease in the small bowel? *J Clin Gastroenterol.* 2013;47(4):328-338.

Magnetic Resonance Imaging (MRI) Pelvis

CPT Codes

72195..... MRI of pelvis, without contrast
72196..... MRI of pelvis, with contrast
72197..... MRI of pelvis, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Iliac crests to ischial tuberosities
- Coverage may vary, depending on the specific clinical indication for the exam

Technology Considerations

- Depending on the patient's presenting signs and symptoms, pelvic imaging should be directed to the most appropriate modality for clinical work-up.
- Diagnostic evaluation of the pelvis may be performed with pelvic ultrasound (trans-abdominal and trans-vaginal), which is the initial imaging modality for most gynecologic abnormalities. Transabdominal pelvic sonography is also used for urinary bladder assessment, such as post-void residual urine volume. Endoscopy and barium examinations are well established procedures for intestinal evaluation. Cystoscopy is often used for lower urinary tract assessment, pelvic CT or MRI.
- Verification of cystic lesions in the pelvis is usually well-established with ultrasound.
- Ultrasound studies may be limited in obese patients.
- CPT code assignment for an MRI procedure is based on the anatomic area imaged. Authorization requests for multiple MR imaging of the same anatomic area to address patient positional changes, additional sequences or equipment are not allowed.

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Adenomyosis of the uterus following pelvic ultrasound

Adnexal mass(es) following pelvic ultrasound

- Usually performed to further evaluate problematic cases which are initially detected on pelvic ultrasound. Some uses of pelvic MRI in adnexal lesion evaluation include: differentiation of an ovarian mass from an exophytic or pedunculated fibroid; more confident identification of an ovarian dermoid/teratoma, following an ultrasound or other imaging exam; and demonstration of findings to suggest malignancy in some adnexal masses.
- Includes assessment of suspected hemorrhagic cystic lesions and tumors

Appendicitis

Diagnosis and management

- In pregnant patients, following a non-diagnostic ultrasound

Note: *This guideline is intended only for pregnant patients*

Bilateral hip osteonecrosis (avascular necrosis; aseptic necrosis)

- MRI is the modality of choice for evaluation of osteonecrosis, particularly when there is clinical suspicion with hip pain and negative or inconclusive hip radiographs

Bladder or urethral diverticula

Common Diagnostic Indications

Congenital anomaly

Contraindication to CT (contrast allergy, renal disease, pregnancy)

- Iodinated contrast risks (i.e., allergy, renal disease)
  - Patient meets appropriateness criteria for CT, and MRI has been shown to have superior diagnostic accuracy to non-contrast CT
- Pregnancy
  - MRI is a reasonable alternative for the requested indication

Endometriosis

- Following pelvic ultrasound

Infectious or inflammatory process of the soft tissues

- CT is usually the imaging modality of choice for infectious and inflammatory conditions
- Including but not limited to the following:
  - Abscess
  - Diffuse inflammation

Inflammatory bowel disease (IBD)

Diagnosis

- Evaluation of suspected Crohn's disease following non-diagnostic upper and lower endoscopy

Management

- Evaluation of new or worsening symptoms to confirm exacerbation or evaluate for complications, including stricture, abscess or fistula

Lymphadenopathy

- When pelvic CT is non-diagnostic
- May be useful for differentiating enlarged lymph nodes from vascular structures (with flow void on MRI), as follow-up from an unenhanced pelvic CT exam

Obstetrical abnormalities pelvimetry or obstetrical complications

Osteomyelitis or septic arthritis

Pelvic floor disorders associated with urinary or bowel incontinence

Pelvic venous thrombosis evaluation

Sacral insufficiency fracture

Sacroiliitis

- Following sacroiliac joint radiographs

Common Diagnostic Indications

Axial Spondyloarthropathy (SpA)

Diagnosis of Spondyloarthropathy (SpA)

- Negative or equivocal radiographs for sacroiliitis (Grade 0-2) **AND**
- Back pain has persisted for at least three months **AND**
- Clinical evidence for inflammatory back pain defined as at least four of the following five features:
  - Age less than 40
  - Insidious onset
  - Improvement with exercise
  - No improvement with rest
  - Pain at night which improves on getting up

Management of Spondyloarthopathy

Therapy response in patients with ankylosing spondylitis

- Baseline study prior to treatment when the diagnosis of AS is based on radiographic findings
- Evaluate therapy response in patients with ankylosing spondylitis and **all of the following**:
  - Established diagnosis of ankylosing spondylitis
  - No response to therapy
  - At least three months of tumor necrosis factor (TNF) inhibitor therapy

Significant pelvic injury

- Following pelvic or sacral radiographs

Sports hernia (athletic pubalgia)

(All of the following)

- Pain persists at least 6 weeks
- Non-diagnostic radiographs
- Following a trial of conservative therapy that lasts at least 6 weeks
- Patient is a surgical candidate
- Pain is insidious, progressive, worsens with valsalva or movement
- No detectable inguinal or ventral hernia on exam

Note: *Groin pain can be sometime be referred from the hip. See separate guideline for femoral neck stress fracture if that is of concern.*

Common Diagnostic Indications

Tumor (primary neoplasm or metastatic disease)

Diagnosis

- Evaluation of suspected prostate cancer in patients with a rising PSA and negative transrectal ultrasound biopsy (TRUS)

Management of biopsy-proven malignancy, when MRI is needed to guide treatment in either of the following scenarios:

- CT is contraindicated or expected to be suboptimal (due to contrast allergy or anticipated contrast nephrotoxicity)
- Evidence-based literature has shown MRI to have superior diagnostic accuracy to CT.

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures)*.
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Undescended testicle (cryptorchidism)

Uterine artery embolization procedures

- Often performed for treatment of persistent bleeding from uterine fibroids

MRI is generally not indicated in the following clinical situations

The indications listed in this section generally do not require advanced imaging using MRI. If there are circumstances that require MRI imaging, a peer-to-peer discussion may be required.

Piriformis syndrome

Note: *Advanced imaging is generally not indicated.*

References

1. American College of Emergency Physicians. Choosing Wisely: CT of abdomen and pelvis for ED patients under 50. ABIM Foundation. October 27, 2014. Available at http://www.choosingwisely.org/clinician-lists/acep-ct-of-abdomen-and-pelvis-for-ed-patients-under-50/ Accessed on Accessed on April 27, 2017.
2. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013 and December 3, 2014. Available at www.choosingwisely.org. Accessed August 15, 2016.
3. American Urological Association. Choosing Wisely: Pelvis CT scans for low-risk, localized prostate cancer. Philadelphia, PA: ABIM Foundation; June 11, 2015. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed on April 27, 2017.
4. Ascher SM, Reinhold C. Imaging of cancer of the endometrium. *Radiol Clin North Am*. 2002;40(3):563-576.
5. Calin A, Dijkmans BA, Emery P, et al. Outcomes of a multicentre randomised clinical trial of etanercept to treat ankylosing spondylitis. *Ann Rheum Dis*. 2004;63:1594-1600.
6. Farber AJ, Wilckens JH. Sports hernia: diagnosis and therapeutic approach. *J Am Acad Orthop Surg*. 2007;15(8):507-514.
7. Fielding JR. MR imaging of the female pelvis. R*adiol Clin North Am.* 2003;41(1):179-192.
8. Garvey JFW, Hazard H. Sports hernia or groin disruption injury? Chronic athletic groin pain: a retrospective study of 100 patients with long-term follow-up. *Hernia*. 2013;815-823.
9. Gorman JD, Sack KE, Davis JC Jr. Treatment of ankylosing spondylitis by inhibition of tumor necrosis factor alpha. *N Engl J Med*. 2002;346:1349–1356.
10. Hegedus EJ, Stern B, Reiman MP, Tarara D, Wright A a. A suggested model for physical examination and conservative treatment of athletic pubalgia. *Phys Ther Sport*. 2013;14(1):3-16.
11. Khan W, Zoga AC, Meyers WC. Magnetic resonance imaging of athletic pubalgia and the sports hernia: Current understanding and practice. *Magn Reson Imaging Clin N Am*. 2013;21(1):97-110.
12. Kingston JA, Jegatheeswaran S, Macutkiewicz C, et al. A European survey on the aetiology, investigation and management of the “sportsman’s groin”. *Hernia*. 2014;18(6):803-10.
13. Lang G, Schmiegel W, Nicolas V, et al. Impact of Small Bowel MRI in Routine Clinical Practice on Staging of Crohn’s Disease. *J Crohns Colitis*; 2015; 9(9):784-794.
14. Lange JFM, Kaufmann R, Wijsmuller a. R, et al. An international consensus algorithm for management of chronic postoperative inguinal pain. *Hernia*. 2014.
15. Litwin DEM, Sneider EB, McEnaney PM, Busconi BD. Athletic Pubalgia (Sports Hernia). *Clin Sports Med*. 2011;30(2):417-434.
16. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol*. 2011;29(5):607-614.
17. Lucey MR, Terrault N, Ojo L, et al. Long-term management of the successful adult liver transplant: 2012 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Liver Transpl*. 2013;19(1):3-26.
18. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
19. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016; pii: S0302-2838(16)30470-5.
20. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
21. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
22. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
23. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2): e57480.
24. Panes J, Bouzas R, Chaparro M, et al. Systematic review: the use of ultrasonography, computed tomography and magnetic resonance imaging for the diagnosis, assessment of activity and abdominal complications of Crohn’s disease.

Aliment Pharmacol Ther. 2011;34(2):125-145.

25. Sandborn WJ. Crohn's disease evaluation and treatment: clinical decision tool. *Gastroenterology*. 2014;147(3):702-705.
26. World Gastroenterology Organisation. Practice Guideline - Inflammatory Bowel Disease. August 2015. Available at http://www.worldgastroenterology.org/UserFiles/file/guidelines/inflammatory-bowel-disease-english-2015.pdf Accessed on September 28, 2016.
27. Wu LM, Xu JR, Gu HY, et al. Is magnetic resonance imaging a reliable diagnostic tool in the evaluation of active Crohn's disease in the small bowel? *J Clin Gastroenterol.* 2013;47(4):328-338.
28. Zoga AC, Kavanagh EC, Omar IM, et al. Athletic Pubalgia and the "sports hernia": MR imaging findings. *Radiology*. 2008;247(3):797-807.

Fetal MRI

CPT Codes

74712..... Magnetic resonance (eg, proton) imaging, fetal, including placental and maternal pelvic imaging when performed; single or first gestation

74713..... each additional gestation (List separately in addition to code for primary procedure)

Standard Anatomic Coverage

- Field of view should be tailored to fetal and maternal size.
- Single shot fast spin echo and other rapid acquisition sequences are important to minimize the effects of fetal motion.

Technology Considerations

- Ultrasound is the gold standard and primary imaging modality for assessment of the fetus.
- MRI is reserved as a problem solving tool in select circumstances for further assessment of abnormalities detected or incompletely characterized on ultrasound.
- MRI should generally be done without contrast as gadolinium is considered a category C drug.
- The long-term effects of MRI on the fetus are unknown; however, no adverse effects have been found to date.

Common Diagnostic Indications

Assessment prior to fetal intervention

- Following non-diagnostic ultrasound

Complication of monochorionic twins

- Following non-diagnostic ultrasound **(any <u>one</u>♦ of the following)**
  - Anatomy of conjoined twins
  - Demise of a monochorionic cotwin

Congenital anomaly of the abdomen and pelvis

- Following non-diagnostic ultrasound **(any <u>one</u>♦ of the following)**
  - Abdominal mass
  - Bowel obstruction
  - Genitourinary anomaly except rectourethral fistula

Congenital anomaly of the chest

- Following non-diagnostic ultrasound **(any <u>one</u>♦ of the following)**
  - Congenital diaphragmatic hernia
  - Congenital pulmonary airway malformation
  - Pleural effusion

Common Diagnostic Indications

Congenital anomaly of the head and neck

- Following non-diagnostic ultrasound **(any one♦ of the following)**
  - Agenesis of the corpus callosum
  - Cleft palate
  - Cortical malformation
  - Dandy-Walker syndrome
  - Encephalocele
  - Holoprosencephaly
  - Infarct, hemorrhagic or non-hemorrhagic
  - Intracranial mass
  - Meningocele/encephalocele
  - Neck mass
  - Posterior fossa anomaly
  - Vascular malformation, including vein of Galen
  - Ventriculomegaly
  - Vermian hypoplasia

Congenital anomaly of the spine

- Following non-diagnostic ultrasound **(any one♦ of the following)**
  - Caudal regression
  - Congenital anomaly of the vertebrae
  - Neural tube defect
  - Sacrococcygeal teratoma

Placental complication

- Following non-diagnostic ultrasound **(any one♦ of the following)**
  - Abruption
  - Accreta
  - Gestational trophoblastic disease
  - Previa

References

1. American College of Radiology. *ACR-SPR Practice Parameter for the Safe and Optimal Performace of Fetal Magnetic Resonance Imaging (MRI).* Reston, VA: ACR; 2015. Available at http://www.acr.org/~/media/ACR/Documents/PGTS/guidelines/MRI_Fetal.pdf Accessed August 29, 2016.
2. Australia and New Zealand Horizon Scanning Network. *Horizon Scanning Technology Horizon Scanning Report: MRI for the detection of foetal abnormalities*. Canberra: Commonwealth of Australia; October 2007. http://www.horizonscanning.gov.au/ Accessed September 10, 2014.
3. Levine D. Obstetric MRI. *J Magn Reson Imaging*. 2006;24(1):1-15.

CT/MR Angiography (CTA/MRA) Pelvis

CPT Codes

72191..... Computed tomographic angiography, pelvis, with contrast material(s), including non-contrast images, if performed, and image post-processing

72198..... Magnetic resonance angiography, pelvis; without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Iliac crests to ischial tuberosities
- Scan coverage may vary, depending on the specific clinical indication for the exam

Technology Considerations

- Doppler ultrasound examination is an excellent means to identify a wide range of vascular abnormalities, both arterial and venous in origin. This well-established modality should be considered in the initial evaluation of many vascular disorders listed below.
- MRA should also be considered in patients with a history of either previous contrast reaction to intravascular administration of iodinated radiographic contrast material or atopy.
- CTA of the pelvis is an alternative exam in patients who cannot undergo MRA.
- Requests for pelvic CTA or MRA in addition to a request for a MRA or CTA abdominal aorta and bilateral iliofemoral lower extremity runoff study are not allowed.

Common Diagnostic Indications

Aneurysm of the iliac or femoral vessels

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the iliac or femoral vessels
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Arteriovenous malformation (AVM) or arteriovenous fistula (AVF)

Note: *For renal or superficial AVM, ultrasound should be considered as the first imaging modality*

Dissection

Of the iliac arteries or branches

Hematoma / hemorrhage

Of the iliac arteries or branches

Mesenteric ischemia

- May have an acute or chronic and progressive (intestinal or abdominal angina) presentation

Common Diagnostic Indications

Pseudoaneurysm
Of the iliac arteries or branches

Stenosis or occlusion of the lower abdominal aorta, iliac arteries or other branch vessels in the pelvis

Surgical planning for a kidney donor

Suspected leak following abdominal aortic surgery

Traumatic vascular injury

Unexplained blood loss in the pelvis

Vascular anatomic delineation for other surgical and interventional procedures
- For vascular delineation prior to operative resection of a pelvic neoplasm
- For pre- and post-procedure evaluation of bypass grafts, stents and vascular anastomoses

Vascular invasion or compression by a pelvic tumor

Vasculitis

Venous thrombosis or occlusion
- Following initial evaluation with inconclusive Doppler ultrasound

Visceral artery aneurysms
- Diagnosis, management, and surveillance of visceral artery aneurysms including:
  - Superior/inferior mesenteric and their branches

References

1. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
2. Zhang LJ, Yang GF, Qi J, Shen W. Renal artery aneurysm: diagnosis and surveillance with multidetector-row computed tomography. *Acta Radiol*. 2007;48(3):274-279.

Computed Tomography (CT) Abdomen and Pelvis Combination

CPT Codes

74176..... CT of abdomen and pelvis, without contrast

74177..... CT of abdomen and pelvis, with contrast

74178..... CT of abdomen and pelvis, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Diaphragmatic dome through pubic symphysis
- Scan coverage may vary, depending on the specific clinical indication

Technology Considerations

- Verification of cystic lesions in the abdominal and pelvis is usually well-established with ultrasound.
- For abdominal symptoms in the pediatric population abdominal ultrasound frequently provides diagnostic information without incurring radiation exposure from CT.

Common Diagnostic Indications

This section contains general abdominal and pelvic, gastrointestinal, genitourinary, and vascular indications.

General Abdominal and Pelvic

Abdominal / pelvic pain

- Unexplained by any of the following:
  - Clinical findings; **OR**
  - Physical examination; **OR**
  - Other imaging studies

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Ascites

- For diagnosis and surveillance, following non-diagnostic ultrasound

Congenital anomaly

Diffuse, unexplained lower extremity edema

Note: *For female patients, to exclude an occult lesion causing mass effect, vascular compression, or intraluminal thrombi, ultrasound should be considered as the initial imaging modality*

Fever of unknown origin

- Lasting more than three weeks with exceptions for immunocompromised patients
- Following standard work-up to localize the source

Hematoma / hemorrhage

Common Diagnostic Indications

Hernia

- For diagnosis of a hernia with suspected complications or presurgical planning including, but not limited to the following types of hernia:
  - Femoral
  - Internal
  - Inguinal
  - Spigelian (through semilunar line, lateral to rectus abdominis muscle)
  - Ventral

Incisional hernia

- For diagnosis of a hernia with suspected complications or presurgical planning

Note: *Ultrasound should be considered as the initial imaging modality*

Infectious or inflammatory process

- Including but not limited to the following:
  - Abscess
  - Diffuse inflammation / phlegmon
  - Fistula
  - Recurrent cystitis (male with at least two episodes or female with failed antibiotic therapy)

Lymphadenopathy

- For initial detection and follow-up

Palpable abdominal / pelvic mass

- When palpable pelvic mass requires further evaluation following pelvic ultrasound in female patients

Note: *For pediatric patients, ultrasound should be considered as the initial imaging modality.*

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Retroperitoneal abnormality – fibrosis, inflammation and neoplasm

Trauma

- Following significant blunt or penetrating injury to the abdomen

Common Diagnostic Indications

Tumor (primary neoplasm or metastatic disease)

Diagnosis, management or surveillance of known or suspected malignancy

Exclusions—advanced imaging is not indicated in the following scenarios:

- Breast cancer
  - Staging of low risk breast cancer (stage 2B or less) in the absence of signs or symptoms suggestive of metastatic disease
  - Surveillance of breast cancer in the absence of signs or symptoms of recurrent disease
- Colon cancer
  - Surveillance imaging of colon cancer in remission, **unless one of the following high risk features is present**:
    - Lymphatic or venous invasion
    - Lymph node involvement
    - Perineural invasion
    - Poorly differentiated tumor
    - T4 tumor
    - Associated with bowel obstruction
    - Close, indeterminate or positive margins
    - Fewer than 12 nodes examined at surgery
    - Localized perforation
- Gynecologic malignancies
  - Surveillance imaging in patients with previously treated gynecologic malignancies including ovarian, endometrial, cervical, vaginal or vulvar cancer *(**Note:** This exclusion does not apply to sarcoma or other rare histologies not typically associated with these structures).*
- Non-Hodgkin's lymphoma
  - Surveillance imaging of non-Hodgkin's lymphoma for a patient in remission and there has been at least two (2) years since the most recent course of chemotherapy
- Prostate cancer
  - Staging of low risk prostate cancer: Gleason score equal to six (6), PSA less than 10 ng/mL, and stage T1 or T2
  - Follow up or surveillance of prostate cancer following completion of therapy in the absence of a rising PSA

Note: *Surveillance applies to patients with no signs or symptoms of recurrent or persistent disease.*

Unexplained weight loss – significant weight loss exceeding 10% of desirable body weight, over short time interval (six months or less), after initial evaluation for other causes

Gastrointestinal

Appendiceal or peri-appendiceal mass – unexplained on physical exam and other imaging studies

Appendicitis

Diagnosis

- Male patients or non-pregnant female patients
- Following a non-diagnostic ultrasound in pregnant patients when MRI is contraindicated or unavailable

Management

- Failure of non-operative therapy
- Complications of appendicitis

Bowel obstruction

Common Diagnostic Indications

Diverticulitis

Enteritis and/or colitis

Inflammatory bowel disease (IBD)

Diagnosis

- Evaluation of suspected Crohn's disease following non-diagnostic upper and lower endoscopy

Management

- Evaluation of new or worsening symptoms to confirm exacerbation or evaluate for complications, including stricture, abscess or fistula

Ischemic bowel

Genitourinary

Acute pyelonephritis

- In a patient with any of the following:
  - Diabetes; **OR**
  - History of renal calculi; **OR**
  - History of renal surgery; **OR**
  - Absence of response after 72 hours of therapy

Hematuria

Hydronephrosis

- Evaluation for possible obstructing ureteral or urinary bladder lesion
- When ultrasound is non-diagnostic or abnormal and unexplained, requiring further evaluation

Renal neoplasm

- For diagnosis, initial staging and pre-operative evaluation, re-staging and treatment monitoring

Note: *For pediatric patients, ultrasound should be considered as the initial imaging modality.*

Undescended testicle (cryptorchidism)

Common Diagnostic Indications

Urinary tract calculi

Initial evaluation of suspected renal or ureteral calculi in patients with no history of nephrolithiasis

Suspected recurrence

- History of radiolucent calculus
- History of radiopaque calculus and atypical presentation
- History of radiopaque calculus and typical presentation, following non-diagnostic ultrasound

Management and follow up

- In patients planning to undergo treatment with percutaneous nephrolithotomy, ureteroscopy or shock wave lithotripsy, when CT has not been performed within the preceding 30 days
- Symptomatic patients with known radiolucent calculi
- Symptomatic patients with radiopaque calculi, following non-diagnostic KUB or ultrasound
- Asymptomatic patients with known radiolucent calculi, persistent hydronephrosis on ultrasound, and treatment involving either shock wave lithotripsy or ureteroscopic stone extraction

Pregnancy

- Diagnosis or management, following non-diagnostic ultrasound or KUB

Worsening renal function

- Following a non-diagnostic ultrasound

Note: *Non-contrast evaluation is indicated in individuals with worsening renal function, as contrast administration may potentially worsen renal function in these patients.*

Vascular

Aneurysm of the abdominal aorta, iliac or femoral vessels

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the abdominal aorta, iliac or femoral vessels
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Pre-operative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Aorto-iliac dissection

- May evaluate with either CT or CTA
  - Usually results from subdiaphragmatic extension of a thoracic aortic dissection

Thrombosis in the systemic and portal venous circulations

- Following initial evaluation with inconclusive Doppler ultrasound

References

1. American Society of Hematology. Choosing Wisely: Limit surveillance CT scans following treatment for lymphoma. Philadelphia, PA: ABIM Foundation; December 4, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-society-hematology-limit-surveillance-ct-scans-following-treatment-for-lymphoma/ Accessed on April 27, 2017.
2. American Urological Association. Choosing Wisely: Pelvis CT scans for low-risk, localized prostate cancer. Philadelphia, PA: ABIM Foundation; June 11, 2015. Available at http://www.choosingwisely.org/clinician-lists/american-urological-association-pelvis-ct-scans-for-low-risk-localized-prostate-cancer/. Accessed on April 27, 2017.
3. Beck WC, Holzman MD, Sharp KW, Nealon WH, Dupont WD, Poulose BK. Comparative effectiveness of dynamic abdominal sonography for hernia vs computed tomography in the diagnosis of incisional hernia. *J Am Coll Surg*. 2013 Mar;216(3):447-453.
4. Dhar M, Denstedt JD. Imaging in diagnosis, treatment, and follow-up of stone patients. *Adv Chronic Kidney Dis*. 2009 Jan;16(1):39-47.
5. Doria AS, Moineddin R, Kellenberger CJ, et al. US or CT for diagnosis of appendicitis in children and adults? A meta-analysis. *Radiology*. 2006 Oct;241(1):83-94.
6. Fulgham P, Assimos D, Pearle M, Preminger G. Clinical Effectiveness Protocols for Imaging in the Management of Ureteral Calculous Disease: AUA Technology Assesssment. Linthicum, MD: American Urological Association; 2012. http://www.auanet.org/common/pdf/education/clinical-guidance/Imaging-Assessment.pdf. Accessed September 20, 2013.
7. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
8. Hoppe H, Studer R, Kessler TM, Vock P, Studer UE, Thoeny HC. Alternate or additional findings to stone disease on unenhanced computerized tomography for acute flank pain can impact management. *J Urol*. 2006 May;175(5):1725-30; discussion 1730.
9. Loch T. Prostate cancer diagnostics: innovative imaging in case of multiple negative biopsies. *World J Urol*. 2011;29(5):607-614.
10. Lucey MR, Terrault N, Ojo L, et al. Long-term management of the successful adult liver transplant: 2012 practice guideline by the American Association for the Study of Liver Diseases and the American Society of Transplantation. *Liver Transpl*. 2013;19(1):3-26.
11. Mandeville JA, Gnessin E, Lingeman JE. Imaging evaluation in the patient with renal stone disease. *Semin Nephrol*. 2011 May;31(3):254-258.
12. Moore CM, Robertson NL, Arsanious N, et al. Image-guided prostate biopsy using magnetic resonance imaging-derived targets: a systematic review. *Eur Urol*. 2013; 63(1):125-140.
13. Mottet N, Bellmunt J, Bolla M, et al. EAU-ESTRO-SIOG Guidelines on Prostate Cancer. Part 1: Screening, Diagnosis, and Local Treatment with Curative Intent. *Eur Urol*. 2016; pii: S0302-2838(16)30470-5.
14. NCCN Imaging Appropriate Use Criteria for Breast Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
15. NCCN Imaging Appropriate Use Criteria for Colon Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
16. NCCN Imaging Appropriate Use Criteria for Prostate Cancer (Version 2.2017). Available at http://www.nccn.org. ©National Comprehensive Cancer Network, 2017.
17. Nelson AW, Harvey RC, Parker RA, et al. Repeat prostate biopsy strategies after initial negative biopsy: meta-regression comparing cancer detection of transperineal, transrectal saturation and MRI guided biopsy. *PLoS One*. 2013;8(2): e57480.
18. Smith-Bindman R, Aubin C, Bailitz J, Bengiamin RN, et al. Ultrasonography versus computed tomography or suspected nephrolithiasis. *N Engl J Med.* 2014 Sep 18;371(12):1100-10.

CT Angiography (CTA)
Abdomen and Pelvis Combination

CPT Codes

74174..... Computed tomographic angiography, abdomen and pelvis, with contrast material(s), including noncontrast images, if performed, and image postprocessing

Standard Anatomic Coverage

- Anatomic coverage for CPT code 74174 (CTA abdomen and pelvis combination) includes the major arterial and/or venous structures in the abdomen, from the diaphragmatic dome to the ischial tuberosities.
- Coverage for an abdominal CTA generally includes the abdominal aorta and these visceral arteries (aortic branches):
  - Renal arteries
  - Celiac artery
  - Splenic artery
  - Hepatic artery
  - Superior mesenteric artery
- Coverage for a pelvic CTA includes the aortic bifurcation and these arteries:
  - Common iliac artery
  - Internal iliac artery (aka hypogastric) and its branches
  - External iliac artery
- Full evaluation of the superior and inferior mesenteric artery generally requires both CTA abdomen and pelvis.
- Complete evaluation of the femoral artery generally requires CT angiography with ileofemoral lower extremity runoff (CPT 75635).

Technology Considerations

- For CTA of the abdominal aorta and iliofemoral vasculature with lower extremity runoff, use CPT code 75635
- Doppler ultrasound examination is an excellent means to identify a wide range of vascular abnormalities, both arterial and venous in origin. This well-established modality should be considered in the initial evaluation of many vascular disorders listed below.
- CTA is an alternative exam in patients who cannot undergo MRA.
- Requests for a combination CTA abdomen and pelvis study in addition to a request for a CTA abdominal aorta and bilateral iliofemoral lower extremity runoff study are not allowed
- The primary reason to combine CTA's of the abdomen and pelvis is to evaluate for a vascular disease that affects both the abdominal aorta (covered by the CTA abdomen) and the iliac arteries (covered by CTA pelvis). Some examples include ischemia, occlusion, aneurysm, trauma, vasculitis.
- Aortic stent grafts often cover the infrarenal abdominal aorta and proximal iliac arteries. CTA abdomen and pelvis should be used to evaluate complications such as endoleak in these cases.
- Aortic dissection will often be requested at a CTA chest (CPT 71275) and abdomen. Pelvis is not required.

Common Diagnostic Indications

Aneurysm of the abdominal aorta, iliac or femoral vessels

- Following inconclusive ultrasound in patients with suspected aneurysm/dilation of the abdominal aorta, iliac or femoral vessels
- Follow-up imaging of patients with an established aneurysm/dilation when most recent ultrasound imaging is inconclusive
- Preoperative assessment or prior to percutaneous endovascular stent graft placement
- Annual post-operative surveillance of stable patients who have undergone open surgical repair when most recent ultrasound imaging is inconclusive
- Post-operative surveillance of stable patients who have been treated with endovascular stent graft
- Suspected complication of an aneurysm/dilation, such as aneurysmal rupture or infection—requiring urgent imaging
- Prior to transcatheter aortic valve implantation/replacement (TAVI or TAVR), unless advanced imaging has been performed for this indication within the preceding 60 days

Arteriovenous malformation (AVM) or arteriovenous fistula (AVF)

Note: *For renal or superficial AVM, ultrasound should be considered as the first imaging modality*

Dissection

Of the abdominal aorta and/or branch vessel

Hematoma / hemorrhage

Of the abdominal aorta and/or branch vessel

Mesenteric ischemia

- May have an acute or chronic and progressive (intestinal or abdominal angina) presentation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Prior to resection of pelvic neoplasm

Pseudoaneurysm

Of the abdominal aorta and/or branch vessel

Stenosis or occlusion of the abdominal aorta or branch vessels

- Due to:
  - Atherosclerosis
  - Thromboembolism
  - Other causes

Suspected leak following abdominal aortic surgery or intervention (endoleak)

Traumatic vascular injury

Unexplained blood loss in the abdomen

Vascular anatomic delineation for other surgical and interventional procedures

- Including but not limited to the following clinical scenarios:
  - For vascular delineation prior to operative resection of an abdominal neoplasm
  - For pre- and post-procedure evaluation of bypass grafts, stents and vascular anastomoses

Vascular invasion or compression by an abdominal tumor

Common Diagnostic Indications

Vasculitis

Venous thrombosis or occlusion

Evaluation of suspected thrombosis or occlusion of major abdominal vessels, including portal and systemic venous systems

- Ultrasound is required as the initial study to evaluate the following:
  - Hepatic or portal vein thrombosis
  - Renal vein thrombosis
  - Splenic vein thrombosis

Note: *Ultrasound is not required for suspected thrombosis of the IVC or other venous structures in the abdomen and pelvis.*

Visceral artery aneurysms

- Diagnosis, management, and surveillance of visceral artery aneurysms including:
  - Renal
  - Celiac
  - Splenic
  - Hepatic
  - Superior/inferior mesenteric and their branches

References

1. Holmes DR Jr, Mack MJ, Kaul S, et al. 2012 ACCF/AATS/SCAI/STS expert consensus document on transcatheter aortic valve replacement. *J Am Coll Cardiol*. 2012 Mar 27;59(13):1200-1254.
2. Zhang LJ, Yang GF, Qi J, Shen W. Renal artery aneurysm: diagnosis and surveillance with multidetector-row computed tomography. *Acta Radiol*. 2007;48(3):274-279.

Computed Tomography (CT)
CT Colonography
(Virtual Colonoscopy)

CPT Codes

74261..... Diagnostic CT colonography without contrast

74262..... Diagnostic CT colonography with contrast including non-contrast images if performed

74263..... Screening CT colonography including image post-processing

Standard Anatomic Coverage

- Use of helical CT and reconstruction algorithms to provide endoluminal visualization of the colon, as well as anatomic depiction throughout much of the abdomen and pelvis. Both 2D and 3D reconstructions are routinely used for colonic evaluation. Colonic preparation is required, similar to standard fiberoptic colonoscopy. Another similarity to fiberoptic colonoscopy is the requirement for air insufflation to distend the colon

Technology Considerations

- CPT codes for CT of the abdomen (74150–74170) and CT of the Pelvis (72192–72194) should not be used when a CT colonography exam is requested.
- Depending on the presenting signs and symptoms, other studies such as fiberoptic colonoscopy and barium examination may be helpful for evaluation of the colon.
- CT colonography requires cleansing bowel preparation and air insufflation for colonic distention, similar to fiberoptic colonoscopy.

Common Diagnostic Indications

This section contains indications for diagnostic CT colonography (74261, 74262) and for screening CT colonography (74263).

Indications for Diagnostic CT Colonography (74261, 74262)

Coagulopathy

Complications from prior fiberoptic colonoscopy

Diverticulitis, with increased risk of perforation

Failed or incomplete fiberoptic colonoscopy of the entire colon, due to inability to pass the colonoscope proximally. Failure to advance the colonoscope may be secondary to:

- Obstructing neoplasm
- Spasm
- Redundant colon
- Altered anatomy or scarring from previous surgery
- Stricture
- Extrinsic compression

Increased sedation risk

- For example, COPD or previous adverse reaction to anesthesia

Known colonic obstruction, when standard fiberoptic colonoscopy is contraindicated

Lifetime or long-term anticoagulation, with increased patient risk if discontinued

Common Diagnostic Indications

Indication for Screening CT Colonography (74263)

As an alternative to either conventional (optical) colonoscopy or double contrast barium enema for colorectal cancer screening, in individuals beginning at the age of 50 years and at a frequency of every 5 years

References

1. Chung DJ, Huh KC, Choi WJ, Kim JK. CT colonography using 16-MDCT in the evaluation of colorectal cancer. *AJR Am J Roentgenol*. 2005;184(1):98-103.
2. Cohnen M, Vogt C, Beck A, et al. Feasibility of MDCT colonography in ultra-low-dose technique in the detection of colorectal lesions: comparison with high-resolution video colonoscopy. *AJR Am J Roentgenol*. 2004;183(5):1355-1359.
3. Halligan S, Altman DG, Taylor SA, et al. CT colonography in the detection of colorectal polyps and cancer: systematic review, meta-analysis, and proposed minimum data set for study level reporting. *Radiology*. 2005;237(3):893-904.
4. Macari M, Bini EJ. CT Colonography: where have we been and where are we going? *Radiology*. 2005;237(3):819-833.

Computed Tomography (CT) Cervical Spine

CPT Codes

72125..... CT of cervical spine, without contrast

72126..... CT of cervical spine, with contrast

72127..... CT of cervical spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire cervical spine (C1-C7), from the craniocervical junction through the T1 vertebra
- Axial images are routinely obtained, with capability for coronal and sagittal reconstructions

Imaging Considerations

- MRI is the modality of choice for most cervical spine imaging indications, unless contraindicated or not tolerated by the patient (for example, secondary to claustrophobia)
- CT is the preferred technique for certain clinical scenarios such as suspected fracture, follow-up of known fracture, osseous tumor evaluation and congenital vertebral defects, as well as procedures such as cervical spine CT myelography
- Do not use CT cervical spine for imaging of the soft tissues of the neck. See CPT codes 70490-70492 CT soft tissue neck for this service

Common Diagnostic Indications

MRI is the preferred modality for most cervical spine imaging, except for a few indications which include CT evaluation of bony abnormalities (such as suspected fracture or fracture follow-up; osseous tumor assessment; developmental vertebral abnormalities) and CT myelography

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Fracture evaluation

- Following initial evaluation with radiographs

Post-myelogram CT or CT following other cervical spine interventional procedure

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

Significant acute trauma to the cervical spine region

When the patient's condition meets the cervical spine MRI guidelines, but there is either a contraindication to MRI or the patient cannot tolerate MRI examination (for example, due to claustrophobia)

For most other indications, MRI is the preferred modality for advanced cervical spine imaging, unless contraindicated

Chiari malformation (Arnold-Chiari malformation)

Common Diagnostic Indications

Congenital spine anomalies

- Cervical spine dysraphism and other congenital anomalies involving the cervical spine and/or spinal cord
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Infectious process

- Including but not limited to the following:
  - Abscess
  - Osteomyelitis
  - Discitis

Neck pain without neurologic or radicular features

Note: *This guideline does not apply to patients with known or suspected malignancy, infection, or underlying conditions which predispose to instability at the craniocervical junction.*

Diagnosis of the etiology of neck pain in patients who are willing and able to undergo spine surgery or epidural steroid injection (ESI) when <u>both</u> of the following criteria are met:

- Lack of improvement or worsening during a six (6) week course of therapy with at least two (2) different forms of treatment
- Cervical spine X-ray is negative or does not clearly explain the cause of the patient's symptoms.

Neck pain with radiculopathy

Note: *This guideline does not apply to patients with known or suspected malignancy, infection, myelopathy, or underlying conditions which predispose to instability at the craniocervical junction.*

Diagnosis of the etiology of cervical nerve root compression in patients who are willing and able to undergo spine surgery or cervical epidural steroid injection (ESI) when <u>either</u> of the following criteria are met:

- Documented abnormality on neurological exam in a dermatome/radicular distribution that has not previously been imaged or has progressed since a prior imaging study has been performed
- Lack of improvement or worsening during a six (6) week course of therapy with at least two (2) different forms of treatment

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Rheumatoid arthritis

- For suspected cervical subluxation in a patient with confirmed rheumatoid arthritis

Severe scoliosis, for the following patient populations:

- In patients with a high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Common Diagnostic Indications

Spondyloarthropathies

Note: *Including but not limited to: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Syringohydromyelia (syrinx)

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. Abbed KM, Coumans JV. Cervical radiculopathy: pathophysiology, presentation, and clinical evaluation. Neurosurgery. 2007 Jan;60(1 Supp1 1):S28-34.
2. Ahn NU, Ahn UM, Ipsen B, Mechanical neck pain and cervicogenic headache. Neurosurgery. 2007 Jan;60(1 Supp1 1):S21-7.
3. Alentado VJ, Lubelski D, Steinmetz MP, Benzel EC, Mroz TE. Optimal duration of conservative management prior to surgery for cervical and lumbar radiculopathy: a literature review. Global Spine J. 2014 Dec;4(4):279-86. doi: 10.1055/s-0034-1387807. Epub 2014 Aug 28. Review.
4. Anekstein Y, Blecher R, Smorgick Y et al. What is the best way to apply the Spurling test for cervical radiculopathy? Clin Orthop Relat Res. 2012 Sep;470(9):2566-72.
5. Corey DL, Comeau D. Cervical radiculopathy. Med Clin North Am. 2014 Jul;98(4):791-9
6. Duggal N, Pickett GE, Mitsis DK, et al. Early clinical and biomechanical results following cervical arthroplasty. Neurosurg Focus. Sep 15 2004;17(3):E9.
7. Ellenberg MR, Honet JC, Treanor WJ. Cervical radiculopathy. Arch Phys Med Rehabil. 1994 Mar;75(3):342-52.
8. Eubanks JD. Cervical radiculopathy: nonoperative management of neck pain and radicular symptoms. Am Fam Physician. 2010 Jan 1;81(1):33-40.
9. Forbush SW, Cox T, Wilson E. Treatment of patients with degenerative cervical radiculopathy using a multimodal conservative approach in a geriatric population: a case series J Orthop Sports Phys Ther. 2011 Oct;41(10):723-33
10. Fortin J, Riethmiller DW, Vilensky JA. No clear winner in differing imaging modalities for cervical radiculopathy. Pain Physician. 2002 Jul;5(3):285-7.
11. Gross A, Kay TM, Cervical Overview Group, et al. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2015 Jan 28;1:CD004250.
12. Gross A, Langevin P, Burnie SJ, et al. Manipulation and mobilisation for neck pain contrasted against an inactive control or another active treatment. Cochrane Database Syst Rev. 2015 Sep 23;(9):CD004249.
13. Kuijper B, Tans JT, Beelen A, Nollet F, de Visser M. Cervical collar or physiotherapy versus wait and see policy for recent onset cervical radiculopathy: randomised trial. BMJ. 2009 Oct 7;339:b3883
14. Mummaneni PV, Kaiser MG, Joint Section on Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and Congress of Neurological Surgeons, et al. Preoperative patient selection with magnetic resonance imaging, computed tomography, and electroencephalography: does the test predict outcome after cervical surgery? J Neurosurg Spine. 2009 Aug;11(2):119-29.
15. Narváez JA, Narváez J, Serrallonga M, et al. Cervical spine involvement in rheumatoid arthritis: correlation between neurological manifestations and magnetic resonance imaging findings. Rheumatology (Oxford). 2008 Dec;47(12):1814-9
16. Nordin M, Carragee EJ, Hogg-Johnson S, Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine (Phila Pa 1976). 2008 Feb 15;33(4 Suppl):S101-22.
17. Rhee JM, Yoon T, Riew KD. Cervical radiculopathy. J Am Acad Orthop Surg. 2007 Aug;15(8):486-94.
18. van Eerd M, Patijn J, Lataster A. Cervical facet pain. Pain Pract. 2010 Mar-Apr;10(2):113-23.

Magnetic Resonance Imaging (MRI) Cervical Spine

CPT Codes

72141..... MRI of cervical spine, without contrast

72142..... MRI of cervical spine, with contrast

72156..... MRI of cervical spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire cervical spine (C1-C7), from the craniocervical junction through the T1 vertebra
- Axial images are routinely obtained, with capability for coronal and sagittal reconstructions

Imaging Considerations

- For most cervical spine abnormalities, MRI is the examination of choice
- CT of the cervical spine is often reserved for suspected fracture, follow-up of a known fracture, osseous tumor evaluation, congenital vertebral defects and procedures such as cervical spine CT myelography
- In most other clinical situations, MRI is the preferred modality for cervical spine imaging, unless contraindicated [due to pacemaker, implantable cardioverter-defibrillator (ICD), and other non-compatible devices unsafe for use in an MRI scanner] or not tolerated by the patient (usually secondary to claustrophobia)
- The CPT code assignment for an MRI procedure is based on the anatomic area imaged. Authorization requests for multiple MRI imaging of the same anatomic area to address patient positional changes, additional sequences or equipment are not allowed. These variations or extra sequences are included within the original imaging request

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Chiari malformation (Arnold-Chiari malformation)

Congenital spine anomalies

- Cervical spine dysraphism and other congenital anomalies involving the cervical spine and/or spinal cord
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Fracture evaluation

- Following initial evaluation with radiographs

Infectious process

- Including but not limited to the following:
  - Abscess
  - Osteomyelitis
  - Discitis

Multiple sclerosis and other white-matter diseases

- Initial diagnosis; **OR**
- Periodic scans to assess asymptomatic progression in multiple sclerosis during the course of disease; **OR**
- Tracking the progress of multiple sclerosis to establish a prognosis or evaluation of response to treatment; **OR**
- To evaluate changes in neurologic signs and symptoms

Common Diagnostic Indications

Myelopathy

Neck pain without neurologic or radicular features

Note: *This guideline does not apply to patients with known or suspected malignancy, infection, or underlying conditions which predispose to instability at the craniocervical junction.*

Diagnosis of the etiology of neck pain in patients who are willing and able to undergo spine surgery or epidural steroid injection (ESI) when both of the following criteria are met:

- Lack of improvement or worsening during a six (6) week course of therapy with at least two (2) different forms of treatment
- Cervical spine X-ray is negative or does not clearly explain the cause of the patient's symptoms.

Neck pain with radiculopathy

Note: *This guideline does not apply to patients with known or suspected malignancy, infection, myelopathy, or underlying conditions which predispose to instability at the craniocervical junction.*

Diagnosis of the etiology of cervical nerve root compression in patients who are willing and able to undergo spine surgery or cervical epidural steroid injection (ESI) when either of the following criteria are met:

- Documented abnormality on neurological exam in a dermatome/radicular distribution that has not previously been imaged or has progressed since a prior imaging study has been performed
- Lack of improvement or worsening during a six (6) week course of therapy with at least two (2) different forms of treatment

Post-operative or post-procedure evaluation

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Rheumatoid arthritis

- For suspected cervical subluxation in a patient with confirmed rheumatoid arthritis

Severe scoliosis, for the following patient populations:

- In patients with a high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Significant acute trauma to the cervical spine region

Spinal cord infarct

Common Diagnostic Indications

Spondyloarthropathies

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Note: *Including but not limited to ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

Syringohydromyelia (syrinx)

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. Abbed KM, Coumans JV. Cervical radiculopathy: pathophysiology, presentation, and clinical evaluation. *Neurosurgery*. 2007 Jan;60(1 Supp1 1):S28-34.
2. Ahn NU, Ahn UM, Ipsen B, Mechanical neck pain and cervicogenic headache. *Neurosurgery*. 2007 Jan;60(1 Supp1 1):S21-7.
3. Alentado VJ, Lubelski D, Steinmetz MP, Benzel EC, Mroz TE. Optimal duration of conservative management prior to surgery for cervical and lumbar radiculopathy: a literature review. *Global Spine J*. 2014 Dec;4(4):279-86. doi: 10.1055/s-0034-1387807. Epub 2014 Aug 28. Review.
4. Anekstein Y, Blecher R, Smorgick Y et al. What is the best way to apply the Spurling test for cervical radiculopathy? *Clin Orthop Relat Res*. 2012 Sep;470(9):2566-72.
5. Corey DL, Comeau D. Cervical radiculopathy. *Med Clin North Am*. 2014 Jul;98(4):791-9
6. Duggal N, Pickett GE, Mitsis DK, et al. Early clinical and biomechanical results following cervical arthroplasty. *Neurosurg Focus*. Sep 15 2004;17(3):E9.
7. Ellenberg MR, Honet JC, Treanor WJ. Cervical radiculopathy. *Arch Phys Med Rehabil*. 1994 Mar;75(3):342-52.
8. Eubanks JD. Cervical radiculopathy: nonoperative management of neck pain and radicular symptoms. *Am Fam Physician.* 2010 Jan 1;81(1):33-40.
9. Forbush SW, Cox T, Wilson E. Treatment of patients with degenerative cervical radiculopathy using a multimodal conservative approach in a geriatric population: a case series J Orthop Sports Phys Ther. 2011 Oct;41(10):723-33
10. Fortin J, Riethmiller DW, Vilensky JA. No clear winner in differing imaging modalities for cervical radiculopathy. Pain Physician. 2002 Jul;5(3):285-7.
11. Gross A, Kay TM, Cervical Overview Group, et al. Exercises for mechanical neck disorders. Cochrane Database Syst Rev. 2015 Jan 28;1:CD004250.
12. Gross A, Langevin P, Burnie SJ, et al. Manipulation and mobilisation for neck pain contrasted against an inactive control or another active treatment. Cochrane Database Syst Rev. 2015 Sep 23;(9):CD004249.
13. Kuijper B, Tans JT, Beelen A, Nollet F, de Visser M. Cervical collar or physiotherapy versus wait and see policy for recent onset cervical radiculopathy: randomised trial. BMJ. 2009 Oct 7;339:b3883
14. Mummaneni PV, Kaiser MG, Joint Section on Disorders of the Spine and Peripheral Nerves of the American Association of Neurological Surgeons and Congress of Neurological Surgeons, et al. Preoperative patient selection with magnetic resonance imaging, computed tomography, and electroencephalography: does the test predict outcome after cervical surgery? J Neurosurg Spine. 2009 Aug;11(2):119-29.
15. Narváez JA, Narváez J, Serrallonga M, et al. Cervical spine involvement in rheumatoid arthritis: correlation between neurological manifestations and magnetic resonance imaging findings. Rheumatology (Oxford). 2008 Dec;47(12):1814-9
16. Nordin M, Carragee EJ, Hogg-Johnson S, Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. Spine (Phila Pa 1976). 2008 Feb 15;33(4 Suppl):S101-22.
17. Rhee JM, Yoon T, Riew KD. Cervical radiculopathy. J Am Acad Orthop Surg. 2007 Aug;15(8):486-94.
18. van Eerd M, Patijn J, Lataster A. Cervical facet pain. Pain Pract. 2010 Mar-Apr;10(2):113-23.

Computed Tomography (CT) Thoracic Spine

CPT Codes

72128..... CT of thoracic spine, without contrast

72129..... CT of thoracic spine, with contrast

72130..... CT of thoracic spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire thoracic spine (T1-T12), from the cervicothoracic region through the thoracolumbar junction
- Axial images are routinely obtained, with capability for coronal and sagittal reconstructions

Imaging Considerations

- Advanced diagnostic imaging of the thoracic spine is indicated in selected clinical scenarios and is performed significantly less often than in the lumbar and cervical regions
- MRI is the modality of choice for most thoracic spine imaging indications, unless contraindicated or not tolerated by the patient (for example, secondary to claustrophobia)
- CT is the preferred technique for certain clinical scenarios such as suspected fracture, osseous tumor evaluation, congenital vertebral defects and interventional procedures such as CT myelography
- Authorization request for re-imaging, due to technically limited exams, is the responsibility of the imaging provider

Common Diagnostic Indications

MRI is the preferred modality for most thoracic spine imaging, except for a few indications which include CT evaluation of bony abnormalities (such as suspected fracture or fracture follow-up; occasional osseous tumor assessment; developmental vertebral abnormalities) and CT myelography

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Fracture evaluation

- Following initial evaluation with radiographs

Post-myelogram CT or CT following other thoracic spine interventional procedure

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

When the patient's condition meets the thoracic spine MRI guidelines, but there is either a contraindication to MRI or the patient cannot tolerate MRI examination (for example, due to claustrophobia)

For most other indications, MRI is the preferred modality for advanced thoracic spine imaging, unless contraindicated

Congenital spine anomalies

- Thoracic spine dysraphism and other congenital anomalies involving the thoracic spine and/or spinal cord
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Common Diagnostic Indications

Infectious process

- Including but not limited to the following:
  - Abscess
  - Osteomyelitis
  - Discitis

Mid-back pain with signs of compression

- In a patient with mid-back or radicular pain and red flag signs including:
  - Reflex abnormality
  - Objective muscle weakness
  - Objective sensory abnormality in the thoracic dermatome distribution
  - Spasticity

Note: *Imaging in patients with polyneuropathy without additional abnormalities on neurological exam is not indicated*[1-4]

Non-specific mid-back pain

- In a patient where focused history and physical exam suggest non-specific thoracic pain and/or referred posterior chest pain and all of the following are met:
  - Patient is a potential candidate for surgery or epidural steroid injection; **AND**
  - Patient has, following clinical examination, completed a minimum of 4-6 consecutive weeks of physician supervised conservative therapy for the current episode of pain, including but not limited to any of the following:
    - NSAIDs
    - Muscle relaxants
    - Steroids
    - Physical therapy; **AND**
  - After trial of conservative therapy as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- Mid-back pain not meeting the above criteria but associated with “red flag” symptoms such as unexplained weight loss, history of malignant disease, fever, drug abuse, or tuberculosis, abnormal labs suggestive of malignancy such as abnormal serum or urine electrophoresis, elevated prostate specific antigen (PSA)

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Severe scoliosis, including the following patient populations:

- In patients with a high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Spondyloarthropathies

Note: *Including but not limited to: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Syringohydromyelia (syrinx)

Common Diagnostic Indications

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. American Association of Neuromuscular and Electrodiagnostic Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; February 10, 2015. Available at www.choosingwisely.org.
2. England JD, Gronseth GS, Franklin G, et al. Practice Parameter: evaluation of distal symmetric polyneuropathy: role of laboratory and genetic testing (an evidence-based review). *Neurology*. 2009;72(2):185-192.
3. Tracy JA, Dyck PJB. Investigations and treatment of chronic inflammatory demyelinating polyradiculoneuropathy and other inflammatory demyelinating polyneuropathies. *Curr Opin Neurol*. 2010;23(3):242-248.
4. England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: a definition for clinical research: report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. *Neurology*. 2005;64(2):199-207.

Magnetic Resonance Imaging (MRI) Thoracic Spine

CPT Codes

72146..... MRI of thoracic spine, without contrast

72147..... MRI of thoracic spine, with contrast

72157..... MRI of thoracic spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire thoracic spine (T1-T12), from the cervicothoracic region through the thoracolumbar junction
- Imaging planes generally include sagittal and axial/oblique axial (parallel with the disc spaces) views

Imaging Considerations

- Advanced imaging of the thoracic spine is indicated in selected clinical scenarios and is performed significantly less often than in the cervical and lumbar regions
- CT is the preferred technique for certain indications, including fracture detection, follow-up of a known fracture, osseous tumor assessment, congenital vertebral defects and for interventional procedures, such as CT myelography
- In most other clinical situations, MRI is the modality of choice for thoracic spine imaging, unless contraindicated or not tolerated by the patient (for example, secondary to claustrophobia)
- The CPT code assignment for an MRI procedure is based on the anatomic area imaged. Requests for multiple MRI imaging of the same anatomic area to address patient positional changes, additional sequences or equipment are not allowed. These variations or extra sequences are included within the original imaging request

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Congenital spine anomalies

- Thoracic spine dysraphism and other congenital anomalies involving the thoracic spine and/or spinal cord
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Fracture evaluation

- Following initial evaluation with radiographs

Infectious process

- Including but not limited to the following:
  - Abscess
  - Osteomyelitis
  - Discitis

Mid-back pain with signs of compression

- In a patient with mid-back or radicular pain and red flag signs including:
  - Reflex abnormality
  - Objective muscle weakness
  - Objective sensory abnormality in the thoracic dermatome distribution
  - Spasticity

Note: *Imaging in patients with polyneuropathy without additional abnormalities on neurological exam is not indicated*[1-4]

Common Diagnostic Indications

Multiple sclerosis and other white-matter diseases

- Initial diagnosis; **OR**
- Periodic scans to assess asymptomatic progression in multiple sclerosis during the course of disease; **OR**
- Tracking the progress of multiple sclerosis to establish a prognosis or evaluation of response to treatment; **OR**
- To evaluate changes in neurologic signs and symptoms

Myelopathy

Non-specific mid-back pain

- In a patient where focused history and physical exam suggest non-specific thoracic pain and/or referred posterior chest pain and all of the following are met:
  - Patient is a potential candidate for surgery or epidural steroid injection; **AND**
  - Patient has, following clinical examination, completed a minimum of 4-6 consecutive weeks of physician supervised conservative therapy for the current episode of pain, including but not limited to any of the following:
    - NSAIDs
    - Muscle relaxants
    - Steroids
    - Physical therapy; **AND**
  - After trial of conservative therapy as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- Mid-back pain not meeting the above criteria but associated with “red flag” symptoms such as unexplained weight loss, history of malignant disease, fever, drug abuse, or tuberculosis, abnormal labs suggestive of malignancy such as abnormal serum or urine electrophoresis, elevated prostate specific antigen (PSA)

Post-operative or post-procedure evaluation

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

Pre-operative or pre-procedure evaluation

Note: *This indication is to be used for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline*

Severe scoliosis, for the following patient populations:

- In patients with a high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Spinal cord infarct

Spondyloarthropathies

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Note: *Including but not limited to: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

Common Diagnostic Indications

Syringohydromyelia (syrinx)

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. American Association of Neuromuscular and Electrodiagnostic Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; February 10, 2015. Available at www.choosingwisely.org.
2. England JD, Gronseth GS, Franklin G, et al. Practice Parameter: evaluation of distal symmetric polyneuropathy: role of laboratory and genetic testing (an evidence-based review). *Neurology*. 2009;72(2):185-192.
3. Tracy JA, Dyck PJB. Investigations and treatment of chronic inflammatory demyelinating polyradiculoneuropathy and other inflammatory demyelinating polyneuropathies. *Curr Opin Neurol*. 2010;23(3):242-248.
4. England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: a definition for clinical research: report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. *Neurology*. 2005;64(2):199-207.

Computed Tomography (CT) Lumbar Spine

CPT Codes

72131..... CT of lumbar spine, without contrast

72132..... CT of lumbar spine, with contrast

72133..... CT of lumbar spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire lumbar spine (L1-L5), from the thoracolumbar region through the lumbosacral junction
- Axial images are routinely obtained, with capability for coronal and sagittal reconstructions

Imaging Considerations

- CT of the lumbar spine is often reserved for suspected fracture, follow-up of a known fracture, skeletal abnormalities such as spondylolysis and spondylolisthesis in operative candidates, congenital vertebral defects, osseous tumor evaluation, and procedures such as lumbar CT myelography
- For most other lumbar spine abnormalities, MRI is the modality of choice, unless contraindicated or not tolerated by the patient (for example, secondary to claustrophobia)

Common Diagnostic Indications

MRI is the preferred modality for most lumbar spine advanced imaging, except for a few indications which include CT evaluation of bony abnormalities (such as suspected fracture or fracture follow-up; skeletal abnormalities such as spondylolysis and spondylolisthesis in operative candidates; osseous tumor assessment; developmental vertebral abnormalities) as well as lumbar CT myelography

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Fracture evaluation

- Following initial evaluation with radiographs

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

Post-myelogram CT or CT following other lumbar spine interventional procedure

Spondylolysis and spondylolisthesis

- Following non-diagnostic or abnormal lumbar spine radiographs (including oblique views) which require additional clarification to direct treatment in an operative candidate

When the patient's condition meets the lumbar spine MRI guidelines, but there is either a contraindication to MRI or the patient cannot tolerate MRI examination (for example, due to claustrophobia)

Common Diagnostic Indications

For most other indications, MRI is the preferred modality for advanced lumbar spine imaging, unless contraindicated

Congenital spine anomalies

- Lumbar spine dysraphism and other congenital anomalies involving the lumbar spine and/or lower spinal cord (Conus Medullaris). filum terminale or nerve roots, when MRI is contraindicated
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Infectious process

- Including but not limited to the following:
  - Abscess
  - Arachnoiditis
  - Discitis
  - Osteomyelitis

Low back pain with signs of cauda equina compression[1]

- In a patient with low back or radicular pain and red flag signs including:
  - Severe bilateral sciatica, especially L5-S1 distribution
  - Saddle or genital sensory disturbance
  - Bladder, bowel or sexual dysfunction

Note: *The diagnosis of acute cord compression is often considered a medical emergency and typically not managed by elective outpatient imaging*

Low back pain with signs of radicular compression

- In a patient with low back or radicular pain and neurologic findings related to the lumbar spine such as:
  - Reflex abnormality
  - Objective muscle weakness
  - Objective sensory abnormality in the lumbar dermatome distribution
  - Spasticity

Note: *Imaging in patients with polyneuropathy without additional abnormalities on neurological exam is not indicated*[2-5]

Non-specific low back pain

- In a patient where focused history and physical exam suggest non-specific lumbar pain and/or referred buttock or lower extremity pain and all of the following are met:
  - Patient is a potential candidate for surgery or epidural steroid injection; **AND**
  - Patient has, following clinical examination, completed a minimum of six (6) consecutive weeks of physician supervised conservative therapy for the current episode of pain, including but not limited to any of the following:
    - NSAIDs
    - Muscle relaxants
    - Steroids
    - Physical therapy; **AND**
  - After trial of conservative therapy as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- Low back pain not meeting the above criteria but associated with “red flag” symptoms such as unexplained weight loss, history of malignant disease, fever, drug abuse, or tuberculosis, abnormal labs suggestive of malignancy such as abnormal serum or urine electrophoresis, elevated prostate specific antigen (PSA)

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Common Diagnostic Indications

Severe scoliosis, including the following patient populations:

- With high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes, such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Spondyloarthropathies

Note: *Including but not limited to: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Tethered cord

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. Gardner A, Gardner E, Morley T. Cauda equina syndrome: a review of the current clinical and medico-legal position. Eur Spine J. 2011;20(5):690-697.
2. American Association of Neuromuscular and Electrodiagnostic Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; February 10, 2015. Available at www.choosingwisely.org.
3. England JD, Gronseth GS, Franklin G, et al. Practice Parameter: evaluation of distal symmetric polyneuropathy: role of laboratory and genetic testing (an evidence-based review). Neurology. 2009;72(2):185-192.
4. Tracy JA, Dyck PJB. Investigations and treatment of chronic inflammatory demyelinating polyradiculoneuropathy and other inflammatory demyelinating polyneuropathies. Curr Opin Neurol. 2010;23(3):242-248.
5. England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: a definition for clinical research: report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. Neurology. 2005;64(2):199-207.

Magnetic Resonance Imaging (MRI) Lumbar Spine

CPT Codes

72148..... MRI of lumbar spine, without contrast
72149..... MRI of lumbar spine, with contrast
72158..... MRI of lumbar spine, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Entire lumbar spine (L1-L5), from the thoracolumbar region through the lumbosacral junction
- Imaging planes generally include sagittal and axial/oblique axial (parallel with disc spaces) views

Imaging Considerations

- For most other lumbar spine abnormalities, MRI is the modality of choice, unless contraindicated or not tolerated by the patient (for example, secondary to claustrophobia)
- Lumbar spine CT is often reserved for suspected fracture, follow-up of a known fracture, skeletal abnormalities such as spondylolysis and spondylolisthesis in operative candidates, congenital vertebral defects, osseous tumor evaluation, and procedures such as lumbar CT myelography
- For the majority of patients with acute low back pain, symptoms and/or physical exam findings will improve or resolve during a trial of conservative treatment and diagnostic imaging is not necessary
- The spinal cord normally ends at L1-L2, which is seen on thoracic MRI. If the conus medullaris is not seen on thoracic spine imaging, the spinal cord is presumed to be tethered and lumbar MRI is appropriate
- Definitive diagnosis is not achieved in as many as 85% of patients with low back pain
- The CPT code assignment for an MRI procedure is based on the anatomic area imaged. Requests for multiple MRI imaging of the same anatomic area to address patient positional changes, additional sequences or equipment are not allowed. These variations or extra sequences are included within the original imaging request

Common Diagnostic Imaging

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Congenital spine anomalies

- Lumbar spine dysraphism and other congenital anomalies involving the lumbar spine and/or lower spinal cord (conus medullaris), filum terminale or nerve roots
- Congenital vertebral defects for assessment of bony defects such as segmentation and fusion anomalies

Fracture evaluation

- Following initial evaluation with radiographs

Infectious process

- Including but not limited to the following:
  - Abscess
  - Arachnoiditis
  - Discitis
  - Osteomyelitis

Common Diagnostic Indications

Low back pain with signs of cauda equina compression[1]

- In a patient with low back or radicular pain and red flag signs including:
  - Severe bilateral sciatica, especially L5-S1 distribution
  - Saddle or genital sensory disturbance
  - Bladder, bowel or sexual dysfunction

Note: *The diagnosis of acute cord compression is often considered a medical emergency and typically not managed by elective outpatient imaging*

Low back pain with signs of radicular compression

- In a patient with low back or radicular pain and neurologic findings related to the lumbar spine such as:
  - Reflex abnormality
  - Objective muscle weakness
  - Objective sensory abnormality in the lumbar dermatome distribution
  - Spasticity

Note: *Imaging in patients with polyneuropathy without additional abnormalities on neurological exam is not indicated*[5-8]

Myelopathy involving the lower spinal cord

Non-specific low back pain[2-4]

- In a patient where focused history and physical exam suggest non-specific lumbar pain and/or referred buttock or lower extremity pain and all of the following are met:
  - Patient is a potential candidate for surgery or epidural steroid injection; **AND**
  - Patient has, following clinical examination, completed a minimum of six (6) consecutive weeks of physician supervised conservative therapy for the current episode of pain, including but not limited to any of the following:
    - NSAIDs
    - Muscle relaxants
    - Steroids
    - Physical therapy; **AND**
  - After trial of conservative therapy as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- Low back pain not meeting the above criteria but associated with “red flag” symptoms such as unexplained weight loss, history of malignant disease, fever, drug abuse, or tuberculosis, abnormal labs suggestive of malignancy such as abnormal serum or urine electrophoresis, elevated prostate specific antigen (PSA)

Post-operative or post-procedure evaluation

Post-trauma

- Neurologic deficit with possible spinal cord injury
- Progressively worsening pain

Pre-operative or pre-procedure evaluation

Note: *This indication is to be used for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline*

Severe scoliosis, for the following patient populations:

- In patients with a high risk for neural axis abnormalities, such as infantile and juvenile idiopathic scoliosis and congenital scoliosis; **OR**
- With adolescent idiopathic scoliosis and atypical findings (pain, rapid progression, development of neurologic signs/symptoms); **OR**
- With scoliosis related to other pathologic processes such as neurofibromatosis; **OR**
- For pre-operative evaluation of severe scoliosis

Common Diagnostic Indications

Spinal cord infarct

Spondyloarthropathies

- For diagnosis following non-diagnostic work-up including but not limited to:
  - Radiographs
  - Standard laboratory work-up for spondyloarthropathy

Note: *Including but not limited to: ankylosing spondylitis, reactive arthritis, psoriatic arthritis, spondyloarthritis associated with inflammatory bowel disease, juvenile-onset spondyloarthritis*

Spondylolysis and spondylolisthesis

- Following non-diagnostic or abnormal lumbar spine radiographs (including oblique views) which require additional clarification to direct treatment, in an operative candidate

Tethered cord

Tumor evaluation

- Including but not limited to the following:
  - Primary or metastatic neoplasm involving the vertebrae
  - Tumor spread within the spinal canal
  - Spinal cord neoplasm

References

1. Gardner A, Gardner E, Morley T. Cauda equina syndrome: a review of the current clinical and medico-legal position. Eur Spine J. 2011;20(5):690-697.
2. American College of Physicians. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; April 4, 2012. Available at http://choosingwisely.org/wp-content/uploads/2012/04/5things_12_factsheet_Amer_College_Phys.pdf. Accessed May 15, 2012
3. North American Spine Society. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; October 9, 2013. Available at http://www.choosingwisely.org/societies/north-american-spine-society/ Accessed October 10, 2015.
4. American College of Emergency Physicians. *Choosing Wisely: Ten Things Physicians and Patients Should Question.* Philadelphia, PA: ABIM Foundation; October 14, 2013 and October 27, 2014. Available at http://www.choosingwisely.org/societies/american-college-of-emergency-physicians/ Accessed October 10, 2015.
5. American Association of Neuromuscular and Electrodiagnostic Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; February 10, 2015. Available at www.choosingwisely.org.
6. England JD, Gronseth GS, Franklin G, et al. Practice Parameter: evaluation of distal symmetric polyneuropathy: role of laboratory and genetic testing (an evidence-based review). *Neurology*. 2009;72(2):185-192.
7. Tracy JA, Dyck PJB. Investigations and treatment of chronic inflammatory demyelinating polyradiculoneuropathy and other inflammatory demyelinating polyneuropathies. *Curr Opin Neurol*. 2010;23(3):242-248.
8. England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: a definition for clinical research: report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. *Neurology*. 2005;64(2):199-207.

MR Angiography (MRA) Spinal Canal

CPT Codes

72159..... Magnetic resonance angiography of spinal canal

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication for the spinal canal MRA
- General landmarks extend from the cranio-cervical junction through the lumbosacral region

Imaging Considerations

- MRA of the spinal canal is an infrequently requested exam. Potential applications which have been described include evaluation of spinal arteriovenous fistula (AVF) and arteriovenous malformation (AVM). These vascular lesions are usually detected by MRI or myelography. Intra-arterial digital subtraction angiography (DSA) of the spinal vasculature may be necessary to define the precise location and type of vascular abnormality
- MRI of the spinal canal CPT 72159 includes imaging of the entire spinal canal. Requests for multiple exams to address each anatomic area of the spinal canal are inappropriate

Magnetic Resonance Angiography of the Spinal Canal

- MR Angiography (MRA) of the spinal canal is an evolving technology under clinical development. This clinical application of MRA and its impact on health outcomes will continue to undergo review, as new evidence-based studies are published. At this point, medically necessary applications are limited (see below). Interval routine coverage for MR angiography of the spinal canal is not generally available and is not considered medically appropriate at this time

Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Spine Bibliography

1. American Academy of Family Physicians. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; 2012. http://choosingwisely.org/wp-content/uploads/2012/04/5things_12_factsheet_Amer_Acad_Fam_Phys.pdf. Accessed May15, 2012.
2. American College of Physicians. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; April 4, 2012. http://choosingwisely.org/wp-content/uploads/2012/04/5things_12_factsheet_Amer_College_Phys.pdf. Accessed May 15, 2012.
3. American College of Rheumatology Extremity Magnetic Resonance Imaging Task Force. Extremity magnetic resonance imaging in rheumatoid arthritis: report of the American College of Rheumatology Extremity Magnetic Resonance Imaging Task Force. *Arthritis Rheum*. 2006 Apr;54(4):1034-1047
4. Benedetti P, Fahr L, Kuhns L, et al. MR imaging findings in spinal ligamentous injury. *AJR Am J Roentgenol*. 2000;175:661-665.
5. Bennett DL, Ohashi K, El-Khoury GY. Spondyloarthropathies: ankylosing spondylitis and psoriatic arthritis. *Radiol Clin North Am*. 2004 Jan;42(1):121-134.
6. Blackmore CC, Emerson SS, Mann FA, Koepsell TD. Cervical spine imaging in patients with trauma: determination of fracture risk to optimize use. *Radiology*. 1999;211:759-765.
7. Bot JC, Blezer EL, Kamphorst W, et al. The spinal cord in multiple sclerosis: relationship of high spatial-resolution quantitative MR imaging findings to histopathologic results. *Radiology*. 2004;233:531-540.
8. Brant-Zawadzki MN, Dennis SC, Gade GF, Weinstein MP. Low back pain. What the clinician wants to know. *Radiology*. 2000;217:321-330.
9. Braun J, van den Berg R, Baraliakos X, et al. 2010 update of the ASAS/EULAR recommendations for the management of ankylosing spondylitis. *Ann Rheum Dis* 2011;70(6):896-904.
10. Bub L, Balckmore CC, Mann FA, Lomoschitz FM. Cervical spine fractures in patients 65 years and older: a clinical prediction rule for blunt trauma. *Radiology*. 2005;234:143-149.
11. Chou R, Fu R, Carrino JA, Deyo RA. Imaging strategies for low-back pain: systematic review and meta-analysis. *Lancet*. 2009. 373(9662):463-472.
12. Chou R, Qaseem A, Owens DK, Shekelle P. Diagnostic imaging for low back pain: advice for high-value health care from the American College of Physicians. *Ann Int Med*. 2011;154:181-189.
13. Chou R, Qaseem A, Snow V, et al. Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. *Ann Intern Med*. 2007;147(7):478-491
14. Deyo RA, Weinstein JN. Low back pain. *N Engl J Med*. 2001;344(5):363-370.
15. Gilbert FJ, Grant AM, Gillan MGC, et al. Low back pain: influence of early MR imaging or CT on treatment and outcome-multicenter randomized trial. *Radiology*. 2004;231:343-351.
16. Gillan MG, Gilbert FJ, Andrew JE, et al. Influence of imaging on clinical decision making in the treatment of lower back pain. *Radiology*. 2001;220:393-399.
17. Gray DT, Hollingworth W, Balckmore CC, et al. Conventional radiography, rapid MR imaging and conventional MR imaging for low back pain: activity-based costs and reimbursement. *Radiology*. 2003;227:669-680.
18. Guyer RD, Ohnmeiss DD. Contemporary concepts in spine care lumbar discography. *Spine*. 1995;20(18):2048-2059.
19. Hanson JA, Blackmore CC, Mann FA, Wilson AJ. Cervical spine injury. a clinical decision rule to identify high-risk patients for helical CT screening. *AJR Am J Roentgenol*. 2000;174:713-717.
20. Jaramillo D, Poussaint TY, Grottkau BE, et al. Scoliosis: evidence-based diagnostic evaluation. *Neuroimaging Clin N Am*. 2003;13:335-341.
21. Jaramillo D, Poussaint TY, Grottkau BE. Scoliosis: evidence-based diagnostic evaluation. *Neuroimaging Clin N Am*. 2003;13:335-341.
22. Jarvik J. Imaging of adults with low back pain in the primary care setting. *Neuroimaging Clin N Am*. 2003;13:293-305.
23. Jarvik JG, Deyo RA. Diagnostic evaluation of low back pain with emphasis on imaging. *Ann Intern Med*. 2002;137:586-597.

24. Jarvik JG, Hollingworth W, Martin B, et al. Rapid magnetic resonance imaging vs radiographs for patients with low back pain: a randomized controlled trial. *JAMA*. 2003;289:2810-2818.
25. Keenan HT, Hollingshead MC, Chung CJ, Ziglar MK. Using CT of the cervical spine for early evaluation of pediatric patients with head trauma. *AJR Am J Roentgenol*. 2001;177:1405-1409.
26. Koeller KK, Rosenblum RS, Morrision AL. Neoplasms of the spinal cord and filum terminale: radiologic-pathologic correlation. *Radiographics*. 2000;20:1721-1749.
27. Mazanec DJ, Podichetty,VK, Hsia A. Lumbar canal stenosis: start with nonsurgical therapy. *Cleve Clin J Med*. 2002;69(11):909-917.
28. National Collaborating Centre for Chronic Conditions (UK). *Rheumatoid Arthritis: National Clinical Guideline for Management and Treatment in Adults.* National Institute for Health and Clinical Excellence (NICE) Clinical Guidelines, No. 79. London: Royal College of Physicians (UK); February 2009.
29. Quality Standards Subcommittee of the American Academy of Neurology. Practice parameters: magnetic resonance imaging in the evaluation of low back syndrome. *Neurology*. 1994;44:767-770.
30. Resnick DK, Malone DG, Ryken TC. Guidelines for the use of discography for the diagnosis of painful degenerative lumbar disc disease. *Neurosurg Focus*. 2002;13(2):1-9.
31. Shekelle P. *Diagnosis and treatment of low back pain: a joint clinical practice guideline from the American College of Physicians and the American Pain Society. What's new? What's different?* National Guideline Clearinghouse, Expert commentary. http://www.guidelines.gov/expert/expert-commentary.aspx?id=16452. February 11, 2008. Accessed January 3, 2012.
32. Sliker C, Mirvis S, Shanmuganathan K. Assessing cervical spine stability in obtunded blunt trauma patients: review of medical literature. *Radiology*. 2005;234:733-739.
33. Staiger TO, Paauw DS, Deyo RA, Jarvik JG. Imaging studies for acute low back pain. When and when not to order them. *Postgrad Med*. 1999;105(4):161-162,165-166,171-172.
34. Wintermark M, Mouhsine E, Theumann N, et al. Thoracolumbar spine fractures in patients who have sustained severe trauma: depiction with multi-detector row CT. *Radiology*. 2003;227:681-689
35. American Association of Neuromuscular and Electrodiagnostic Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; February 10, 2015. Available at www.choosingwisely.org.
36. England JD, Gronseth GS, Franklin G, et al. Practice Parameter: evaluation of distal symmetric polyneuropathy: role of laboratory and genetic testing (an evidence-based review). *Neurology*. 2009;72(2):185-192.
37. Tracy JA, Dyck PJB. Investigations and treatment of chronic inflammatory demyelinating polyradiculoneuropathy and other inflammatory demyelinating polyneuropathies. *Curr Opin Neurol*. 2010;23(3):242-248.
38. England JD, Gronseth GS, Franklin G, et al. Distal symmetric polyneuropathy: a definition for clinical research: report of the American Academy of Neurology, the American Association of Electrodiagnostic Medicine, and the American Academy of Physical Medicine and Rehabilitation. *Neurology*. 2005;64(2):199-207.
39. North American Spine Society. *Choosing Wisely: Five Things Physicians and Patients Should Question*. Philadelphia, PA: ABIM Foundation; October 9, 2013. Available at http://www.choosingwisely.org/societies/north-american-spine-society/ Accessed October 10, 2015.
40. American College of Emergency Physicians. *Choosing Wisely: Ten Things Physicians and Patients Should Question.* Philadelphia, PA: ABIM Foundation; October 14, 2013 and October 27, 2014. Available at http://www.choosingwisely.org/societies/american-college-of-emergency-physicians/ Accessed October 10, 2015.

Computed Tomography (CT) Upper Extremity

CPT Codes

73200..... CT upper extremity, without contrast

73201..... CT upper extremity, with contrast

73202..... CT upper extremity, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication for the exam and varies considerably, based on anatomic considerations (from shoulder through fingers) and clinical manifestations
- Depending on the protocol used, the CT data acquisition(s) may allow for diagnostic multi-planar reconstructions through the region of interest

Imaging Considerations

- Conventional radiographs should be obtained before advanced imaging
- CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with MRI or radionuclide bone scintigraphy
- If radiographic findings are typical of osteomyelitis, advanced imaging may not be necessary
- In osteomyelitis, CT may be helpful in defining bone sequestra
- For evaluation of musculoskeletal tumors, MRI is generally preferred over CT, unless there is a contraindication to performance of an MRI exam
- Use of contrast (intravenous or intra-articular for CT arthrogram) is at the discretion of both the ordering and imaging physicians
- Brachial plexus imaging: MRI, when not contraindicated, is the preferred imaging modality for brachial plexus. The brachial plexus is a network of nerves in the neck, passing under the clavicle and into the axilla. Assign either a CT or MRI of the upper extremity for imaging the brachial plexus

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Chronic shoulder pain

- In a patient where focused history and physical exam suggest non-specific upper extremity pain, rotator cuff tendinopathy, adhesive capsulitis or subacromial impingement syndrome; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- Patient has completed a minimum of six (6) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
  - Physical therapy (home exercise only if physical therapy is not available); **AND**
- After trial of conservative treatment as listed above, patient fails to show substantial improvement on clinical reevaluation

CT accompanying an arthrogram (CT arthrography)

Fracture evaluation

- To confirm a suspected (occult) fracture following initial radiographs; **OR**
- To define the extent of an acute fracture and position of fracture fragments; **OR**
- To assess fracture healing for delayed union or non-union

Common Diagnostic Indications

Hemarthrosis (bloody joint effusion)

- Documented by arthrocentesis except in cases when arthrocentesis is contraindicated (e.g. non-traumatic causes of hemarthrosis such as sickle cell, anticoagulant, or hemophilia)

Infectious process

- In a patient where focused history and physical exam suggest an underlying soft tissue infection when:
  - Patient is unresponsive to treatment including but not limited to antibiotics or incision/drainage
- Abscess - to determine the location and extent for surgical treatment
- Osteomyelitis – following non-diagnostic radiographs and when MRI is contraindicated
- Fasciitis

Intra-articular loose body, including synovial osteochondromatosis

Neuropathic osteodystrophy (Charcot joint)

- Following conventional radiographs, when there is need for additional diagnostic information from a CT exam to direct treatment decisions (such as concern for an underlying infectious process)

Osteonecrosis [avascular necrosis (AVN); aseptic necrosis]

- Requires initial plain films, prior to advanced imaging
- MRI is often the preferred imaging modality, particularly for evaluation in the early stages of osteonecrosis
- Common anatomic locations for osteonecrosis in the upper extremity are:
  - Humeral head
  - Radial head
  - Carpal navicular bone
  - Lunate bone (lunate osteonecrosis also referred to as Kienbock's disease)

Post-operative or post-procedure evaluation

Pre-operative or pre-procedure evaluation

Note: *This indication is to be used for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline*

Pre-operative evaluation of anterior glenohumeral instability

- Radiography insufficient for presurgical planning; **AND**
- Recurrent anterior shoulder dislocation; **OR**
- First time dislocation
  - Young and at high risk for recurrence[1-2]

Septic arthritis - when MRI is contraindicated

- When any of the following risk factors are present:
  - Underlying joint disease
  - Joint prosthesis
  - IV drug abuse
  - Diabetes
  - Presence of cutaneous ulcers; **OR**
- Pre-operative planning

Significant trauma

- Usually preceded by initial plain film radiographs

Common Diagnostic Indications

Soft tissue mass

(any <u>one</u> of the following)

- Soft-tissue evaluation when prominent calcifications are seen on radiograph;
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging
- Following a non-diagnostic radiograph to evaluate a palpable mass found on physical exam

Note: *MRI is typically preferred in the evaluation of soft tissue masses*

Tumor evaluation: primary neoplasm or metastatic disease

(any <u>one</u> of the following)

- Biopsy-proven malignancy
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging

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When the patient's condition meets the upper extremity MRI guidelines, but there is either a contraindication to MRI or the patient cannot tolerate MRI examination (for example, due to claustrophobia)

References

1. Bencardino JT, Gyftopoulos S, Palmer WE. Imaging in anterior glenohumeral instability. *Radiology*. 2013;269(2):323-337.
2. Piasecki DP, Verma NN, Romeo AA, Levine WN, Bach BR Jr, Provencher MT. Glenoid bone deficiency in recurrent anterior shoulder instability: diagnosis and management. *J Am Acad Orthop Surg*. 2009;17(8):482-493.
3. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. *Clin Radiol*. 2009 ;64(6):615-621.

Magnetic Resonance Imaging (MRI) Upper Extremity (Any Joint)

CPT Codes

73221..... MRI upper extremity, any joint, without contrast

73222..... MRI upper extremity, any joint, with contrast

73223..... MRI upper extremity, any joint, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication for the exam and varies considerably, based on anatomic (from shoulder joint through hand/digits) and clinical considerations
- MRI routinely provides multi-planar imaging through the region of interest

Imaging Considerations

- Conventional radiographs should be obtained before advanced imaging
- Use of contrast (intravenous or intra-articular) is at the discretion of both the ordering and imaging physicians
- CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with MRI or radionuclide bone scintigraphy
- MRI is used more often to evaluate internal derangements of the joints and related tendinous, ligamentous and cartilaginous structures
- MRI is also useful for evaluation of possible osteomyelitis, despite negative or non-diagnostic plain films and/or triple-phase bone scintigraphy. One exception for osteomyelitis is detection of bone sequestra, which may be better depicted with CT
- If radiographic findings are typical of osteomyelitis, advanced imaging may not be necessary
- For evaluation of musculoskeletal tumors, MRI is generally preferred over CT, unless there is a contraindication to performance of an MRI exam
- For suspected osteonecrosis, MRI is often more sensitive than CT and bone scintigraphy
- Implanted surgical hardware, including joint prostheses, may produce sufficient local artifact to preclude adequate imaging through the region containing hardware

Common Diagnostic Indications

This section contains general upper extremity, shoulder, elbow, and wrist and hand joint indications.

General Upper Extremity

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

EMG-proven entrapment neuropathy after conservative therapy to direct treatment

- Suspected entrapment neuropathy, cubital tunnel detail, and/or carpal tunnel are not considered medically necessary

Fracture evaluation[12]

(Any <u>one</u> of the following)

- To confirm a suspected occult/stress fracture following non-diagnostic initial radiographs at high risk sites:
  - Scaphoid
  - Lunate
- To define the extent of an acute fracture when surgery is being considered
- To assess fracture healing for delayed union or non-union, when repeat radiographs are non-diagnostic

Common Diagnostic Indications

Hemarthrosis (bloody joint effusion)

- Documented by arthrocentesis except in cases when arthrocentesis is contraindicated (e.g. non-traumatic causes of hemarthrosis such as sickle cell, anticoagulant, or hemophilia)

Infectious process

- In a patient where focused history and physical exam suggest a underlying soft tissue infection when:
  - Patient is unresponsive to treatment including but not limited to antibiotics or incision/drainage
- Abscess – to determine the location and extent for surgical treatment
- Osteomyelitis – following non-diagnostic radiographs
- Fasciitis

Intraarticular loose body

- Following non-diagnostic radiographs

Note: *Includes synovial osteochondromatosis*

Ligament and tendon injuries

- In a patient following a focused history and physical exam; **AND**
- After a trial of conservative treatment (that may include physical therapy, for the current episode of pain); **AND**
- Patient fails to show substantial improvement on clinical reevaluation

MRI accompanying an arthrogram (MR arthrography)

Neuropathic osteodystrophy (Charcot joint)

- Following conventional radiographs, when there is need for additional diagnostic information from an MRI exam to direct treatment decisions (such as concern for an underlying infectious process)

Non-specific upper extremity pain

- In a patient where focused history and physical exam suggest non-specific upper extremity pain; **AND**
- Following normal or non-diagnostic conventional radiographs; **AND**
- Atraumatic; **AND**
- At least one of the following:
  - Significant weakness; **OR**
  - No improvement following clinical re-evaluation after a minimum of six (6) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
    - NSAIDs or steroids (oral or injection) – unless contraindicated
    - Physical therapy (home exercise only if physical therapy is not available)

Note: *For suspicion of specific etiology, especially red flag conditions such as tumor, infection and acute trauma, please refer to the corresponding indication*

Osteochondral lesion

Osteonecrosis [avascular necrosis (AVN); aseptic necrosis]

- Requires initial plain films, prior to advanced imaging
- Common anatomic locations for osteonecrosis in the upper extremity are:
  - Humeral head
  - Radial head
  - Carpal navicular bone
  - Lunate bone (lunate osteonecrosis also referred to as Kienbock's disease)

Pigmented Villonodular synovitis (PVNS)

Common Diagnostic Indications

Post-operative or post-procedure evaluation

Pre-operative or pre-procedure evaluation

Note: *This indication is to be used for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline*

Septic arthritis

- When any of the following risk factors are present:
  - Underlying joint disease
  - Joint prosthesis
  - IV drug abuse
  - Diabetes
  - Presence of cutaneous ulcers; **OR**
- Pre-operative planning

Significant trauma

- Usually preceded by initial plain film radiographs

Soft tissue mass

(any <u>one</u> of the following)

- Soft-tissue evaluation when prominent calcifications are seen on radiograph
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging
- Following a non-diagnostic radiograph to evaluate a palpable mass found on physical exam

Tumor evaluation: primary neoplasm or metastatic disease

(any <u>one</u> of the following)

- Biopsy-proven malignancy
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging

Shoulder Joint Imaging

Anterior glenohumeral instability/labral tear

Diagnosis of anterior glenohumeral instability/anterior labral tear

- Recurrent anterior shoulder dislocation[2] OR
- First time dislocation
  - Young and at high risk for recurrence[3]

Acute shoulder pain

- Following non-diagnostic conventional radiographs; **AND**
- In a patient who is a candidate for corticosteroid or anesthetic injection and one of the following:
  - Suspected bursitis; **OR**
  - Suspected long head of biceps tenosynovitis

Chronic shoulder pain

- In a patient where focused history and physical exam suggest non-specific upper extremity pain, adhesive capsulitis or subacromial impingement syndrome; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- Patient has completed a minimum of six (6) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
  - Physical therapy (home exercise only if physical therapy is not available); **AND**
- After trial of conservative treatment as listed above, patient fails to show substantial improvement on clinical re-evaluation

Common Diagnostic Indications

Rotator Cuff Tear

Diagnosis of acute rotator cuff tear

(All of the following)

- Following non-diagnostic radiographs and/or ultrasound
- At least one (1) positive sign to support the diagnosis of rotator cuff tear (see **Table 1**)
- No improvement after an initial trial of conservative therapy, including 4 weeks of physical therapy, unless the patient is at high risk for an acute full thickness rotator cuff tear (see **Table 2**)

Diagnosis of chronic rotator cuff tear

(All of the following)

- At least one (1) positive sign to support the diagnosis of rotator cuff tear (see **Table 1**)
- Following non-diagnostic radiograph and/or ultrasound
- Symptoms have persisted for more than 3 months despite optimal medical management

Management of rotator cuff tear

- Post-operative [5]
  - Suspicion of recurrent rotator cuff tear
  - Post-surgical complication

Note: *For patients who have not had surgery when there is a concern for recurrent rotator cuff tear, see the diagnosis of rotator cuff tear guideline. Ultrasound, radiographs, or CT arthrography are generally preferred in the evaluation of recurrent rotator cuff tear after total shoulder arthroplasty*

Table 1: Findings suggestive of a rotator cuff tear include but are not limited to the following: [12]

Positive (elicits weakness and/or pain) for at least one of the following:		
• Apley scratch test • Apprehension • Belly press/belly off • Cross body • Drop arm/sign • Empty can / Full can	• External rotation lag sign • Hawkins-Kennedy • Hornblower • Infraspinatus muscle strength test • Jobe's test	• Lift off • Neer • Painful arc • Patte • Resisted abduction

Table 2: High risk patients have at least one of the following symptoms to suggest either an acute full thickness rotator cuff tear or an alternative etiology for acute shoulder pain

• Acute traumatic event	• Decreased pulse
• Positive drop arm	• Plateau in therapy response
• Profound loss of strength	• Worsening of symptoms during therapy
• Loss of sensation	• At least two signs of a SLAP tear

Common Diagnostic Indications

Superior Labrum Anterior Posterior (SLAP) tears

Diagnosis of SLAP tears

- Clinical findings of a SLAP tear (see Table 3) and one of the following:
  - Symptoms do not improve or worsen after 4 weeks of conservative therapy
  - High risk patient defined as (see Table 4)

Management of Labral tears

- Pre-operative-
  - Labral tear established by a modality other than MRI; **OR**
  - More than 1 year between MRI and surgical evaluation
- Post-operative
  - No clinical improvement; **AND**
  - At least three months after surgery

Table 3: Clinical findings of a SLAP tear may include but are not limited to the following: [6-8]

Pain exacerbated by overhead activity or heavy lifting
Popping or locking of the shoulder
Signs of shoulder instability: • Speed's biceps tendon test • O'Brien's test • Compression-Rotation test • Yergason's test

Table 4: Patients at High Risk for SLAP tears:

• Acute trauma; **AND**
• Under 45 years of age; **OR**
• Evidence of suprascapular nerve entrapment including but not limited to
  ○ Posterolateral shoulder pain; **OR**
  ○ Supraspinatus and/or infraspinatus weakness; **OR**
  ○ Supraspinatus and/or infraspinatus atrophy

Suspected occult shoulder fracture

- With high clinical suspicion and negative or inconclusive shoulder radiographs

Elbow Imaging

Biceps tendon rupture

- At insertion onto radial tuberosity

Capitellar osteochondritis

Epicondylitis

- In a patient following a focused history and physical exam; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- After a trial of conservative treatment (that may include physical therapy for strengthening); **AND**
- Patient fails to show substantial improvement on clinical re-evaluation

Note: *Epicondylitis is generally considered a clinical diagnosis and imaging usually does not change management. Specialist evaluation should be strongly considered prior to advanced imaging*

Ulnar collateral ligament tear

Common Diagnostic Indications

Suspected occult elbow fracture

- With high clinical suspicion and negative or inconclusive elbow radiographs

Triceps tendon rupture

- From olecranon insertion site

Additional Indications for Wrist and Hand Imaging

Scaphoid fracture

Triangular fibrocartilage complex (TFCC) tear

Ulnar collateral ligament tear (gamekeeper's thumb)

MRI is not indicated in the following clinical situations

The indications listed in this section do not require advanced imaging using MRI. If there are circumstances that require MRI imaging, a peer-to-peer discussion may be required.

Subacromial impingement [9-11]

Note: *Imaging is not indicated unless there is concern for a rotator cuff tear*

References

1. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. *Clin Radiol*. 2009 Jun;64(6):615-621.
2. Bencardino JT, Gyftopoulos S, Palmer WE. Imaging in anterior glenohumeral instability. *Radiology*. 2013;269(2):323-337.
3. Li X, Ma R, Nielsen NM, Gulotta LV, Dines JS, Owens BD. Management of shoulder instability in the skeletally immature patient. J *Am Acad Orthop Surg*. 2013;21(9):529-537.
4. Jain NB, Wilcox RB 3rd, Katz JN, Higgins LD. Clinical examination of the rotator cuff. *PM R*. 2013;5(1):45-56.
5. Mohana-Borges AV, Chung CB, Resnick D. MR imaging and MR arthrography of the postoperative shoulder: spectrum of normal and abnormal findings. *Radiographics*. 2004;24(1):69-85.
6. Hanchard NC, Lenza M, Handoll HH, Takwoingi Y. Physical tests for shoulder impingements and local lesions of bursa, tendon or labrum that may accompany impingement. *Cochrane Database Syst Rev*. 2013;4:CD007427.
7. Keener JD, Brophy RH. Superior labral tears of the shoulder: pathogenesis, evaluation, and treatment. *J Am Acad Orthop Surg*. 2009;17(10):627-637.
8. Nam EK, Snyder SJ. The diagnosis and treatment of superior labrum, anterior and posterior (SLAP) lesions. *Am J Sports Med*. 2003;31(5):798-810
9. Diercks R, Bron C, Dorrestijn O, et al. Guideline for diagnosis and treatment of subacromial pain syndrome. *Acta Orthop*. 2014;85(3):314-322.
10. Ketola S, Lehtinen J, Rousi T, Nissinen M, Huhtala H, Arnala I. Which patients do not recover from shoulder impingement syndrome, either with operative treatment or with nonoperative treatment? *Acta Orthop.* March 2015:1-6.
11. Ketola S, Lehtinen J, Arnala I, et al. Does arthroscopic acromioplasty provide any additional value in the treatment of shoulder impingement syndrome?: a two-year randomised controlled trial. *J Bone Joint Surg Br.* 2009;91(10):1326-1334.
12. Boden BP, Osbahr DC, Jimenez C. Low-risk stress fractures. *Am J Sports Med*. 29(1):100-111.
13. Hegedus EJ, Goode a. P, Cook CE, et al. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. *Br J Sports Med.* 2012;46(14):964-978

Magnetic Resonance Imaging (MRI) Upper Extremity (Non-Joint)

CPT Codes

73218..... MRI upper extremity, non-joint, without contrast

73219..... MRI upper extremity, non-joint, with contrast

73220..... MRI upper extremity, non-joint, without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication for the exam and varies considerably, based on anatomic (from shoulder joint through hand/digits) and clinical considerations
- MRI routinely provides multi-planar imaging through the region of interest

Imaging Considerations

- Conventional radiographs should be obtained before advanced imaging
- CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete or non-displaced fractures may be better imaged with MRI or radionuclide bone scintigraphy
- MRI is often the preferred modality for evaluation of soft tissue abnormalities and for interrogation of possible osteomyelitis, despite negative or non-diagnostic plain films and/or triple-phase bone scintigraphy. One exception for osteomyelitis is detection of bone sequestra, which may be better depicted with CT
- If radiographic findings are typical of osteomyelitis, advanced diagnostic imaging may not be necessary
- Use of contrast is at the discretion of both the ordering and imaging physicians
- Brachial Plexus Imaging: MRI, when not contraindicated is the preferred imaging modality for brachial plexus. The brachial plexus is a network of nerves in the neck, passing under the clavicle and into the axilla. Assign either a CT or MRI of the upper extremity (non-joint) for imaging the brachial plexus

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Brachial plexopathy

Brachial plexus mass

EMG-proven entrapment neuropathy after conservative therapy to direct treatment

- Suspected entrapment neuropathy, cubital tunnel detail, and/or carpal tunnel are not considered medically necessary

Fracture evaluation

(Any <u>one</u> of the following)

- To confirm a suspected occult/stress fracture following non-diagnostic initial radiographs at high risk sites:
  - Scaphoid
  - Lunate
- To define the extent of an acute fracture when surgery is being considered
- To assess fracture healing for delayed union or non-union, when repeat radiographs are non-diagnostic

Common Diagnostic Indications

Infectious process

- In a patient where focused history and physical exam suggest an underlying soft tissue infection when:
  - Patient is unresponsive to treatment including but not limited to antibiotics or incision/drainage
- Abscess - to determine the location and extent for surgical treatment
- Osteomyelitis – following non-diagnostic radiographs
- Fasciitis

Myositis

- To determine optimal location for biopsy; **OR**
- To monitor treatment response

Persistent upper extremity pain – unresponsive to six (6) weeks of conservative treatment

- In a patient where focused history and physical exam suggest non-specific upper extremity pain; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- Patient has completed a minimum of six (6) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
  - NSAIDs or steroids (oral or injection) – unless contraindicated; **OR**
  - Physical therapy (home exercise only if physical therapy is not available); **AND**
- After trial of conservative treatment as listed above, patient fails to show substantial improvement on clinical re-evaluation

Note: *For suspicion of specific etiology, please refer to corresponding indication*

Post-operative or post-procedure evaluation

Pre-operative or pre-procedure evaluation

Note: *This indication is to be used for pre-operative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Septic arthritis

- When there is a clinical consideration of contiguous spread of infection into the adjacent soft-tissues of the joint, which would not normally be included on an MRI joint exam; **AND**
- For cases of known septic arthritis, MRI may be used when any of the following risk factors are present:
  - Underlying joint disease
  - Joint prosthesis
  - IV drug abuse
  - Diabetes
  - Presence of cutaneous ulcers; **OR**
- Pre-operative planning

Significant trauma

- Usually preceded by initial plain film radiographs

Soft tissue mass

(any <u>one</u> of the following)

- Soft-tissue evaluation when prominent calcifications are seen on radiograph
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging
- Following a non-diagnostic radiograph to evaluate a palpable mass found on physical exam

Common Diagnostic Indications

Tumor evaluation: primary neoplasm or metastatic disease

(any <u>one</u> of the following)

- Biopsy-proven malignancy
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging

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Ulnar collateral ligament tear (gamekeeper's thumb)

References

1. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. *Clin Radiol*. 2009 Jun;64(6):615-621.

CT Angiography (CTA) and MR Angiography (MRA) Upper Extremity

CPT Codes

73206..... Computed tomographic angiography, upper extremity, with contrast material(s), including non-contrast images, if performed, and image post-processing

73225..... Magnetic resonance angiography, upper extremity, without and with contrast

Standard Anatomic Coverage

- Depends on the specific anatomic area of interest, from the axillary region through the hand and digits

Imaging Considerations

- CT and MR angiographic techniques include arterial and/or venous assessment, depending on the clinical indication
- Other generally available non-invasive arterial studies of the upper extremity circulation should be considered prior to advanced diagnostic imaging with CTA or MRA. These include segmental systolic pressure measurements, plethysmographic analysis, continuous wave Doppler and/or duplex ultrasonography
- CT angiography utilizes the data obtained from standard CT imaging. A request for a CT exam in addition to a CT Angiography of the same anatomic area during the same imaging session is inappropriate
- For MR arthrography of the upper extremity, see CPT codes 73221-73223
- For imaging the brachial plexus, see CT upper extremity or MRI upper extremity, non-joint

Common Diagnostic Indications

Aneurysm / dilation

Arterial entrapment syndrome

Arterio-venous malformation (AVM) or fistula (AVF)

Dialysis graft evaluation

- Following duplex Doppler assessment

Dissection

Intramural hematoma

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Raynaud's syndrome

Steno-occlusive disease

- Usually atherosclerotic in origin

Thromboembolic disease – arterial or venous

Vascular invasion or compression by a musculoskeletal neoplasm

Vasculitis

Computed Tomography (CT) Lower Extremity

CPT Codes

73700..... CT lower extremity without contrast

73701..... CT lower extremity with contrast

73702..... CT lower extremity without contrast, followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the anatomic area of concern and varies considerably, based on anatomic (from hip through toes) and clinical considerations
- Depending on the protocol used, the CT data acquisition(s) may allow for diagnostic multi-planar reconstructions through the region of interest

Imaging Considerations

- Conventional radiographs should be obtained before advanced imaging
- CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with MRI or radionuclide bone scintigraphy
- If radiographic findings are typical of osteomyelitis, advanced imaging may not be necessary
- In osteomyelitis, CT may be helpful in defining bony sequestra
- Use of contrast (intravenous and intra-articular) is at the discretion of both the ordering and imaging physicians

Common Diagnostic Indications

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

CT accompanying an arthrogram (CT arthrography)

Fracture evaluation

- To confirm a suspected (occult) fracture following initial radiographs; **OR**
- To define the extent of an acute fracture and position of fracture fragments; **OR**
- To assess fracture healing for delayed union or non-union

Hemarthrosis (bloody joint effusion)

- Documented by arthrocentesis except in cases when arthrocentesis is contraindicated (e.g. non-traumatic causes of hemarthrosis such as sickle cell, anticoagulant, or hemophilia)

Infectious process

- In a patient where focused history and physical exam suggest an underlying soft tissue infection when:
  - Patient is unresponsive to treatment including but not limited to antibiotics or incision/drainage
- Abscess – to determine the location and extent for surgical treatment
- Osteomyelitis – following non-diagnostic radiographs and when MRI is contraindicated
- Fasciitis

Neuropathic osteodystrophy (Charcot joint)

- Following conventional radiographs, when there is need for additional diagnostic information from a CT exam to direct treatment decisions (such as concern for an underlying infectious process)

Common Diagnostic Indications

Osteonecrosis [avascular necrosis (AVN); aseptic necrosis]

- Requires initial plain films, prior to advanced imaging
- MRI is often the preferred imaging modality, particularly for evaluation during the early stages of osteonecrosis

Persistent lower extremity pain (excluding knee joint)

- In a patient where focused history and physical exam suggest non-specific lower extremity pain; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- After a trial of conservative treatment (that may include physical therapy, NSAIDs, steroids unless contraindicated, for this current episode of pain); **AND**
- Patient fails to show substantial improvement on clinical re-evaluation

Note: *For suspicion of specific etiology, please refer to corresponding indication*

Post-operative or post-procedure evaluation

Note: *For post-operative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*
Exclusion: *This indication does not apply to preoperative evaluation for primary total knee arthroplasty for osteoarthritis.*

Septic arthritis - when MRI is contraindicated

- When any of the following risk factors are present:
  - Underlying joint disease
  - Joint prosthesis
  - IV drug abuse
  - Diabetes
  - Presence of cutaneous ulcers; **OR**
- Pre-operative planning

Significant trauma

- Usually preceded by initial plain film radiographs

Tarsal coalition

- Following foot radiographs

Soft tissue mass

(any <u>one</u> of the following)

- Soft-tissue evaluation when prominent calcifications are seen on radiograph
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging
- Following a non-diagnostic radiograph to evaluate a palpable mass found on physical exam

Note: *MRI is typically preferred in the evaluation of soft tissue masses*

Tumor evaluation: primary neoplasm or metastatic disease

(any <u>one</u> of the following)

- Biopsy-proven malignancy
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging

When the patient's condition meets the lower extremity MRI guidelines, but there is either a contraindication to MRI or the patient cannot tolerate MRI examination (for example, due to claustrophobia)

References

1. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. *Clin Radiol*. 2009 Jun;64(6):615-621.
2. Ward EE, Jacobson JA, Fessell DP, et al. Sonographic detection of Baker's cysts: comparison with MRI. *AJR Am J Roentgenol*. 2001;176:373-380.

Magnetic Resonance Imaging (MRI) Lower Extremity (Joint & Non-Joint)

CPT Codes

73718..... MRI lower extremity, other than joint, without contrast
73719..... MRI lower extremity, other than joint, with contrast
73720..... MRI lower extremity, other than joint, without contrast followed by re-imaging with contrast
73721..... MRI lower extremity, any joint, without contrast
73722..... MRI lower extremity, any joint, with contrast
73723..... MRI lower extremity, any joint, without contrast followed by re-imaging with contrast

Standard Anatomic Coverage

- Scan coverage depends on the specific clinical indication and varies considerably, based on anatomic and clinical considerations. If medically appropriate, an MRI exam may be requested for each major area of the right and left lower extremities: hip, thigh, knee, lower leg (calf), ankle, or foot (includes toes)
- Routine MRI examinations provide multi-planar imaging of the joint or non-joint region(s) of interest

Imaging Considerations

- Conventional radiographs should be obtained before advanced imaging
- Use of contrast (intravenous and intra-articular) is at the discretion of both the ordering and imaging physicians
- CT is often the preferred modality for evaluation of displaced fractures and subluxations, whereas stress fractures and some incomplete and non-displaced fractures may be better imaged with MRI or radionuclide bone scintigraphy
- MRI is often used to evaluate soft tissue abnormalities and to interrogate for possible osteomyelitis, despite negative or non-diagnostic plain films and/or triple-phase bone scintigraphy. One exception for osteomyelitis is detection of bone sequestra, which may be better depicted with CT
- If radiographic findings are typical of osteomyelitis, advanced imaging may not be necessary
- For suspected osteonecrosis, MRI is often more sensitive than CT or bone scintigraphy
- Implanted surgical hardware, including joint prostheses, may produce sufficient local artifact to preclude adequate imaging through the region containing hardware
- For suspected Baker's cysts, ultrasound should be performed before advanced imaging exams

Common Diagnostic Indications

This section contains general lower extremity, hip, knee, and ankle and foot indications.

General Lower Extremity

Abnormalities detected on other imaging studies which require additional clarification to direct treatment

Common Diagnostic Indications

Fracture evaluation[5-12]

(Any <u>one</u> of the following)

- To confirm a suspected occult/stress fracture following non-diagnostic initial radiographs at high risk sites:
  - Femoral neck/proximal femur
  - Tibia (anterior/lateral)
  - Patella
  - Medial malleolus
  - Talus
  - Navicular
  - Metatarsal base (second and fifth digits)
  - Great toe seasamoid
- To define the extent of an acute fracture when surgery is being considered
- To assess fracture healing for delayed union or non-union, when repeat radiographs are non-diagnostic

Hemarthrosis (bloody joint effusion)

- Documented by arthrocentesis except in cases when arthrocentesis is contraindicated (e.g. non-traumatic causes of hemarthrosis such as sickle cell, anticoagulant, or hemophilia)

Infectious process

- In a patient where focused history and physical exam suggest an underlying soft tissue infection when:
  - Patient is unresponsive to treatment including but not limited to antibiotics or incision/drainage
- Abscess - to determine the location and extent for surgical treatment
- Osteomyelitis – following non-diagnostic radiographs
- Fasciitis

Intraarticular loose body

- Following non-diagnostic radiographs

Note: *Includes synovial osteochondromatosis*

MRI accompanying an arthrogram (MR arthrography)

Myositis

- To determine optimal location for biopsy; **OR**
- To monitor treatment response

Osteochondral lesion

Osteonecrosis [avascular necrosis (AVN); aseptic necrosis]

- Requires initial plain films, prior to advanced imaging
- MRI is often the preferred imaging modality, particularly for evaluation during the early stages of osteonecrosis

Persistent lower extremity pain (excluding knee joint)

- In a patient where focused history and physical exam suggest non-specific lower extremity pain; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- After a trial of conservative treatment (that may include physical therapy, NSAIDs, steroids unless contraindicated, for this current episode of pain); **AND**
- Patient fails to show substantial improvement on clinical re-evaluation

Note: *For suspicion of specific etiology, please refer to corresponding indication*

Pigmented Villonodular synovitis (PVNS)

Common Diagnostic Indications

Post-operative or post-procedure evaluation

Note: *For post-operative evaluation of conditions not specifically referenced elsewhere in this guideline. This guideline does not include post-operative knee replacement for osteoarthritis*

Preoperative or pre-procedure evaluation, for conditions other than knee replacements for osteoarthritis

Note: *For preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Exclusion: *This indication does not apply to preoperative evaluation for primary total knee arthroplasty for osteoarthritis. Radiographs are typically sufficient for the preoperative evaluation for osteoarthritis prior to total knee arthroplasty.*

Septic arthritis

- When any of the following risk factors are present:
  - Underlying joint disease
  - Joint prosthesis
  - IV drug abuse
  - Diabetes
  - Presence of cutaneous ulcers; **OR**
- Pre-operative planning

Significant trauma

- Usually preceded by initial plain film radiographs

Soft tissue mass

(any <u>one</u> of the following)

- Soft-tissue evaluation when prominent calcifications are seen on radiograph;
- Spontaneous soft tissue hemorrhage with or without palpable mass
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging
- Evaluation of a palpable soft tissue mass (excluding posterior knee masses) on physical examination following a non-diagnostic radiograph
- Evaluation of a palpable posterior knee mass on physical examination following a non-diagnostic radiograph AND a non-diagnostic ultrasound

Tumor evaluation: primary neoplasm or metastatic disease

(any <u>one</u> of the following)

- Biopsy-proven malignancy
- Surveillance, without pathologic tissue confirmation, of an unexplained mass identified on prior imaging

Hip Joint

Labral tear

Occult hip fracture

- With high clinical suspicion and negative or inconclusive hip radiographs

Knee Joint

Chondromalacia patella (patellofemoral pain syndrome)[3]

- In a patient following a focused history and physical exam; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- Patient has completed a minimum of four (4) consecutive weeks of physician supervised conservative treatment for the current episode of pain; **AND**
- Patient fails to show substantial improvement on clinical re-evaluation

Common Diagnostic Indications

Ligament tear

- In a patient where focused history and physical exam suggests a ligament tear; **AND**
- Patient has completed a minimum of four (4) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
  - Physical therapy (home exercise only if physical therapy is not available); **AND**
- After trial of conservative treatment as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- For pre-operative evaluation, based on physical exam findings which may include one of the following:
  - Positive Lachman test; **OR**
  - Positive pivot shift test; **OR**
  - Positive anterior or posterior drawer test; **OR**
  - Positive medial or lateral stress tests

Meniscal tear/injury

- In a patient where focused history and physical exam suggests a meniscal tear; **AND**
- Patient has completed a minimum of four (4) consecutive weeks of physician supervised conservative treatment for the current episode of pain, including but not limited to:
  - NSAIDs or steroids (oral or injection) – unless contraindicated; **AND**
  - Physical therapy (home exercise only if physical therapy is not available); **AND**
- After trial of conservative treatment as listed above, patient fails to show substantial improvement on clinical re-evaluation; **OR**
- For pre-operative evaluation, based on physical exam findings which may include one of the following:
  - Positive McMurray test with minimal knee flexion; **OR**
  - A severe twisting injury after which activity could not be resumed; **OR**
  - An anterior cruciate ligament tear is present; **OR**
  - Locking; **OR**
  - Swelling and symptoms develop immediately after an acute injury; **OR**
  - Inability to bear weight; **OR**
  - Inability to fully extend knee

Osteochondritis dissecans[4]

Post-operative evaluation following repair of a ligamentous or tendinous tear, with new symptoms

Ankle and Foot

Acute and chronic tendon injuries

- In a patient following a focused history and physical exam; **AND**
- Following non-diagnostic conventional radiographs; **AND**
- After a trial of conservative treatment (that may include physical therapy, for the current episode of pain); **AND**
- Patient fails to show substantial improvement on clinical re-evaluation

Acute tendon rupture

- For pre-operative evaluation based on
  - Severe muscle weakness from the involved tendon; **OR**
  - Non-diagnostic X-ray for bone avulsion; **OR**
  - Non-diagnostic ultrasound evaluation

Common Diagnostic Indications

Diabetic foot disease

- Osteomyelitis – following non-diagnostic radiographs

Morton's neuroma

- When the diagnosis is not clear on physical examination or ultrasound

Neuropathic osteodystrophy (Charcot joint)

- Following foot radiographs, when there is need for additional diagnostic information from an MRI exam to direct treatment decisions (such as concern for an underlying infectious process)

Plantar fasciitis

- For pre-operative evaluation following a failure of six (6) months of physician supervised conservative treatment

Tarsal coalition

- Following foot radiographs

Note: *CT may be preferred for bony coalition*

Tarsal tunnel

- Following EMG nerve conduction study if not responsive to four weeks of conservative treatment
- Neuropathy secondary to entrapment or compression of the posterior tibial nerve or its branches in the fibro-osseous tunnel, deep to the flexor retinaculum

References

1. Lakkaraju A, Sinha R, Garikipati R, Edward S, Robinson P. Ultrasound for initial evaluation and triage of clinically suspicious soft-tissue masses. *Clin Radiol*. 2009 Jun;64(6):615-621
2. Ward EE, Jacobson JA, Fessell DP, et al. Sonographic detection of Baker's cysts: comparison with MRI. *AJR Am J Roentgenol*. 2001;176:373-380.
3. American Medical Society for Sports Medicine. *Choosing Wisely: Five Things Physicians and Patients Should Question*. ABIM Foundation; 2014. Available at www.choosingwisely.org.
4. American Academy of Orthopaedic Surgeons. *Diagnosis and Treatment of Osteochondritis Dissecans: Guideline and Evidence Report*. Rosemont, IL: AAOS; December 4, 2010. http://www.aaos.org/Research/guidelines/OCDGuideline.asp. Accessed April 11, 2013.
5. Tins BJ, Garton M, Cassar-Pullicino VN, Tyrrell PNM, Lalam R, Singh J. Stress fracture of the pelvis and lower limbs including atypical femoral fractures-a review. *Insights Imaging.* 2015;6(1):97-110.
6. Boden BP, Osbahr DC, Jimenez C. Low-risk stress fractures. *Am J Sports Med.* 29(1):100-111.
7. Kiuru MJ, Pihlajamaki HK, Ahovuo JA. Fatigue stress injuries of the pelvic bones and proximal femur: evaluation with MR imaging. *Eur Radiol.* 2003;13(3):605-611.
8. Kiuru MJ, Pihlajamaki HK, Hietanen HJ, Ahovuo JA. MR imaging, bone scintigraphy, and radiography in bone stress injuries of the pelvis and the lower extremity. *Acta Radiol.* 2002;43(2):207-212.
9. Ohta-Fukushima M, Mutoh Y, Takasugi S, Iwata H, Ishii S. Characteristics of stress fractures in young athletes under 20 years. *J Sports Med Phys Fitness.* 2002;42(2):198-206.
10. Boden BP, Osbahr DC. High-risk stress fractures: evaluation and treatment. *J Am Acad Orthop Surg.* 8(6):344-353.
11. Murray SR, Reeder MT, Udermann BE, Pettitt RW. High-risk stress fractures: pathogenesis, evaluation, and treatment. *Compr Ther*. 2006;32(1):20-25.
12. Arendt EA, Griffiths HJ. The use of MR imaging in the assessment and clinical management of stress reactions of bone in high-performance athletes. *Clin Sports Med.* 1997;16(2):291-306

CT Angiography (CTA) and MR Angiography (MRA) Lower Extremity

CPT Codes

73706..... Computed tomographic angiography, lower extremity, with contrast material(s), including noncontrast images, if performed, and image postprocessing

73725..... Magnetic resonance angiography, lower extremity, without and with contrast

Standard Anatomic Coverage

- Depends on the area of interest and may extend from the iliofemoral regions through the feet

Imaging Considerations

- Other generally available non-invasive arterial studies of the lower extremity circulation should be considered prior to advanced diagnostic imaging with CTA or MRA. These may include segmental systolic pressure measurements, plethysmographic analysis, continuous wave Doppler and/or duplex ultrasonography of the lower extremity arterial or venous circulations
- MRA should also be considered in patients with a history of either previous contrast reaction to intravascular administration of iodinated radiographic contrast material or atopy
- CT angiography utilizes the data obtained from standard CT imaging. An authorization request for a CT exam in addition to a CT angiography of the same anatomic area during the same imaging session is inappropriate
- A request for a CT lower extremity venogram is a request for a CTA of the lower extremity. A quick look at the vasculature of the lower extremity at the time of a CT or CTA of the chest for pulmonary embolism evaluation should not be separately entered or reported

Common Diagnostic Indications

Aneurysm / dilation

Arterial entrapment syndrome

Arteriovenous malformation (AVM) or fistula (AVF)

Critical ischemia

- For example, in diabetic vascular disease with ischemic ulcers or gangrene

Dissection

Intramural hematoma

Post-operative or post-procedure evaluation

Preoperative or pre-procedure evaluation

Note: *This indication is for preoperative evaluation of conditions not specifically referenced elsewhere in this guideline.*

Thromboembolic disease – arterial or venous

Common Diagnostic Indications

Vascular assessment for lower extremity claudication

- CPT coding for abdominal aortic and run-off evaluation, which involves image post-processing for three-dimensional reconstructions, should follow:
  - For CTA: 75635 - CTA of abdominal aorta and bilateral iliofemoral lower extremity run-off without contrast, followed by re-imaging with contrast
  - For MRA: 74185 - abdominal MRA and 73725 - bilateral lower extremity MRAs
- Either CTA or MRA is indicated in a patient with classic presenting symptoms of claudication from peripheral arterial disease, such as diminished / absent peripheral pulses and cramping pain in the legs (particularly in the thighs and calves) when walking, which disappears at rest
- In the absence of classic peripheral symptoms of claudication, then obtain a vascular surgical consultation and perform lower extremity non-invasive arterial evaluation, which may include the following: segmental systolic pressure measurements, segmental limb plethysmography, Continuous wave Doppler and duplex ultrasonography. Ankle brachial indices (ABI) of < 0.9 may undergo advanced imaging. Rest pain or severe occlusive disease typically occurs with ABI < 0.5

Vascular invasion or compression by a musculoskeletal neoplasm

Vasculitis

Venous compression, due to surrounding mass effect

Venous thrombosis

Extremity Bibliography

1. Bencardino JT, Palmer WP. Imaging of hip disorders in athletes. *Radiol Clin N Am*. 2002;40:267-287.
2. Bezooijen R, van den Bosch HCM, Tielbeek AV, et al. Peripheral arterial disease: sensitivity-encoded multiposition MR angiography compared with intraarterial angiography and conventional multiposition MR angiography. *Radiology*. 2004;231:263-271.
3. Bilecen D, Aschwanden M, Heidecker HG, Bongartz G. Optimized assessment of hand vascularization on contrast-enhanced MR angiography with a subsystolic continuous compression technique. *AJR Am J Roentgenol*. 2004;182:180-182.
4. Buckwalter KA, Rydberg J, Kopecky KK, et al. Musculoskeletal imaging with multislice CT. *AJR Am J Roentgenol*. 2001;176:979-986.
5. Burbank KM, Stevenson JH, Czarnecki GR, Dorfman J. Chronic shoulder pain: Part II. Treatment. *Am Fam Physician*. 2008 Feb 15; 77(4):493-497.
6. Calfee RP, Patel A, DaSilva MF, Akelman E. Management of lateral epicondylitis: current concepts. *J Am Acad Orthop Surg*. 2008 Jan;16(1):19-29.
7. Carrino JA, Schweitzer ME. Imaging of sports related knee injuries. *Radiol Clin N Am*. 2002;40:181-202.
8. Chatha DS, Cunningham PM, Schweitzer ME. MR imaging of the diabetic foot: diagnostic challenges. *Radiol Clin N Am*. 2005;43:747-759.
9. Chiles C, Davis KW, Williams DW. Navigating the thoracic inlet. *Radiographics*. 1999;19:1161-1176.
10. Chow LC, Rubin GD. CT angiography of the arterial system. *Radiol Clin N Am*. 2002;40:729-749.
11. Chung CB, Lektrakul N, Resnick D. Straight and rotational instability patterns of the knee: concepts and magnetic resonance imaging. *Radiol Clin N Am*. 2002;40:203-216.
12. Del Grande F, Carrino JA, Del Grande M, Mammen AL, Christopher Stine L. Magnetic resonance imaging of inflammatory myopathies. *Top Magn Reson Imaging*. 2011 Apr;22(2):39-43.
13. Demondion X, Bacqueville E, Paul C, et al. Thoracic outlet: assessment with MR imaging in asymptomatic and symptomatic populations. *Radiology*. 2003;227:461-468.
14. Dunfee WR, Dalinka MK, Kneeland JB. Imaging of athletic injuries to the ankle and foot. *Radiol Clin N Am*. 2002;40:289-312.
15. Farber JM, Buckwalther KA. Sports-related injuries of the shoulder: instability. *Radiol Clin N Am*. 2002;40:235-249.
16. Fayad LM, Johnston P, Fishman EK. Multidetector CT of musculoskeletal disease in the pediatric patient: principles, techniques, and clinical applications. *Radiographics*. 2005;25:603-618.
17. Fleckenstein JL, Wolfe GI. MRI vs EMG: which has the upper hand in carpal tunnel syndrome? *Neurology*. 2002;58:1583-1584.
18. Fritz RC. Magnetic resonance imaging of sports-related injuries to the shoulder: impingement and rotator cuff. *Radiol Clin N Am*. 2002;40:217-234.
19. Froger CL, Duijm LEM, Liem YS, et al. Stenosis detection with MR angiography and digital subtraction angiography in dysfunctional hemodialysis access fistulas and grafts. *Radiology*. 2005;234:284-291.
20. Goff JD, Crawford R. Diagnosis and treatment of plantar fasciitis. *Am Fam Physician*. 2011 Sep 15;84(6):676-82. PMID: 21916393
21. Goyen M, Ruehm SG, Debatin JF. MR angiography for assessment of peripheral vascular disease. *Radiol Clin N Am*. 2002;40:835-846.
22. Grimer R, Judson I, Peake D, Seddon B. Guidelines for the management of soft tissue sarcomas [published online ahead of print May 31, 2010]. *Sarcoma*. 2010;2010:506182.
23. Helms CA. The meniscus: recent advances in MR imaging of the knee. *AJR Am J Roentgenol*. 2002;179:1115-112.
24. Hernigou P, Daltro G, Flouzat-Lachaniette CH, Roussignol X, Poignard A. Septic arthritis in adults with sickle cell disease often is associated with osteomyelitis or osteonecrosis. *Clin Orthop Relat Res*. 2010 Jun;468(6):1676-81. Epub 2009 Nov 3.

25. Hirsch AT, Criqui MH, Terat-Jacobson D, et al. Peripheral arterial disease detection, awareness, and treatment in primary care. *JAMA*. 2001;286:1317-1324.
26. Ho VB, Corse WR. MR angiography of the abdominal aorta and peripheral vessels. *Radiol Clin N Am*. 2003;41:115-144.
27. Jackson JL, O'Malley PG, Kroenke K. Evaluation of acute knee pain in primary care. *Ann Intern Med*. 2003;139:575-588.
28. Janka R, Fellner C, Wenkel E, et al. Contrast-enhanced MR angiography of peripheral arteries including pedal vessels at 1.0T: feasibility study with dedicated peripheral angiography coil. *Radiology*. 2005;235:319-326.
29. Jarvik JG, Yuen E, Haynor DR, et al. MR nerve imaging in a prospective cohort of patients with suspected carpal tunnel syndrome. *Neurology*. 2002;58:1597-1602.
30. Jbara M, Chen Q, Marten P, et al. Shoulder MR arthrography: how, why, when. *Radiol Clin N Am*. 2005;43:683-692.
31. Kapoor A, Page S, Lavalley M, Gale DR, Felson DT. Magnetic resonance imaging for diagnosing foot osteomyelitis: a meta-analysis. *Arch Intern Med*. 2007;167(2):125-132.
32. Karcaaltincaba M, Akata D, Aydingoz U, et al. Three dimensional MDCT angiography of the extremities: clinical application with emphasis on musculoskeletal uses. *AJR Am J Roentgenol*. 2004;183:113-117.
33. Katz JN, Simmons BP. Carpal tunnel syndrome. *N Eng J Med*. 2002;346:1807-1812.
34. Lipsky BA, Berendt AR, Deery HG, et al; Infectious Diseases Society of America. Diagnosis and treatment of diabetic foot infections. *Clin Infect Dis*. 2004;39(7):885-910.
35. Loewe C. Peripheral MR angiography. *Magn Reson Imaging Clin N Am*. 2004;12:749-779.
36. Manaster BJ. Adult chronic hip pain: radiographic evaluation. *Radiographics*. 2000;20:S3-S25.
37. Margaretten ME, Kohlwes J, Moore D, Bent S. Does this adult patient have septic arthritis? *JAMA*. 2007;297(13):1478-88. PMID:17405973
38. Mathews CJ, Kingsley G, Field M, et al. Management of septic arthritis: a systematic review. *Ann Rheum Dis*. 2007;66(4):440-445.
39. Meissner OA, Reiger J, Weber C, et al. Critical limb ischemia: hybrid MR angiography compared with DSA. *Radiology*. 2005;235:308-318.
40. Mohana-Borges AVR, Chung CB, Resnick D. MR imaging and MR arthrography of the postoperative shoulder: spectrum of normal and abnormal findings. *Radiographics*. 2004;24:69-85.
41. Nelemans PJ, Leiner T, de Vet HC, van Engelshoven JM. Peripheral arterial disease meta-analysis of the diagnostic performance of MR angiography. *Radiology*. 2000;217:105-114.
42. Pretorius ES, Fishman EK. Volume-rendered three-dimensional spiral CT: musculoskeletal applications. *Radiographics*. 1999;19:1143-1160.
43. Qayyum A, MacVicar AD, Padhani AR, et al. Symptomatic brachial plexopathy following treatment for breast cancer: utility of MR imaging with surface-coil techniques. *Radiology*. 2000;214:837-842.
44. Rofsky NM, Adelman MA. MR angiography in the evaluation of atherosclerotic peripheral vascular disease. *Radiology*. 2000; 214:325-338.
45. Ruehm SG, Wiesner W, Debatin JF. Pelvic and lower extremity veins: contrast-enhanced three-dimensional MR Venography with a dedicated vascular coil—initial experience. *Radiology*. 2000;215:421-427.
46. Sofka CM, Potter HG. Imaging of elbow injuries in the child and adult athlete. *Radiol Clin N Am*. 2002;40:251-265.
47. Stevens DL, Bisno AL, Chambers HF, et al.; Infectious Diseases Society of America. Practice guidelines for the diagnosis and management of skin and soft-tissue infections. *Clin Infect Dis*. 2005;41(10):1373-1406.
48. Stoller DW, Tirman PFJ, Bredella MA. *Diagnostic Imaging: Orthopedics*. Salt Lake City, Utah: Amirsys; 2004.
49. Swan JS, Carroll TJ, Kennell TW, et al. Time-resolved three-dimensional contrast-enhanced MR angiography of the peripheral vessels. *Radiology*. 2002;225:43-52.
50. Thomas JL, Christensen JC, Kravitz SR, et al; American College of Foot and Ankle Surgeons heel pain committee. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. *J Foot Ankle Surg*. 2010 May-Jun;49(3 Suppl):S1-S19.
51. Walker UA. Imaging tools for the clinical assessment of idiopathic inflammatory myositis. *Curr Opin Rheumatol*. 2008;20(6):656-661.
52. Wittenberg KH, Adkins MC. MR imaging of nontraumatic brachial plexopathies: frequency and spectrum of findings. *Radiographics*. 2000;20:1023-1032.
53. Yu WD, Shapiro MS. Cysts and other masses about the knee. *Phys Sport Med*. 1999;27(7):59-68.

54. Zhang HL, Khilnani NM, Prince MR, et al. Diagnostic accuracy of time-resolved 2D projection MR angiography for symptomatic infrapopliteal arterial occlusive disease. *AJR Am J Roentgenol*. 2005;184:938-947.
55. Diercks R, Bron C, Dorrestijn O, et al. Guideline for diagnosis and treatment of subacromial pain syndrome. *Acta Orthop*. 2014;85(3):314-322.
56. Ketola S, Lehtinen J, Rousi T, Nissinen M, Huhtala H, Arnala I. Which patients do not recover from shoulder impingement syndrome, either with operative treatment or with nonoperative treatment? *Acta Orthop.* March 2015:1-6.
57. Ketola S, Lehtinen J, Arnala I, et al. Does arthroscopic acromioplasty provide any additional value in the treatment of shoulder impingement syndrome?: a two-year randomised controlled trial. *J Bone Joint Surg Br.* 2009;91(10):1326-1334.
58. Tins BJ, Garton M, Cassar-Pullicino VN, Tyrrell PNM, Lalam R, Singh J. Stress fracture of the pelvis and lower limbs including atypical femoral fractures-a review. *Insights Imaging.* 2015;6(1):97-110.
59. Boden BP, Osbahr DC, Jimenez C. Low-risk stress fractures. *Am J Sports Med.* 29(1):100-111.
60. Kiuru MJ, Pihlajamaki HK, Ahovuo JA. Fatigue stress injuries of the pelvic bones and proximal femur: evaluation with MR imaging. *Eur Radiol.* 2003;13(3):605-611.
61. Kiuru MJ, Pihlajamaki HK, Hietanen HJ, Ahovuo JA. MR imaging, bone scintigraphy, and radiography in bone stress injuries of the pelvis and the lower extremity. *Acta Radiol.* 2002;43(2):207-212.
62. Ohta-Fukushima M, Mutoh Y, Takasugi S, Iwata H, Ishii S. Characteristics of stress fractures in young athletes under 20 years. *J Sports Med Phys Fitness.* 2002;42(2):198-206.
63. Boden BP, Osbahr DC. High-risk stress fractures: evaluation and treatment. *J Am Acad Orthop Surg.* 8(6):344-353.
64. Murray SR, Reeder MT, Udermann BE, Pettitt RW. High-risk stress fractures: pathogenesis, evaluation, and treatment. *Compr Ther*. 2006;32(1):20-25.
65. Arendt EA, Griffiths HJ. The use of MR imaging in the assessment and clinical management of stress reactions of bone in high-performance athletes. *Clin Sports Med.* 1997;16(2):291-306
66. Hegedus EJ, Goode a. P, Cook CE, et al. Which physical examination tests provide clinicians with the most value when examining the shoulder? Update of a systematic review with meta-analysis of individual tests. *Br J Sports Med.* 2012;46(14):964-978

Positron Emission Tomography (PET) PET Applications including Oncologic Tumor Imaging

CPT Codes

Dedicated PET Imaging:

78811..... PET imaging, limited area

78812..... PET imaging, skull to mid-thigh

78813..... PET imaging, whole body

PET/CT Imaging:

78814..... PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; limited area

78815..... PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; skull base to mid-thigh

78816..... PET imaging, with concurrently acquired CT for attenuation correction and anatomic localization; whole body

Commonly Used Radiopharmaceutical/Scanner

- 2-(fluorine-18) fluoro-2-deoxy-d-glucose (FDG), performed on a dedicated PET or integrated (hybrid) PET/CT scanner
- Radiopharmaceuticals other than 2-(fluorine-18) fluoro-2-deoxy-d-glucose (FDG) are still under active investigation.

Technology Considerations

The use of PET is generally limited to clinical situations in which tissue confirmation of malignancy has been established and standard imaging has not provided sufficient information to guide treatment decisions.

Standard imaging usually consists of CT or MRI, but may include xray, bone scan or ultrasound. In the majority of situations where residual or recurrent disease is of concern, biopsy remains the most reliable method of confirmation. In addition, timing of PET with regard to radiation treatment and other forms of therapy is critical, as the inflammatory response may lead to false positive findings.

For situations where standard imaging with contrast is recommended but a contraindication to contrast administration exists, special consideration for PET imaging will be given when the results of the study are needed to guide treatment.

Based on these considerations and the considerable nuance that exists across tumor types, peer-to-peer discussions will often be necessary to determine appropriateness of PET imaging.

Routine surveillance with PET or other imaging studies in asymptomatic patients has not been shown to improve survival or impact the ability to palliate recurrent disease, and is therefore not recommended.

Common Diagnostic Indications

Note: Initial treatment strategy refers to staging.

Anal cancer

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease
- Radiation planning
  - For definitive treatment only
- Subsequent treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic
  - Restaging of local recurrence when salvage surgery is planned
- Surveillance
  - Not indicated for surveillance

Bladder, renal pelvis and ureter

- Initial treatment strategy
  - Evaluation of stage II or stage III bladder cancer prior to surgery
  - When bone metastasis is suspected based on signs and symptoms and standard imaging has not demonstrated bone lesions

  Note: *PET is not indicated in bladder tumors which have not invaded the muscle (stage < cT2).*
- Subsequent treatment strategy
  - Assessment of treatment response when standard imaging is not indicated or inconclusive
  - Evaluation of objective signs or symptoms of disease when CT or MRI has not clearly demonstrated recurrence or progression
- Surveillance
  - Not indicated for surveillance

Bone/cartilage and connective/other soft tissue

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease
  - Standard imaging suggests a resectable solitary metastasis
  - As a baseline prior to neoadjuvant chemotherapy for deep tumors larger than 3 cm
- Subsequent treatment strategy
  - After completion of neoadjuvant chemotherapy for deep lesions larger than 3 cm
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Breast cancer, invasive (male and female)

- Initial treatment strategy when a diagnosis of invasive breast cancer has been established and **any of the following** apply:
  - Locally advanced disease (stage IIIA-IIIC) has been established and standard imaging does not clearly demonstrate metastatic disease
  - Symptom-directed staging has been performed and is equivocal or suspicious for metastatic disease
  - Standard imaging studies are equivocal or non-diagnostic for the extent of known metastatic disease
- Subsequent treatment strategy
  - Detection of recurrent or progressive disease, when standard imaging is equivocal or non-diagnostic
  - Suspected worsening of disease based on objective signs or symptoms (such as rising tumor markers), when standard imaging has been performed and does not clearly identify site of recurrence or progression
- Surveillance
  - Not indicated for surveillance

Note: *Standard imaging includes CT or MRI and bone scan, and may also include ultrasound when liver involvement is suspected. In the setting of bone-only metastatic disease, evaluation for progression or regression may be best imaged by PET.*

Central nervous system (CNS) cancers (primary malignancies of the brain and spinal cord)

- Initial treatment strategy
  - To evaluate possible systemic disease in proven CNS lymphoma
- Subsequent treatment strategy
  - Not indicated
- Surveillance
  - Not indicated for surveillance

Note: *Standard PET (body) imaging is sometimes used as staging, particularly for CNS lymphoma, or metastatic disease detected in the central nervous system. Primary brain tumors traditionally are imaged utilizing metabolic Brain FDG-PET scanning.*

Cervical cancer

- Initial treatment strategy
  - After definitive diagnosis of stage IB2 or higher cervical cancer
- Subsequent treatment strategy
  - Assessment of response to definitive chemoradiation when performed at least 12 weeks following therapy
  - Detection of recurrent or progressive disease, when standard imaging is equivocal or non-diagnostic
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Colorectal cancer

- Initial treatment strategy—Detection of metastatic disease when the following are true:
  - Standard imaging has been performed (CT or ultrasound) and suggests resectable metastatic disease, **AND**
  - Confirmation of metastatic disease will impact the decision to proceed with curative surgery;

  OR

  - Lesion(s) is/are greater than 1 cm in diameter, **AND**
  - Lesion(s) is/are in a location not amenable to biopsy, or biopsy is considered high risk.

  Note: *A negative standard workup is considered sufficient for staging. In patients who cannot undergo contrast-enhanced CT due to contrast allergy or renal disease, PET may be utilized if the patient has potentially curable disease.*
- Radiation planning—Rectal cancer only
  - For preoperative treatment only
- Subsequent treatment strategy
  - CT is equivocal for metastatic disease and lesion(s) is/are greater than 1 cm in diameter
  - CT demonstrates potentially surgically curable recurrence
  - CT does not demonstrate a focus of recurrence but CEA level is rising
  - Signs or symptoms are suggestive of recurrence and CT with contrast is contraindicated.

  Note: *PET is not appropriate to assess response to chemotherapy due to an unacceptably high rate of false positive and false negative studies*
- Surveillance
  - Not indicated for surveillance

Esophageal and gastroesophageal junction cancers

- Initial treatment strategy
  - Standard imaging has been performed and has not demonstrated metastatic disease
- Radiation planning
  - For preoperative or definitive treatment only
- Subsequent treatment strategy
  - Assessment of response to chemoradiation, (as definitive treatment or prior to surgery) when performed at least 5 weeks after completion of therapy; **OR**,
  - Evaluation of suspected recurrence based on signs or symptoms, when standard modalities are equivocal for recurrent disease
- Surveillance
  - Not indicated for surveillance

Gastric cancer

- Initial treatment strategy—Detection of metastatic disease in tumors initially staged **1B or higher** when **all of the following** are true:
  - Standard imaging has been performed and has not clearly demonstrated metastatic disease.
  - Patient is a candidate for curative surgery.
- Radiation planning
  - For preoperative or definitive treatment only
- Subsequent treatment strategy
  - To determine resectability of residual disease following completion of primary (neoadjuvant) treatment, when follow-up evaluation with standard modalities does not demonstrate metastatic disease
  - Evaluation of suspected recurrence based on signs or symptoms, when standard modalities are equivocal for recurrent disease
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Germ cell tumors of the ovary and testis

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease.
- Subsequent treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic
  - Residual mass >3 cm and normal markers
- Surveillance
  - Not indicated for surveillance

Head and neck, including lip, oral cavity, pharynx, larynx, nasal cavity, ear, sinuses, eye, or occult head and neck primary

- Initial treatment strategy
  - Evaluation of Stage III and IV cancers (tumors greater than 4 cm in size, or any evidence of regional node involvement) of the oral cavity, oropharynx, hypopharynx, nasopharynx, larynx and sinus
  - Following biopsy suggestive of a head and neck primary tumor (squamous cell cancer, adenocarcinoma, or anaplastic undifferentiated epithelial tumor) when CT or MRI evaluation of the neck has not detected a primary site of tumor
- Radiation planning
  - For preoperative or definitive treatment only
- Subsequent treatment strategy
  - Evaluation of disease following clinical response to treatment, no sooner than 12 weeks after completion of therapy
  - Evaluation of suspected recurrence based on signs or symptoms, when CT or MRI is equivocal or non-diagnostic for recurrent disease
  - Follow up of an equivocal post-treatment PET scan, no sooner than 4 weeks after the study, to determine need for further intervention such as neck dissection
- Surveillance
  - Not indicated for surveillance

Note: *PET is not generally indicated for initial evaluation of lip and salivary gland cancers, regardless of stage.*

Kidney cancer

- Initial treatment strategy
  - Evaluation of the extent of disease when curative resection of primary tumor or limited metastatic disease is planned, and standard imaging is equivocal for additional sites of disease.
- Subsequent treatment strategy—Evaluation of suspected recurrence when **all of the following** are true:
  - Standard imaging is equivocal for recurrent disease.
  - Biopsy cannot be performed.
  - Tumor has been shown to be PET avid (if a prior PET scan has been performed).
- Surveillance
  - Not indicated for surveillance

Note: *Bone scan and brain MRI should be performed for clinical suspicion of metastatic disease in renal cell carcinoma, as false negative PET results are commonly reported for this tumor type.*

Common Diagnostic Indications

Lung cancer

Pulmonary nodule

- Evaluation of a solitary pulmonary nodule when **all of the following** features are present:
  - Nodule is well-demarcated, solid or part solid, and lacks a benign calcification pattern.
  - Size is greater than 8 mm but less than 3 cm in greatest diameter
  - Nodule is surrounded by aerated lung parenchyma
  - There is no associated adenopathy, atelectasis or pleural effusion

Non-small cell lung cancer

- Initial treatment strategy
  - Diagnosis in patients with a strong clinical or radiographic suspicion of non-small cell lung cancer
  - Evaluation of the extent of disease following biopsy confirmation of non-small cell lung cancer
- Radiation planning
  - For preoperative or definitive treatment only
- Subsequent treatment strategy
  - Evaluation following induction or neoadjuvant therapy to determine eligibility for resection
  - Assessment of response to definitive chemoradiation when performed at least 12 weeks following therapy
  - Evaluation of signs or symptoms of disease when CT or MRI has not clearly demonstrated recurrence or progression
  - Differentiation of tumor from benign conditions (atelectasis, consolidation, or radiation fibrosis) when CT clearly delineates the abnormal findings
- Surveillance
  - Not indicated for surveillance

Note: *Areas previously treated with radiation therapy can remain FDG avid for up to 2 years.*

Small cell lung cancer

- Initial treatment strategy
  - Prior to definitive therapy when standard imaging suggests limited stage disease
- Radiation planning
  - Prior to initiation of radiation therapy
- Subsequent treatment strategy
  - Not routinely indicated
- Surveillance
  - Not indicated for surveillance

Lymphoma

Suspected lymphoma

- Initial evaluation of suspected lymphoma when lymph nodes are not amenable to biopsy

Note: *PET scan prior to histologic determination is not routinely recommended, as PET-avid lymphadenopathy can result from both benign and other malignant processes.*

Chronic lymphocytic leukemia (CLL) or Small lymphocytic lymphoma (SLL)

- Suspicion of Richter's transformation when PET is utilized to direct biopsy

Note: *Suspicion of Richter's transformation is most commonly based on a presentation of rapidly enlarging lymph nodes, onset of B symptoms, hepatosplenomegaly, and elevated serum lactate dehydrogenase (LDH) levels.*

Common Diagnostic Indications

Hodgkin's lymphoma

- Initial treatment strategy (often performed as an adjunct to CT chest/abdomen/pelvis)
- Radiation planning
  - Definitive or consolidative treatment
- Subsequent treatment strategy
  - Evaluation of response following 2–4 cycles of treatment
  - Post-treatment evaluation
  - Evaluation of suspected recurrence or progression of disease based on standard imaging or objective signs/symptoms
- Surveillance
  - Not indicated for surveillance

Note: *For post-treatment evaluation, PET should not be performed sooner than 3 weeks following completion of all cycles of chemotherapy, or sooner than 12 weeks following completion of radiation therapy.*

Low grade/indolent non-Hodgkin's lymphoma or lymphoproliferative disorders (other than CLL/SLL)

- Initial treatment strategy
  - Evaluation of suspected transformation to a more aggressive lymphoma based on clinical signs or symptoms
  - Prior to initiation of therapy
- Radiation planning
  - Definitive or consolidative treatment
- Subsequent treatment strategy
  - Post-treatment response evaluation, when initial PET scan has demonstrated FDG uptake
  - Evaluation of suspected recurrence or progression of disease based on standard imaging, when there is an indication to resume systemic treatment
  - Evaluation of suspected transformation to a more aggressive lymphoma based on clinical signs or symptoms
- Surveillance
  - Not indicated for surveillance

Note: *For post-treatment evaluation, PET should not be performed sooner than 3 weeks following completion of all cycles of chemotherapy, or sooner than 12 weeks following completion of radiation therapy.*

Intermediate or High grade (aggressive) non-Hodgkin's lymphoma and other subtypes

- Initial treatment strategy (often performed as an adjunct to CT chest/abdomen/pelvis)
- Radiation planning
  - Definitive or consolidative treatment
- Subsequent treatment strategy
  - Evaluation of response following 2–4 cycles of treatment of stage III and IV disease, when standard imaging has not clearly demonstrated progression or regression of disease
  - Post-treatment evaluation
  - Evaluation of suspected recurrence or progression of disease based on standard imaging or objective signs/symptoms
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Myeloma

- Initial treatment strategy
  - Differentiation of smoldering myeloma from active myeloma when skeletal survey and/or whole body MRI is negative for bone involvement
- Subsequent treatment strategy
  - When routine evaluation with laboratory findings or bone survey suggests recurrence or progression of disease
- Surveillance
  - Not indicated for surveillance

Note: *Routine follow-up evaluation includes quantitative immunoglobulins and M protein (serum and urine), routine CBC, kidney function, and calcium levels, and bone surveys. Additional evaluation may also include bone marrow aspirate and biopsy, serum free light chain assays, MRI, and flow cytometry.*

Neuroendocrine tumor, particularly poorly differentiated disease

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease
- Subsequent treatment strategy
- Surveillance
  - Not indicated for surveillance

Note: *Somatostatin receptor imaging should be considered in those tumors for which falsely negative FDG PET or PET/CT results are commonly reported, including well-differentiated neuroendocrine tumors.*

Other cancers not listed

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic regarding the extent of disease
- Subsequent treatment strategy
  - Detection of recurrent or progressive disease, when standard imaging is equivocal or non-diagnostic
- Surveillance
  - Not indicated for surveillance

Ovarian cancer (epithelial)

- Initial treatment strategy
  - Evaluation of indeterminate lesions detected by other imaging modalities, including ultrasound and CT or MRI, when additional information is required to guide management
- Subsequent treatment strategy
  - Evaluation of objective evidence of recurrent disease (such as rising tumor markers or increasing ascites) when CT or MRI does not clearly demonstrate recurrence or progression
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Pancreatic adenocarcinoma

- Initial treatment strategy—Detection of extra-pancreatic disease in patients who are candidates for resection when **all of the following** are true:
  - Dedicated, high quality imaging of the pancreas has been performed (see Note below)
  - Extra-pancreatic disease has not been clearly identified
  - **Any of the following** high-risk features are present
    - CA 19-9 level greater than 100 U/ml
    - Primary tumor greater than 2 cm in size
    - Enlarged regional nodes
    - Tumor is considered borderline resectable
- Radiation planning
  - For preoperative or definitive treatment in patients without distant metastasis
- Subsequent treatment strategy
  - Detection of recurrent or progressive disease, when standard imaging is equivocal or non-diagnostic
- Surveillance
  - Not indicated for surveillance

Note: *Standard, high quality dedicated imaging evaluation of the pancreas includes a dedicated pancreatic protocol CT scan (multi-detector computed tomography angiography using a dual-phase pancreatic protocol, with images obtained in the pancreatic and portal venous phase of contrast enhancement) or MRI if CT is contraindicated. MRI may also be used to clarify CT-indeterminate liver lesions or suspected pancreatic tumors not visible on CT.*

Paraneoplastic syndrome including neurologic syndrome

- PET or PET/CT is indicated for initial evaluation of individuals with paraneoplastic syndrome

Prostate adenocarcinoma

Not medically necessary for any indication

Note: *FDG-PET/CT is not recommended for routine use for prostate cancer management because data remain insufficient. Furthermore, further study is needed to determine the best use of choline PET/CT in men with prostate cancer.*

Skin cancer, including:

Melanoma

- Initial treatment strategy—Evaluation for metastatic disease when **any of the following** are true:
  - To determine the extent of involvement in stage III and IV disease when used instead of CT chest, abdomen and pelvis
  - Standard imaging studies are equivocal or non-diagnostic for the extent of known metastatic disease
  - When the primary site is unknown and standard imaging is negative
- Radiation planning
  - For definitive treatment only
- Subsequent treatment strategy
  - Evaluation of objective signs or symptoms of metastatic disease when CT or MRI has not clearly demonstrated recurrence or progression
  - To assess treatment response in unresectable stage III and IV disease when used instead of CT chest, abdomen and pelvis
- Surveillance
  - Not indicated for surveillance

Note: *An isolated finding of a new skin lesion is not sufficient evidence of systemic recurrence.*

Common Diagnostic Indications

Mucosal Melanoma

- Initial treatment strategy
  - Detection of metastatic disease
- Radiation planning
  - For pre-operative or definitive treatment only
- Subsequent treatment strategy
  - Evaluation of disease following clinical response to treatment, no sooner than 12 weeks after completion of therapy
  - Evaluation of signs or symptoms of metastatic disease when CT or MRI has not clearly demonstrated recurrence or progression
- Surveillance
  - Not indicated for surveillance

Note: *An isolated finding of a new mucosal lesion is not sufficient evidence of systemic recurrence.*

Merkel cell carcinoma

- Initial treatment strategy
- Subsequent treatment strategy
- Surveillance
  - Not indicated for surveillance

Thorax, other than lung cancer, including pleural malignancies, cancers of the thymus, heart, and mediastinum

- Initial treatment strategy
  - For initial staging when surgical resection is being considered and there is no known metastatic disease
- Subsequent treatment strategy
  - For restaging after induction chemotherapy, if patient is medically operable
- Surveillance
  - Not indicated for surveillance

Common Diagnostic Indications

Thyroid

- Initial treatment strategy
  - Poorly differentiated papillary
  - Anaplastic
  - Medullary
  - Hurthle Cell
- Subsequent treatment strategy
  - Poorly differentiated papillary
  - Anaplastic
  - Medullary
  - Hurthle Cell
  - Well-differentiated papillary or follicular thyroid cancer
    - For evaluation of suspected recurrence when **both of the following** are met:
      - With negative I131 scan, or a history of a negative I131 scan
      - Stimulated thyroglobulin level greater than two (2) ng/dL in the absence of antibodies.
- Surveillance
  - Not indicated for surveillance

Note: *PET is most useful for non-iodine avid thyroid cancer. Furthermore, alternative imaging modalities should be considered in those tumor types for which falsely negative PET or PET/CT results are commonly reported, including medullary thyroid carcinoma. PET should be used with caution unless disease is known to be FDG-avid.*

Uterine cancer

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease
- Subsequent treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic
- Surveillance
  - Not indicated for surveillance

Vaginal, vulvar and penile cancers

- Initial treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic for the extent of metastatic disease
  - Staging of penile cancer when pelvic lymph nodes are enlarged on CT or MRI and needle biopsy is not technically feasible
- Subsequent treatment strategy
  - Standard imaging studies are equivocal or non-diagnostic
  - Restaging of local recurrence when exenterative surgery is planned
- Surveillance
  - Not indicated for surveillance

Note: *Alternative imaging modalities should be considered in those tumor types for which falsely negative PET or PET/CT results are commonly reported, including many renal cell (kidney) carcinomas. PET should be used with caution.*

Screening: PET or PET/CT is considered not medically necessary as a screening test (i.e., for evaluation of patients without specific signs and symptoms of disease).

PET for screening or diagnosis of breast cancer is not a covered benefit by the Centers for Medicare & Medicaid Services and multiple health plans.

Other Considerations

PET mammography is an evolving technology under clinical development. This technology and its impact on health outcomes will continue to undergo review as new evidence-based studies are published. Interval routine coverage for PET mammography is not generally available and is not considered medically appropriate at this time.

PET bone scanning is currently only a covered benefit by the Centers for Medicare & Medicaid Services with CED. PET bone scanning is an evolving technology under clinical development. This technology and its impact on health outcomes will continue to undergo review as new evidence-based studies are published.

PET bone scan is considered not medically necessary.

PET Imaging of Infectious Processes

For diagnosis of chronic osteomyelitis involving the axial skeleton

References

1. Alpert JB, Lowry CM, Ko JP. Imaging the Solitary Pulmonary Nodule. *Clin Chest Med.* 2015;36(2):161-178.
2. American Society of Clinical Oncology. Choosing Wisely: Monitoring for cancer recurrence. ABIM Foundation; October 29, 2013. Available at http://www.choosingwisely.org/clinician-lists/american-society-clinical-oncology-monitoring-for-cancer-recurrence/ Accessed on January 29, 2018.
3. American Society of Clinical Oncology. Choosing Wisely: PET CT and radionuclide bone scans in staging early breast cancer. ABIM Foundation; April 4, 2012. Available at http://www.choosingwisely.org/clinician-lists/american-society-clinical-oncology-pet-ct-radionuclide-bone-scans-in-staging-early-breast-cancer/ Accessed on January 29, 2018.
4. American Society of Clinical Oncology. Choosing Wisely: PET CT and radionuclide bone scans in staging early prostate cancer. ABIM Foundation; April 4, 2012. Available at http://www.choosingwisely.org/clinician-lists/american-society-clinical-oncology-pet-ct-radionuclide-bone-scans-in-staging-early-prostate-cancer/ Accessed on January 29, 2018.
5. American Society of Clinical Oncology. Choosing Wisely: Surveillance testing imaging for breast cancer. ABIM Foundation; April 4, 2012. Available at http://www.choosingwisely.org/clinician-lists/american-society-clinical-oncology-surveillance-testing-imaging-for-breast-cancer/ Accessed on January 29, 2018.
6. Atri M, Zhang Z, Dehdashti F, et al. Utility of PET/CT to evaluate retroperitoneal lymph node metastasis in high-risk endometrial cancer: Results of ACRIN 6671/GOG 0233 trial. *Radiology* 2017;283(2):450-459. doi: 10.1148/radiol.2016160200. Epub 2017 Jan 3.
7. Bradley JD, Dehdashti F, Mintun MA, Govindan R, Trinkaus K, Siegel BA. Positron emission tomography in limited-stage small-cell lung cancer: a prospective study. *J Clin Oncol.* 2004;22(16): 3248-3254.
8. Brink I, Schumacher T, Mix M, et al. Impact of [18F]FDG-PET on the primary staging of small-cell lung cancer. *Eur J Nucl Med Mol Imaging.* 2004;31(12):1614-1620.
9. Bruzzi, JF, Swisher SG, Truong MT, et al. Detection of interval distant metastases: Clinical utility of integrated CT-PET imaging in patients with esophageal carcinoma after neoadjuvant therapy. *Cancer*. 2007;109(1):125-134.
10. Caroline I, Rosenthal MA. Imaging modalities in high-grade gliomas: pseudoprogression, recurrence, or necrosis? *J Clin Neurosci.* 2012;19(5):633-637.
11. Cayvarli H, Bekiş R, Akman T, Altun D. The Role of 18F-FDG PET/CT in the evaluation of gastric cancer recurrence. *Mol Imaging Radionucl Ther*. 2014;23(3):76-83.
12. Cerfolio RJ, Bryant AS, Ojha B. Restaging patients with N2 (stage IIIa) non-small cell lung cancer after neoadjuvant chemoradiotherapy: a prospective study. *J Thorac Cardiovasc Surg*. 2006;131(6):1229-1235.
13. Chang MC, Chen JH, Liang JA, Yang KT, Cheng KY, Kao CH. 18F-FDG PET or PET/CT for detection of metastatic lymph nodes in patients with endometrial cancer: a systematic review and meta-analysis. *Eur J Radiol*. 2012;81(11):3511-3517.
14. Chen J, Cheong JH, Yun MJ, et al. Improvement in preoperative staging of gastric adenocarcinoma with positron

emission tomography. *Cancer*. 2005;103(11):2383-2390.
15. Christensen JA, Nathan MA, Mullan BP, Hartman TE, Swensen SJ, Lowe VJ. Characterization of the solitary pulmonary nodule: 18F-FDG PET versus nodule-enhancement CT. *AJR Am J Roentgenol.* 2006;187(5):1361-1367.
16. De Santis M, Becherer A, Bokemeyer C, et al. 2-18fluoro-deoxy-D-glucose positron emission tomography is a reliable predictor for viable tumor in postchemotherapy seminoma: an update of the prospective multicentric SEMPET trial. *J Clin Oncol*. 2004;22(6):1034-1039.
17. Farma JM, Santillan AA, Melis M, et al. PET/CT fusion scan enhances CT staging in patients with pancreatic neoplasms. *Ann Surg Oncol*. 2008;15(9):2465-2471.
18. Fischer B, Lassen U, Mortensen J, et al. Preoperative staging of lung cancer with combined PET-CT. *N Engl J Med*. 2009;361(1):32-39.
19. Fletcher JW, Djulbegovic B, Soares HP, et al. Recommendations on the use of (18F) FDG PET in oncology. *J Nucl Med.* 2008;49:480-508.
20. Furukawa H, Ikuma H, Seki A, et al. Positron emission tomography scanning is not superior to whole body multidetector helical computed tomography in the preoperative staging of colorectal cancer. *Gut*. 2006;55(7):1007-1011.
21. Ghaneh P, Wong WL, Titman A, et al. PET-PANC: Multi-centre prospective diagnostic accuracy and clinical value trial of FDG PET/CT in the diagnosis and management of suspected pancreatic cancer (abstract). *J Clin Oncol.* 2016;34(15_ suppl):4008.
22. Gould MK, Donington J, Lynch WR, et al. Evaluation of individuals with pulmonary nodules: when is it lung cancer? Diagnosis and management of lung cancer, 3rd ed: American College of Chest Physicians evidence-based clinical practice guidelines. *Chest*. 2013;143(5 Suppl):e93S-120S.
23. Gould MK, Maclean CC, Kuschner WG, Rydzak CE, Owens DK. Accuracy of positron emission tomography for diagnosis of pulmonary nodules and mass lesions: a meta-analysis. *JAMA*. 2001;285(7):914-924.
24. Kollberg P, Almquist H, Blackberg M, et al. [(18)F]Fluorodeoxyglucose–positron emission tomography/computed tomography improves staging in patients with high-risk muscle-invasive bladder cancer scheduled for radical cystectomy. *Scand J Urol*. 2015;49(4):296-301.
25. Lim JS, Yun MJ, Kim MJ, et al. CT and PET in stomach cancer: preoperative staging and monitoring of response to therapy. *Radiographics*. 2006;26(1):143-156.
26. Lind P, Kohlfürst S. Respective roles of thyroglobulin, radioiodine imaging, and positron emission tomography in the assessment of thyroid cancer. *Semin Nucl Med*. 2006;36(3):194-205.
27. Lu YY, Chen JH, Chien CR, et al. Use of FDG-PET or PET/CT to detect recurrent colorectal cancer in patients with elevated CEA: a systematic review and meta-analysis. *Int J Colorectal Dis*. 2013;28(8):1039-1047.
28. Lu YY, Chen JH, Liang JA, et al. Clinical value of FDG PET or PET/CT in urinary bladder cancer: a systemic review and meta-analysis. *Eur J Radiol.* 2012;81(9):2411-2416.
29. MacManus M, Nestle U, Rosenzweig KE, et al. Use of PET and PET/CT for radiation therapy planning: IAEA expert report 2006–2007. *Radiother Oncol*. 2009;91(1):85-94.
30. Maziak DE, Darling GE, Inculet RI, et al. Positron emission tomography in staging early lung cancer: a randomized trial. *Ann Intern Med*. 2009;151(4):221-228.
31. Meyers BF, Downey RJ, Decker PA, et al; American College of Surgeons Oncology Group Z0060. The utility of positron emission tomography in staging of potentially operable carcinoma of the thoracic esophagus: results of the American College of Surgeons Oncology Group Z0060 trial. J Thorac Cardiovasc Surg. 2007; 133(3):738-745.
32. Mohile NA, DeAngelis LM, Abrey LE. The utility of body FDG PET in staging primary central nervous system lymphoma. *Neuro Oncol*. 2008;10(2):223-228.
33. Mosci C, Iagaru A. PET/CT imaging of thyroid cancer. *Clin Nucl Med*. 2011;36(12):e180-e185.
34. Moulton CA, Gu CS, Law CH, et al. Effect of PET before liver resection on surgical management for colorectal adenocarcinoma metastases: a randomized clinical trial. *JAMA*. 2014;311(18):1863-1869.
35. Muros MA, Llamas-Elvira JM, Ramírez-Navarro A, et al. Utility of fluorine-18-fluorodeoxyglucose positron emission tomography in differentiated thyroid carcinoma with negative radioiodine scans and elevated serum thyroglobulin levels. *Am J Surg.* 2000;179(6):457-461.
36. National Comprehensive Cancer Network, Inc.: NCCN Imaging Appropriate Use Criteria Compendium: Clinical Practice Guidelines for Anal Carcinoma; Bladder Cancer; Bone Cancer; Breast Cancer; Central Nervous System Cancers; Cervical Cancer; Chronic Lymphocytic Leukemia/Small Lymphocytic Lymphoma; Colon Cancer; Esophageal and Esophagogastric Junction Cancers; Gastric Cancer; Head and Neck Cancers; Hodgkin Lymphoma; Kidney Cancer; Melanoma; Merkel; Multiple Myeloma; Neuroendocrine Tumors; Non-Small Cell Lung Cancer; Ovarian Cancer

Including Fallopian Tube Cancer and Primary Peritoneal Cancer; Pancreatic Adenocarcinoma; Penile Cancer; Prostate Cancer; Rectal Cancer; Small Cell Lung Cancer; Soft Tissue Sarcoma; Testicular Cancer; Thyroid Carcinoma; Uterine Neoplasms; Vulvar Cancer. Referenced with permission. To view the most recent and complete version of the NCCN Guidelines, go online to www.nccn.org.

37. Ozkan E, Aras G, Kucuk NO. Correlation of 18F-FDG PET/CT findings with histopathological results in differentiated thyroid cancer patients who have increased thyroglobulin or antithyroglobulin antibody levels and negative 131I whole-body scan results. *Clin Nucl Med*. 2013;38(5):326-331.
38. Ozkan E, Soydal C, Araz M, Aras G, Ibis E. The additive clinical value of 18F-FDG PET/CT in defining the recurrence of disease in patients with differentiated thyroid cancer who have isolated increased antithyroglobulin antibody levels. *Clin Nucl Med.* 2012;37(8):755-758.
39. Park JW, Jo MK, Lee HM. Significance of 18F-fluorodeoxyglucose positron-emission tomography/computed tomography for the postoperative surveillance of advanced renal cell carcinoma. *BJU Int*. 2009;103(5):615-619.
40. Pastorino U, Veronesi G, Landoni C, et al. Fluorodeoxyglucose positron emission tomography improves preoperative staging of resectable lung metastasis. *J Thoracic Cardiovasc Surg*. 2003; 126(6):1906-1910.
41. Patel K, Hadar N, Lee J, Siegel BA, Hillner BE, Lau J. The lack of evidence for PET or PET/CT surveillance of patients with treated lymphoma, colorectal cancer, and head and neck cancer: a systematic review. *J Nucl Med*. 2013; 54(9):1518-1527.
42. Rajkumar SV, Dimopoulos MA, Palumbo A, et al. International Myeloma Working Group updated criteria for the diagnosis of multiple myeloma. *Lancet Oncol*. 2014 Nov;15(12):e538-48.
43. Rijkers AP, Valkema R, Duivenvoorden HJ, van Eijck CH. Usefulness of F-18-fluorodeoxyglucose positron emission tomography to confirm suspected pancreatic cancer: a meta-analysis. *Eur J Surg Oncol*. 2014;40(7):794-804.
44. Risum S, Høgdall C, Loft A, et al. The diagnostic value of PET/CT for primary ovarian cancer—a prospective study. *Gynecol Oncol*. 2007;105(1):145-149.
45. Risum S, Høgdall C, Markova E, et al. Influence of 2-(18F) fluoro-2-deoxy-D-glucose positron emission tomography/computed tomography on recurrent ovarian cancer diagnosis and on selection of patients for secondary cytoreductive surgery. *Int J Gynecol Cancer*. 2009;19(4):600-604.
46. Robertson NL, Hricak H, Sonoda Y, et al. The impact of FDG-PET/CT in the management of patients with vulvar and vaginal cancer. *Gynecol Oncol*. 2016;140(3):420-424.
47. Rodriguez Rivera AM, Alabbas H, Ramjaun A, Meguerditchian AN. Value of positron emission tomography scan in stage III cutaneous melanoma: a systematic review and meta-analysis. *Surg Oncol*. 2014;23(1):11-16.
48. Salani R, Backes FJ, Fung MF, et al. Posttreatment surveillance and diagnosis of recurrence in women with gynecologic malignancies: Society of Gynecologic Oncologists recommendations. *Am J Obstet Gynecol*. 2011; 204(6):466-478.
49. Salvatore B, Paone G, Klain M, et al. Fluorodeoxyglucose PET/CT in patients with differentiated thyroid cancer and elevated thyroglobulin after total thyroidectomy and (131)I ablation. *Q J Nucl Med Mol imaging. Off Publ Ital Assoc Nucl Med [and] Int Assoc Radiopharmacol (IAR), [and] Sect Soc Radiopharm*. 2008;52(1):2-8.
50. Schröer-Günther MA, Wolff RF, Westwood ME, et al. F-18-fluoro-2-deoxyglucose positron emission tomography (PET) and PET/computed tomography imaging in primary staging of patients with malignant melanoma: a systematic review. *Syst Rev*. 2012;1:62.
51. Schuetze SM, Rubin BP, Vernon C, et al. Use of positron emission tomography in localized extremity soft tissue sarcoma treated with neoadjuvant chemotherapy. *Cancer*. 2005;103(2):339-348.
52. Sim YT, Goh YG, Dempsey MF, Han S, Poon FW. PET-CT evaluation of solitary pulmonary nodules: correlation with maximum standardized uptake value and pathology. *Lung*. 2013;191(6):625-632.
53. Siva S, Byrne K, Seel M, et al. 18F-FDG PET provides high-impact and powerful prognostic stratification in the staging of Merkel cell carcinoma: a 15-year institutional experience. *J Nucl Med*. 2013;54(8):1223-1229.
54. Treglia G, Kakhki VR, Giovanella L, Sadeghi R. Diagnostic performance of fluorine-18-fluorodeoxyglucose positron emission tomography in patients with Merkel cell carcinoma: a systematic review and meta-analysis. *Am J Clin Dermatol*. 2013;14(6):437-447.
55. Vural GU, Akkas BE, Ercakmak N, Basu S, Alavi A. Prognostic significance of FDG PET/CT on the follow-up of patients of differentiated thyroid carcinoma with negative 131I whole-body scan andelevated thyroglobulin levels: correlation with clinical and histopathologic characteristics and long-term follow-up data. *Clin Nucl Med.* 2012;37(10):953-959.
56. Xing Y, Bronstein Y, Ross MI, et al. Contemporary diagnostic imaging modalities for the staging and surveillance of melanoma patients: a meta-analysis. *J Natl Cancer Inst*. 2011;103(2):129-142.

Quantitative CT (QCT) Bone Mineral Densitometry

CPT Codes

77078..... Computed tomography, bone mineral density study, 1 or more sites; axial skeleton (e.g., hips, pelvis, spine)

Standard Anatomic Coverage

- For central QCT, spine and hip measurements are obtained

Imaging Considerations

- Bone mineral densitometry may be performed on the central axial skeleton (i.e., spine, femoral head, proximal femur)
- Central dual x-ray absorptiometry (DXA), also referred to as dual-energy x-ray absorptiometry (DEXA), is the most commonly used test to evaluate bone mineral density and is considered the technology of choice, when available.
- QCT has a high sensitivity for detection of bone loss. However, when compared with DXA, QCT is often less readily available, more expensive and incurs higher radiation exposure.
- QCT may not be covered as a screening exam in patients at low risk for osteoporosis.

Common Diagnostic Indications

Initial examination – when any one of the following criteria are met

- Menopausal or post-menopausal women – as an initial examination to screen for osteoporosis
- Men of 70 years age or older, regardless of risk factors
- Anyone presenting with a fragility or pathologic fracture
- Anyone with a disease or condition associated with development of osteoporosis, including any of the following abnormalities:
  - Anorexia nervosa
  - Chronic liver disease
  - Chronic renal failure
  - Cushing's syndrome
  - Delayed menarche or untreated premature menopause
  - Heavy alcohol consumption
  - Hypercalciuria
  - Hypogonadism
  - Inflammatory bowel disease
  - Low trauma fractures or vertebral fractures
  - Malabsorption syndromes
  - Primary hyperparathyroidism
  - Prolonged immobilization
  - Radiographic evidence of osteopenia
  - Rheumatoid arthritis
  - Thyroid disease
- Anyone on a medication associated with development of osteoporosis, including but not limited to the following medications:
  - Glucocorticoids (e.g., prednisone, prednisolone, decadron, dexamethasone) – treatment for longer than 3 months
  - Phenytoin (Dilantin) – treatment for longer than 3 months
  - Heparin – treatment for longer than 1 month
  - Depo-Provera injectable contraceptive – long-standing use (longer than 2 years)
  - Lithium treatment
  - Lupron therapy
  - Cytotoxic agents which affect bone density (e.g., adjuvant chemotherapy in many premenopausal females with breast cancer)
  - Proton pump inhibitors (PPI) and histamine-2 (H2) receptor blockers for gastroesophageal reflux disease in patients over 50 years of age, under treatment for longer than 3 months
- Anyone who is considering therapy for osteoporosis, if bone mineral densitometry would facilitate the decision

Repeat examination – when any one of the following criteria are met:

- Anyone under treatment for osteoporosis, to monitor the response to therapy for bone loss – at intervals of every 2 to 3 years
- Untreated individuals who met the criteria for initial evaluation, without significant osteopenia on prior bone densitometry and without interval increased risk for accelerated bone loss – at intervals of every 3 to 5 years

References

1. American College of Radiology. *ACR–SPR–SSR Practice Parameter for the Performance of Quantitative Computed Tomography (QCT) Bone Densitometry.* Revised 2013. Available at http://www.acr.org/~/media/DE78D218C7A64526A821A9E8645AB46D.pdf. Accessed August 26, 2016.
2. Guglielmi G, Muscarella S, Bazzocchi A. Integrated imaging approach to osteoporosis: state-of-the-art review and update. *Radiographics*. 2011;31(5):1343-1364.
3. Lentle BC, Prior JC. Prior osteoporosis: what a clinical expects to learn from a patient's bone density exam. *Radiology*. 2000;228:620-628.
4. Morris CA, Cabral D, Cheng H, et al. Patterns of bone mineral density testing. current guidelines, testing rates, and interventions. *J Gen Intern Med*. 2004;19:783-790.
5. North American Society Menopause Society. Management of osteoporosis in postmenopausal women: 2010 position statement of The North American Menopause Society. *Menopause*. 2010 Jan-Feb;17(1):25-54.
6. The International Society for Clinical Densitometry (ISCD). Official Positions. Available at http://www.iscd.org/official-positions/2015-iscd-official-positions-adult/. Updated 2015. Accessed November 8, 2016
7. U.S. Preventive Services Task Force. Screening for osteoporosis: U.S. Preventive Services Task Force recommendation statement. *Ann Intern Med*. 2011 Aug 16;155(4):276-7.

Magnetic Resonance Imaging (MRI) Bone Marrow Blood Supply

CPT Codes

77084..... MRI of bone marrow blood supply

Standard Anatomic Coverage

- MRI of the bone marrow blood supply is used to image multiple anatomic areas in the axial and appendicular skeleton

Imaging Considerations[1]

- In addition to MRI, several other imaging procedures are available to assess the bone marrow, including skeletal radiographic survey and nuclear scintigraphy.
- To undertake extensive coverage of the skeleton with MRI of the bone marrow blood supply, phased array MR coils are often used.
- Performed most often to study a specific lesion(s), based on the results of other imaging or laboratory studies, or to evaluate focal pain or neurologic symptoms.
- On some occasions used to survey the whole body for marrow replacement or infiltration by neoplastic cells [5–12]. In these instances, the entire body is imaged from the vertex to the heels, usually in a single plane (coronal or sagittal) acquired with overlapping stations.

Common Diagnostic Indications

Myeloma [2, 3]

- Diagnosis when all of the following are met:
  - No lytic bone lesions seen on whole body radiography
    - Note: for further characterization of an equivocal bone lesion seen on whole body radiography. A dedicated MRI of the region (i.e. cervical, thoracic, lumber spine, pelvis or extremity) should be obtained
  - To establish the diagnosis of myeloma at least one of the following is required:
    - Biopsy proven plasmacytoma
    - Clonal bone marrow plasma cells greater than 10%
    - M-protein greater than or equal to 3 g/dL and/or 10 to 60 percent bone marrow plasma cells

Note: *The evidence for use of MRI in myeloma is insufficient for the evaluation of the following: Response to therapy, prognosis, and monoclonal gammopathy of uncertain significance (MGUS). For myeloma with back pain, see tumor evaluation (cervical, thoracic, lumbar spine).*

References

1. Siegel MJ. MRI of Bone Marrow. In: Kransdorf MJ, Reinhold C, Ho VB, eds. *Syllabus of the American Roentgen Ray Society (ARRS) 2006 Categorical Course. Body MRI.* ARRS; 2006:243-254.
2. Dimopoulos MA, Hillengass J, Usmani S,et al. Role of Magnetic Resonance Imaging in the Management of Patients With Multiple Myeloma: A Consensus Statement. *J Clin Oncol*. 2015 Jan 20.
3. Rajkumar SV, Dimopoulos MA, Palumbo A, et al. International Myeloma Working Group updated criteria for the diagnosis of multiple myeloma. *Lancet Oncol*. 2014 Nov;15(12):e538-48.

MRI Bone Marrow Blood Supply Bibliography

1. Angtuaco EJ, Fasses AB, Walker R, et al. Multiple myeloma: clinical review and diagnostic imaging. *Radiology*. 2004; 231(1):11-13.
2. Centers for Medicare & Medicaid Services. *National Coverage Determination (NCD) for Magnetic Resonance Imaging (220.2)*. Available at http://www.cms.gov/medicare-coverage-database/. Accessibility verified September 2, 2016.
3. Kumar J, Seith A, Kumar A, Sharma R, Bakhshi S, Kumar R, Agarwala S. Whole-body MR imaging with the use of parallel imaging for detection of skeletal metastases in pediatric patients with small-cell neoplasms: comparison with skeletal scintigraphy and FDG PET/CT. *Pediatr Radiol*. 2008;38(9):953-962.
4. Lecouvet FE, Vande Berg BC, Michaux L, et al. Stage III multiple myeloma: clinical and prognostic value of spinal bone marrow MR imaging. *Radiology*. 1998; 209(3):653-660.
5. Rahmouni A, Montazel JL, Divine M, et al. Bone marrow with diffuse tumor infiltration in patients with lymphoproliferative diseases: dynamic gadolinium-enhanced MR imaging. *Radiology*. 2003; 229(3):710-717.
6. Schmidt GP, Reiser MF, Baur-Melnyk A. Whole-body imaging of the musculoskeletal system: the value of MR imaging. *Skeletal Radiol*. 2007;36(12):1109-1119.
7. Van de Berg BC, Lecouvet FE, Michaux L, et al. Stage I multiple myeloma: value of MR imaging of the bone marrow in the determination of prognosis. *Radiology*. 1996;201:243-246.
8. Siegel MJ. MRI of Bone Marrow. In: Kransdorf MJ, Reinhold C, Ho VB, eds. *Syllabus of the American Roentgen Ray Society (ARRS) 2006 Categorical Course. Body MRI.* ARRS; 2006:243-254.
9. Dimopoulos MA, Hillengass J, Usmani S,et al. Role of Magnetic Resonance Imaging in the Management of Patients With Multiple Myeloma: A Consensus Statement. *J Clin Oncol*. 2015 Jan 20
10. Rajkumar SV, Dimopoulos MA, Palumbo A, et al. International Myeloma Working Group updated criteria for the diagnosis of multiple myeloma. *Lancet Oncol*. 2014 Nov;15(12):e538-48.

Magnetic Resonance Spectroscopy (MRS)

CPT Codes

76390..... Magnetic Resonance Spectroscopy (MRS)

Standard Anatomic Coverage

- Application of MRS has been described in multiple anatomic areas to further evaluate the biochemical properties of specific tissues.

Background

- MR Spectroscopy is not currently a covered benefit by the Centers for Medicare and Medicaid Services, through a National Coverage Determination.
- MR spectroscopy provides a biochemical profile of different metabolic constituents in tissues. When MRS is performed, metabolites which may be measured include Choline (Cho), N-Acetyl Aspartate (NAA), Creatine (Cr), lactate and lipid.
- Certain ratios of metabolites have been described as suggestive of high grade malignancy. An example is a Choline/ Creatine ratio greater the 2:1, compared with the normal ratio from spectroscopic data of approximately 1.
- When performed, MRS usually accompanies an MRI exam.
- Potential uses of MRS that have been described include neuroimaging of brain tissue (for brain tumor differentiation from non-tumor conditions such as necrosis and abscess; cerebrovascular accident; dementia; epilepsy; Parkinson's disease; mitochondrial disorders), breast lesion assessment and evaluation of lower extremity ischemia.

Magnetic Resonance Spectroscopy

- MR Spectroscopy is an evolving technology under clinical development. This technology and its impact on health outcomes will continue to undergo review, as new evidence-based studies are published. At this point, medically necessary applications are limited (see below). Interval routine coverage for MR spectroscopy is not generally available and is not considered medically appropriate at this time.

Diagnostic Indications

Differentiate recurrent or residual brain tumor from post-therapy changes, (e.g., delayed radiation necrosis)

Differentiate brain tumor from other non-tumor diagnoses, (e.g., abscesses or other infectious or inflammatory processes)

References

1. Centers for Medicare & Medicaid Services. *National Coverage Determination (NCD) for Magnetic Resonance Spectroscopy (220.2.1)*. Available at http://www.cms.gov/medicare-coverage-database/. Accessibility verified August 8, 2016.