

2011 Imaging Criteria

Magnetic Resonance Imaging (MRI), Brain + Contrast^(1, 2, 3, 4)

ICD-9-CM: 88.91
 CPT: 70552, 70553
 I/O Setting: Outpatient

INDICATION(S)

- 100 Follow-up of primary brain tumor
- 200 Single brain tumor by CT
- 300 CNS evaluation for brain metastases
- 400 Multiple sclerosis (MS)
- 500 Acoustic neuroma/cerebellar pontine angle tumor
- 600 Follow-up of intracranial abscess
- 700 CNS infection
- 800 Suspected CNS involvement with sarcoidosis

- 100 Follow-up of primary brain tumor **[One]**^(5*RIN, 6, 7, 8)
 - 110 New/worsening CNS Sx/findings ♦
 - 120 Periodic assessment⁽⁹⁾
- 200 Single brain tumor by CT⁽⁷⁾
- 300 CNS evaluation for brain metastases **[One]**⁽¹⁰⁾
 - 310 Baseline scan as part of staging **[One]**^(11*MDR)
 - 311 Sarcoma
 - 312 Melanoma^(12, 13)
 - 313 Small cell lung cancer⁽¹⁴⁾
 - 320 Baseline scan positive **[One]**⁽¹⁵⁾
 - 321 Periodic assessment during chemotherapy/radiation Rx⁽¹⁶⁾
 - 322 Restaging after chemotherapy/radiation Rx completed
 - 330 New/worsening CNS Sx/findings **[One]** ♦⁽¹⁷⁾
 - 331 Known cancer elsewhere
 - 332 Known brain metastasis by prior CT/MRI
- 400 Multiple sclerosis (MS) **[One]**^(18, 19, 20, 21)
 - 410 Suspected MS and clinically isolated syndrome **[One]**^(22, 23, 24, 25)
 - 411 Optic neuritis^(26, 27)
 - 412 Ophthalmoplegia⁽²⁸⁾

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- 413 Transverse myelitis^(29, 30)
- 420 Known MS with new/worsening symptoms^(31*MDR)
- 500 Acoustic neuroma/cerebellar pontine angle tumor **[One]**^(32, 33)
- 510 Suspected acoustic neuroma/cerebellar pontine angle tumor **[Both]**
- 511 Unilateral hearing loss/tinnitus with ear normal by PE⁽³⁴⁾
- 512 Findings **[One]**⁽³⁵⁾
- 1 Asymmetric neural hearing loss by audiometry⁽³⁶⁾
 - 2 Abnormal acoustic reflex testing⁽³⁷⁾
 - 3 Roll-over by phonetically balanced word testing⁽³⁷⁾
- 520 Follow-up known acoustic neuroma **[One]**
- 521 6 mos from diagnosis/annual follow-up⁽³⁸⁾
- 522 Post radiosurgery/surgical excision⁽³⁹⁾
- 600 Follow-up of intracranial abscess **[One]**^(40, 41)
- 610 New/worsening CNS Sx/findings **[One]** ♦
- 611 Focal neurologic finding by PE⁽⁴²⁾
- 612 Vomiting
- 613 Headache by Hx
- 614 Mental status changes by Hx/PE⁽⁴³⁾
- 615 Seizure by Hx/PE
- 620 Follow-up assessment during Rx⁽⁴⁴⁾
- 630 Follow-up assessment after Rx completed
- 700 CNS infection **[One]**⁽⁴⁵⁾
- 710 Suspected infection in immunocompetent host **[Both]** ♦⁽⁴⁶⁾
- 711 New/worsening CNS Sx/findings **[One]**⁽⁴⁷⁾
- 1 Focal neurologic finding by PE⁽⁴²⁾
 - 2 Headache by Hx
 - 3 Photophobia⁽⁴⁸⁾
 - 4 Meningismus^(49, 50)
 - 5 Mental status changes by Hx/PE⁽⁴³⁾
 - 6 Seizure by Hx/PE
- 712 Associated findings **[One]**⁽⁴⁷⁾
- 1 Temperature > 100.4 F(38.0 C)
 - 2 WBC > 12,000/cu.mm(12x10⁹/L)
- 720 Suspected infection in immunocompromised host **[One]** ♦^(51, 52)
- 721 Focal neurologic finding by PE⁽⁴²⁾
- 722 Atypical headache by Hx⁽⁵³⁾
- 723 Mental status changes by Hx/PE⁽⁴³⁾
- 724 Seizure by Hx/PE

730 Follow-up assessment⁽⁵⁴⁾

800 Suspected CNS involvement with sarcoidosis⁽⁵⁵⁾

Notes

(1)

An MRI study using a contrast material such as gadolinium will, in specific circumstances, improve the sensitivity of the study. Gadolinium causes highly vascular tissue and areas of disrupted blood-brain barrier to appear brighter on MRI.

(2)

Current magnetic resonance techniques lack ionizing radiation and provide images with high spatial resolution, excellent soft-tissue contrast, and multi-planar imaging capability (Widjaja and Raybaud, *Neurosurg Focus* 2008; 25(3): E3). Newer techniques include diffusion-weighted MRI and magnetic resonance spectroscopy. Diffusion-weighted imaging is being used for the evaluation of demyelinating disorders, presurgical evaluation and planning of brain tumors, and seizure disorders. Magnetic resonance spectroscopy is being used for evaluating many brain disorders, including brain tumors, leukodystrophies, and brain injuries (Abdelhalim and Alberico, *Neurol Clin* 2009; 27(1): 285-301, x; Provenzale, *Emerg Radiol* 2007; 14(1): 1-12).

(3)

CT and MRI each have relative advantages and disadvantages. CT, which tends to be better tolerated by patients, has the advantages of a shorter study time, better sensitivity for detecting acute hemorrhage, and excellent visualization of bony structures with less degradation of image quality by motion artifact. CT is often the preferred modality in rapidly evolving neurologic conditions (e.g., SAH, ICH) because it is widely available and may be performed easily in the setting of life support equipment. CT, however, poses the disadvantage of patient radiation exposure which carries an increased long-term risk of cancer. MRI tends to be more sensitive in detecting lesions in the brain, as well as assessment of cerebral ischemia. In acute stroke imaging, both CT and MRI are used to rapidly obtain the necessary anatomical, vascular, and functional information (Adam and Dixon, *Grainger & Allison's Diagnostic Radiology: A Textbook of Medical Imaging* 5th ed. 2008, 1936 p.).

(4)

The following are examples of relative and absolute contraindications to the use of magnetic resonance imaging:

- Implanted devices that are electrically or magnetically activated (e.g., cardiac pacemakers, automatic cardioverter defibrillators, drug infusion pumps, cochlear implants)
- Ferromagnetic metal objects (e.g., cerebral aneurysm clips, intraocular metallic foreign body, prostheses, screws)
- Pregnancy, first trimester
- Renal insufficiency in cases when magnetic resonance imaging is performed with gadolinium-based contrast

(5)-RIN:

These criteria address a previously diagnosed brain tumor. For symptomatology which makes one suspect a new brain lesion, see the appropriate indication within this criteria subset.

(6)

The most common primary brain tumors in adults are gliomas and meningiomas, with gliomas accounting for more than 80% of primary brain tumors (Chandana et al., *Am Fam Physician* 2008; 77(10): 1423-1430; Grant, *J Neurol Neurosurg Psychiatry* 2004; 75 Suppl 2: ii18-23).

(7)

Gadolinium-enhanced MRI (GdMRI) is the preferred imaging method for evaluating patients with suspected or confirmed primary tumor or metastatic intraspinal extension, suspected or confirmed disc space infection, or an epidural abscess (Chin, *Semin Neurol* 2002; 22(2): 205-220; Runge et al., *Top Magn Reson Imaging* 2001; 12(4): 231-263). Contrast improves lesion delineation, localizes regions likely to provide positive biopsy, and identifies active disease (Jacobs et al., *NeuroRx* 2005; 2(2): 333-347).

(8)

Whether to perform a CT or MRI in this setting is a matter of clinical judgment. MRI is preferred for imaging all types of brain tumors because of its high sensitivity, its ability to identify tumor sites near bone, its sensitivity to tissue edema, and its capability of accurately delineating tumors and their relationship to normal structures.

(9)

Periodic assessment is performed to evaluate response to therapy.

(10)

MRI with contrast is considered the best method for imaging brain metastases. The contrast enhances any disruption of the blood-brain barrier that can occur with tumors (American College of Radiology (ACR), *ACR Appropriateness Criteria for Pre-Irradiation Evaluation and Management of Brain Metastasis*. 2005.).

(11)-MDR:

There may be instances other than sarcoma, melanoma, or small cell lung cancer for which initial staging may include CNS imaging. Although this may be reasonable depending on the grade, extent, and location of the primary tumor, these cases require secondary medical review.

(12)-DEF:

Melanoma is a malignant tumor of melanocytes, which are found predominantly in skin.

(13)

The incidence of melanoma is increasing more rapidly than any other malignancies, at a rate of > 4% per year (Jemal et al., CA Cancer J Clin 2008; 58(2): 71-96). Although the precise pathogenic etiology of melanoma is unknown, risk factors such as association with intermittent, intense sun exposure, older age, and exposure to pesticides have been identified (Mackie et al., Ann Oncol 2009; 20 Suppl 6: vi1-7). A family history of melanoma increases a patient's risk for developing melanoma.

(14)

CT or MRI may be performed as part of initial staging in patients with known small cell carcinoma of the lung to facilitate decision-making regarding therapy. Patients with documented CNS involvement at presentation are not candidates for prophylactic radiation therapy. Also, conventional chemotherapy is ineffective for treatment of small cell carcinoma of the lung once it has metastasized to the brain because the CNS is protected by the blood-brain barrier.

(15)

The interval for periodic assessment in stable patients is a matter of clinical judgment. Studies are generally performed no more frequently than every two cycles of chemotherapy.

(16)

The assessment is generally not necessary more frequently than every two cycles of chemotherapy.

(17)

Although any malignancy can metastasize, breast and lung cancer are the two most common primary sites of cancer in patients presenting with brain metastases (American College of Radiology (ACR), ACR Appropriateness Criteria for Pre-Irradiation Evaluation and Management of Brain Metastasis. 2005.). Patients with documented malignancy that develop new CNS symptoms or findings should undergo imaging to exclude the possibility of brain metastases.

(18)

Multiple sclerosis (MS) is a chronic inflammatory disease of the CNS. The natural history of MS is characterized by the relapse and remission of various focal symptoms; some patients experience a chronic progressive pattern of disability (Courtney et al., Med Clin North Am 2009; 93(2): 451-476; Birnbaum, Adv Neurol 2006; 98: 111-124). Sites of autoimmune mediated demyelination cause focal neurologic impairment, which may correlate with MRI signal intensity changes within the white matter. The hallmark of MS lesions is their bright appearance on T2-weighted images in the brain; lesions are also commonly seen in the spinal cord (Simon, Radiol Clin North Am 2006; 44(1): 79-100; Bakshi et al., Neurology 2004; 63(11 Suppl 5): S3-11). The use of MRI has allowed earlier confirmation of the diagnosis, resulting in earlier medical intervention and improved management of the disease. LP results and visual evoked potentials can suggest the diagnosis.

(19)

MRI is primarily used for the evaluation of suspected MS, as well as for following new or worsening symptoms. MRI can exclude other conditions that would account for the patient's symptoms and exam findings, can establish the presence of clinically silent lesions, and can demonstrate new lesions (Royal College of Physicians, Multiple Sclerosis. National clinical guideline for diagnosis and management in primary and secondary care. 2004, 197). CT is not indicated as a diagnostic test for suspected MS.

(20)

Functional, magnetization transfer, diffusion tensor, and spectroscopy MRI are now being used outside clinical trials as adjunctive measures for diagnosing and monitoring disease progression and treatment response (Ali and Buckle, Neurol Clin 2009; 27(1): 203-219, ix; Bakshi et al., Lancet Neurol 2008; 7(7): 615-625; Rovira and Leon, Eur J Radiol 2008; 67(3): 409-414; Fazekas et al., J Neuroimaging 2007; 17 Suppl 1: 50S-55S).

(21)

Gadolinium contrast is used to identify any disruption of the blood-brain barrier secondary to active inflammation. The number of enhancing lesions is the most clinically relevant measure of ongoing disease activity (Simon, Radiol Clin North Am 2006; 44(1): 79-100, viii; Bakshi et al., Neurology 2004; 63(11 Suppl 5): S3-11).

(22)

MS can present with sensory deficits, motor dysfunction, or cerebellar or brainstem dysfunction. There is usually no set pattern to the symptoms (Lublin, *Neurol Clin* 2005; 23(1): 1-15).

(23)

There are a number of diseases that may present in a similar manner to MS. These include acute disseminated encephalomyelitis, CNS vasculitis, migraine, tumor, sarcoidosis, Lyme disease, Sjogren's syndrome, SLE, and vitamin B₁₂ deficiency (Courtney et al., *Med Clin North Am* 2009; 93(2): 451-476; Miller et al., *Mult Scler* 2008; 14(9): 1157-1174; Krupp et al., *Neurology* 2007; 68(16 Suppl 2): S7-12; Birnbaum, *Adv Neurol* 2006; 98: 111-124). Many of these diagnoses can be ruled out with laboratory testing (e.g., CBC, ANA, ESR, vitamin B₁₂, TSH).

(24)

Patients may present with clinically isolated syndrome (CIS) or a monosymptomatic attack. These attacks last at least 24 hours and consist of symptoms of optic neuritis, brain stem syndrome (e.g., internuclear ophthalmoplegia), or spinal cord syndrome (e.g., partial transverse myelitis, hyperreflexia, decreased motor, bowel, or bladder control) (Miller et al., *Mult Scler* 2008; 14(9): 1157-1174; Simon et al., *AJNR Am J Neuroradiol* 2006; 27(2): 455-461).

(25)

MRI is considered positive for MS if the following criteria are met (Frohman et al., *Neurology* 2003; 61(5): 602-611; McDonald et al., *Ann Neurol* 2001; 50(1): 121-127; Tintore et al., *AJNR Am J Neuroradiol* 2000; 21(4): 702-706; Barkhof et al., *Brain* 1997; 120 (Pt 11): 2059-2069):

For dissemination in space, 3 out of 4 of the following are found:

- 1 gadolinium-enhancing brain or spinal cord lesion *or* 9 T2 brain or cord lesions if there is no gadolinium-enhancing lesion
- ≥ 1 infratentorial brain or cord lesion
- ≥ 1 juxtacortical lesion
- ≥ 3 periventricular lesions

For dissemination in time:

- The appearance on a subsequent MRI (≥ 3 months from the previous MRI) of a new T2 or gadolinium-enhancing lesion at a site different from the initial event

Newer criteria have been proposed that include dissemination in space of at least one T2 lesion in each of at least 2 locations: juxtacortical, periventricular, infratentorial, or spinal cord. The dissemination in time requires a new T2 lesion on a follow-up scan (Swanton et al., *Lancet Neurol* 2007; 6(8): 677-686). The modified criteria are highly specific (93%) and more accurate for the clinical development of MS than the McDonald criteria (Swanton et al., *J Neurol Neurosurg Psychiatry* 2006; 77(7): 830-833).

(26)-DEF:

Optic neuritis is an inflammation of the optic nerve. Symptoms include pain in and around the eye, altered visual acuity (e.g., blurred vision), and altered color perception.

(27)

A higher risk for developing future demyelination is seen in young females presenting with unilateral or painful optic neuritis, along with the finding of MRI abnormalities at the time of the attack (The Optic Neuritis Study Group, *Arch Neurol* 2008; 65(6): 727-732; Miller et al., *Mult Scler* 2008; 14(9): 1157-1174; Thrower, *Neurology* 2007; 68(24 Suppl 4): S12-15).

(28)-DEF:

Ophthalmoplegia is paralysis of the eye muscles.

(29)-DEF:

Transverse myelitis is inflammation (leading to demyelination) involving the full diameter of the spinal cord but limited in longitudinal extent.

(30)

The risk of developing subsequent MS is highest when the patient presents with asymmetric, incomplete transverse myelitis (Miller et al., *Mult Scler* 2008; 14(9): 1157-1174; Thrower, *Neurology* 2007; 68(24 Suppl 4): S12-15).

(31)-MDR:

Because conventional MRI does not show remyelination or the pathophysiology of lesions well, there is a mismatch between symptomatology and MRI findings (Zivadinov et al., *J Neurol* 2008; 255 Suppl 1: 61-74). Currently, conventional MRI is not indicated for routine follow-up of patients with known MS unless the patient exhibits a clinical change. A new lesion by imaging may not reflect treatment failure but may be a manifestation of the natural history of the disease (Simon, *Radiol Clin North Am* 2006; 44(1): 79-100, viii; Filippi et al., *Eur J Neurol* 2006; 13(4): 313-325). Studies are ongoing regarding the correlation of MRI activity with relapse rate.

The evidence varies as to whether MRI should be used to monitor treatment, rather than waiting for relapses and changes in clinical symptomatology (Sormani et al., *Ann Neurol* 2009; 65(3): 268-275). Until solid results point to the use of MRI for routine follow-up, requests for MRI without a clinical change require secondary medical review.

(32)

An acoustic neuroma is a benign neoplasm of the Schwann cells of the vestibular nerve (CN VIII). Although vertigo is the most common presenting symptom, it is often associated with tinnitus or unilateral hearing loss (Chawla and Olshaker, *Med Clin North Am* 2006; 90(2): 291-304).

(33)

MRI with gadolinium contrast is the gold standard imaging tool. It provides excellent soft tissue visualization, is the most sensitive for detecting acoustic neuromas, and will show all detectable neuromas (Curtin and Hirsch, *Neurosurg Clin N Am* 2008; 19(2): 175-205, v).

(34)-DEF:

Tinnitus describes a subjective sense of ringing, whistling, booming, or buzzing within the ear.

(35)

The brainstem auditory evoked response is known as BAER or ABER and is almost always abnormal with an acoustic neuroma. Auditory brainstem response is less sensitive to small (< 2 cm) neuromas and the test is often nondiagnostic in patients with profound hearing loss (Cheng et al., *J Otolaryngol* 2003; 32(6): 394-399). This test is an appropriate screening in patients with limited symptoms (e.g., isolated vertigo, symmetric hearing loss, unilateral hearing loss explained by history) and therefore at low risk for acoustic neuroma.

(36)

A 15 to 20 db difference is common, but there is no absolute threshold.

(37)

The abnormal acoustic reflex and roll-over phenomenon are audiometric tests.

(38)

Routine follow-up is indicated for patients who have not undergone radiotherapy or surgical excision. Initial follow-up 6 mos after diagnosis, then annually is appropriate if tumor growth is ≥ 2 mm/year (Doherty and Friedman, *Curr Opin Otolaryngol Head Neck Surg* 2006; 14(5): 305-313).

(39)

Residual tumor is not uncommon following surgical excision or radiotherapy for acoustic neuroma (Curtin and Hirsch, *Neurosurg Clin N Am* 2008; 19(2): 175-205, v; Wiet et al., *Otolaryngol Clin North Am* 2006; 39(4): 751-762, vii). Routine follow-up for these patients is recommended to assess for residual tumor growth or recurrence. The frequency of follow-up is a matter of clinical judgment.

(40)

Abscesses involving the CNS are uncommon. They sometimes result from direct trauma or neurosurgery, but may be caused by meningitis, rhinosinusitis, mastoiditis, and other extra-cranial sources (Ziai and Lewin, *Neurol Clin* 2008; 26(2): 427-468, viii).

(41)

Whether to perform a CT or MRI in this setting is a matter of clinical judgment. While MRI provides greater detail, CT is often sufficient for follow-up studies. It is generally best to perform the same study serially as this allows direct comparison of studies.

(42)

Focal neurologic finding refers to a specific deficit that corresponds to a particular area of the brain (e.g., right arm weakness from a left motor cortex insult).

(43)

Mental status changes include confusion, lethargy, disorientation, somnolence, stupor, and coma.

(44)

The frequency of assessment is a matter of clinical judgment based upon the size, location, and number of intracranial abscesses. Follow-up is necessary to monitor resolution of the abscess in response to antibiotic therapy. If there is no progress, surgical drainage may be necessary.

(45)

The superior contrast resolution of MRI makes it a more sensitive imaging tool for evaluating intracerebral abnormalities associated with a variety of complicated CNS infectious processes. Gadolinium contrast improves lesion delineation, localizes regions likely to provide positive biopsy, and identifies active disease. Additional information may be obtained from using diffusion-weighted imaging. In uncomplicated cases, CT may be obtained initially to identify patients at higher risk for herniation with intracranial abnormalities such as hydrocephalus, mass lesions, cerebral edema, and midline brain shift. LP often follows CT in the event the patient is considered low risk for herniation (Fitch et al., *Infect Dis Clin North Am* 2008; 22(1): 33-52, v-vi; Kastrup et al., *NeuroRx* 2005; 2(2): 324-332).

(46)

These criteria address CNS infection in the immunocompetent host, where the concern is generally for meningitis or encephalitis.

(47)

In the setting of meningitis or encephalitis, an immunocompetent host will usually demonstrate signs of infection such as fever, elevated WBC, neck stiffness, or neurologic signs. Imaging in this context is helpful to rule out other possible etiologies that might confound or complicate the diagnosis.

(48)-DEF:

Photophobia is abnormal visual intolerance to light.

(49)-DEF:

Meningismus is a symptom complex associated with meningeal irritation, such as neck stiffness or a positive Kernig's or Brudzinski's sign (stretching of the nerve roots causes neck pain).

(50)

Meningismus may be seen with any meningeal irritant but should raise the suspicion of infectious meningitis.

(51)

Immunocompromised hosts are individuals whose immune system is defective either because of a primary underlying immunodeficiency disorder or because of the administration of medications that suppress the immune response.

(52)

Although both CT and MRI are effective imaging tools in patients with AIDS-related disease, MRI is the study of choice. MRI is preferred for tuberculous meningitis, common in patients with AIDS, because it can reveal small infarctions, granulomas, and inflammation of the ventricles. MRI is also preferred in suspected fungal infections due to its superior resolution and sensitivity to tissue edema (Fitch et al., *Infect Dis Clin North Am* 2008; 22(1): 33-52, v-vi; Kastrup et al., *NeuroRx* 2005; 2(2): 324-332).

(53)

These criteria address headaches of concern to the provider and patient because of features that are atypical for the patient. The headache may be atypical because it is unusually severe, long-lasting, or because it has new or differing characteristics from prior headaches.

(54)

Follow-up assessment is not necessary more frequently than every 7 to 10 days if the patient is stable or improving.

(55)

Neurological involvement in sarcoidosis is seen in approximately 5% to 10% of cases; approximately half of these cases involve the CNS. Presenting signs and symptoms of CNS involvement include mental status changes (e.g., somnolence), seizures, and cranial nerve palsies. CT or MRI imaging may diagnose neurosarcoidosis but gadolinium-enhanced MRI is the preferred imaging study to evaluate the brain parenchyma, the spinal cord, and the meninges (Lower and Weiss, *Clin Chest Med* 2008; 29(3): 475-492, ix).