

National Imaging Associates, Inc.*	
Clinical guidelines BRAIN (HEAD) CT	Original Date: September 1997
CPT Codes: 70450 70460 70470	Last Revised Date: April 2021
Guideline Number: NIA_CG_002	Implementation Date: January 2022

REDUCING RADIATION EXPOSURE

Brain CT/CTA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain CT/Brain CTA combination studies section.

Important Note: Brain MRI is preferred to Brain CT in most circumstances where the patient can tolerate MRI and sufficient time is available to schedule the MRI examination. Assessment of subarachnoid hemorrhage, acute trauma, or bone abnormalities of the calvarium (fracture, etc.) may be better imaged with CT. CT is also appropriate in an urgent situation where MRI is not readily available (stroke, increased ICP, CNS infection).

‡ Designates when CT is indicated only when MRI is contraindicated or cannot be performed

INDICATIONS FOR BRAIN CT

For evaluation of headache

(ACR, 2019^c; Holle, 2013; Quinones-Hinojosa, 2003; Schaefer, 2007; Wilbrink, 2009)

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration) [‡]
- **Cluster headaches or other trigeminal-autonomic cephalgias, i.e., paroxysmal hemicrania, hemicrania continua, short-lasting unilateral neuralgiform headache attacks (SUNCT/SUNA) imaging is indicated once to eliminate secondary causes (IHS, 2018) Cluster headaches—imaging is indicated once to eliminate secondary causes—‡**
- New acute headache, sudden onset:
 - With a personal or family history (brother, sister, parent, or child) of brain aneurysm or AVM (arteriovenous malformation).
 - < 48 hours of “worst headache in my life” or “thunderclap” headache:
 - **Note: The duration of a thunderclap type headache lasts more than 5 minutes. Sudden onset new headache reaching maximum intensity within 2-3 minutes.**
 - ~~Note: The duration of a thunderclap type headache lasts more than 5 minutes. Sudden onset new headache reaching maximum intensity within 2-3 minutes.~~

* National Imaging Associates, Inc. (NIA) is a subsidiary of Magellan Healthcare, Inc.

- Prior history of stroke or intracranial bleed
- Known coagulopathy or on anticoagulation
- New onset of headache with any of the following (ACR, 2019c; Micieli, 2020; Mitsikostas, 2016):
 - Acute, new, or fluctuating neurologic deficits, such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes or with signs of increased intracranial pressure (papilledema). ‡
 - ⊖ *** Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration**

~~* Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration~~

~~Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)~~

- History of cancer, or significantly immunocompromised ‡
- Fever
- Subacute head trauma
- Age ≥ 50 ‡
- New severe unilateral headache with radiation to or from the neck, a. Associated with suspicion of carotid or vertebral artery dissection. ‡
- Related to activity or event (sexual activity, exertion, position) (new or progressively worsening) ‡
- Persistent or worsening during a course of physician-physician-directed treatment (ACR, 2019c; Kuruvilla, 2015; Martin, 2011) ‡

~~* Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration~~

~~Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)~~

- ⊖
- Special considerations in the pediatric population with persistent headache (Trofimova, 2018):
 - Occipital location ‡
 - Age < 6 years- ‡
 - Symptoms indicative of **increased** intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting ‡
 - Documented absence of family history of headache ‡
 - Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g., immune deficiency, sickle cell disease, neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease)

For evaluation of neurologic symptoms or deficits

(ACR, 2019**2012a**)

- Acute, new, or fluctuating neurologic symptoms or deficits, such as, sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes-
 - * Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration

For evaluation of known or suspected stroke or vascular disease

(ACR 2017^a, 2019^a; Jauch, 2013)

- Known or suspected stroke with any acute, new, or fluctuating symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination, or mental status changes-

* Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration

- ~~* Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration~~
- Suspected stroke with **first-degree** family history of aneurysm (brother, sister, parent, or child) or known coagulopathy or on anticoagulation-
- Symptoms of transient ischemic attack (TIA) (episodic neurologic **symptoms such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes**) **±**
- Suspected acute subarachnoid hemorrhage (SAH)-
- Follow-up for known hemorrhage, hematoma, or vascular abnormalities-
- Suspected central venous thrombosis - see **background** (ACR, 2017^a; Bushnell, 2014) **±**
- Evaluation of neurological signs or symptoms in sickle cell disease (Arkuszewski, 2010; Mackin, 2014; Thust, 2014)

For evaluation of known or suspected trauma

(ACR, ~~2019a~~2019^f; Alrajhi, 2015; Jagoda, 2008; Menditto, 2012; Polinder, 2018)

- Known or suspected trauma or injury to the head with documentation of one or more of the following acute, new, or fluctuating:
 - Focal neurologic findings
 - Motor changes
 - Mental status changes
 - Amnesia
 - Vomiting
 - Seizures
 - Headache
 - Signs of increased intracranial pressure
- Known coagulopathy or on anticoagulation
- Known or suspected skull fracture by physical exam and/or **positive x-ray prior imaging**
- Repeat scan 24 hours post head trauma for anticoagulated patients with suspected diagnosis of delayed subdural hematoma-
- Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed
- Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit **±**

For evaluation of suspected brain tumor, mass, or metastasis

(ACR, 2018; Kerjnick, 2008; NCCN, 20~~2019~~)

- Suspected brain tumor with any acute, new, or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, visual loss*, lack of coordination or mental status changes \pm
* Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
- Suspected brain metastasis ~~in~~ or intracranial involvement in patients with a history of cancer based on symptoms or examination findings (may include new or changing lymph nodes) \pm
- Langerhans cell histiocytosis with visual, neurological, or endocrine abnormality; polyuria or polydipsia; suspected craniofacial bone lesions, aural discharge, or suspected hearing impairment/mastoid involvement (Haupt, 2013, NCCN, 2020)

For evaluation of known brain tumor, mass, or metastasis

- Follow-up of known malignant brain ~~malignant~~ tumor \pm
- Suspected recurrence with prior history of CNS cancer (either primary or secondary) based on neurological symptoms or examination findings \pm
- Patient with history of CNS cancer (either primary or secondary) and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years (NCCN, 2020) \pm
- Follow-up of known non-malignant tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors
- Follow-up of known meningioma (NHS, 2018) \pm
 - If <2cm or heavily calcified at 2 years and 5 years
 - > 2cm annually for 3 years and then scans at 5 years and 10 years
 - Multiple meningiomas, annually
 - After treatment (surgery or radiotherapy), post-operative if concern for residual tumor, every 6-12 months, then annually for 3-5 years based on WHO Grade (see background)
 - ~~— If <2cm or heavily calcified at 2 years and 5 years~~
 - ~~— > 2cm annually for 3 years and then scans at 5 years and 10 years.~~
 - ~~— Multiple meningiomas, annually~~
 - ~~• After treatment (surgery or radiotherapy), post-operative if concern for residual tumor, every 6-12 months then annually for 3-5 years based on WHO Grade (see background)~~
- Bone tumor or abnormality of the skull (Gomez, 2018)
- Langerhans cell histiocytosis (Haupt, 2013, NCCN, 2020)
 - To assess treatment response and surveillance of known brain/skull lesions
 -

Indication for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases \pm
(NCCN, ~~2019~~2020)

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine, or Lumbar Spine

For evaluation of known or suspected seizure disorder

(Cendes, 2013; Gaillard, 2009; Krumholz, 2007; Ramli, 2015)

- New onset of seizures or newly identified change in seizure activity/pattern \pm

For evaluation of known or suspected inflammatory disease or infection (e.g., meningitis or abscess) and MRI is contraindicated or cannot be performed

(Lummel, 2016; Tunkel, 2008) **±**

- Suspected intracranial abscess or brain infection with acute altered mental status OR positive lab findings (such as elevated WBC's) OR follow-up assessment during or after treatment completed.
- Meningitis with positive signs and symptoms (such as fever, headache, mental status changes, stiff neck) OR positive lab findings (such as elevated white blood cells or abnormal lumbar puncture fluid exam).
- Suspected encephalitis with headache and altered mental status OR follow-up as clinically warranted
- Endocarditis with suspected septic emboli.
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with **abnormal inflammatory markers or autoimmune antibodies positive lab findings.**
- **Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up (Godasi, 2019; Zuccoli, 2011).**
- **Immunocompromised patient (e.g., transplant recipients, HIV with CD4 < 200, primary immunodeficiency syndromes, hematologic malignancies) with focal neurologic-symptoms, headaches, behavioral, cognitive, or personality changes (Graham, 2000)**

For evaluation of clinical assessment documenting cognitive impairment of unclear cause

(AAN, ~~2012~~2017; Harvey, 2012; HQO, 2014; Narayanan, 2016)

- Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments ***/formal -/**neuropsychological testing showing at least mild cognitive impairment AND a completed basic metabolic workup (such as thyroid function testing, liver function testing, complete blood count, electrolytes, and B12). **±**
***Other examples include: Ottawa 3DY (O3DY), Brief Alzheimer's Screen (BAS), Blessed Dementia Scale (BDS), caregiver-completed AD8 (cAD8), Brief Cognitive Rating Scale (BCRS), Clinical Dementia Rating (CDR) (Carpenter, 2011; McDougall, 1990)**

For evaluation of movement disorders

(Mascalchi, 2012)

- Acute onset of a movement disorder with concern for stroke or hemorrhage **±**
- For evaluation of Parkinson's disease with atypical feature or other movement disorder (i.e., suspected Huntington disease, chorea, parkinsonian syndromes, hemiballismus, atypical dystonia) to exclude an underlying structural lesion **±**

Note: CT has limited utility in the chronic phases of disease. Imaging is not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia) (Albanese, 2011; Comella, 2019; Sharifi, 2014)

For evaluation of cranial nerve and visual abnormalities

- Anosmia ~~or dysosmia~~ (loss of smell) or dysosmia (documented by objective testing) that is persistent and of unknown origin (Policeni, 2017; Rouby, 2011) ‡
- Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit, etc.) (Chang, 2019) ‡
Note: Not explained by underlying ocular diagnosis, glaucoma, or macular degeneration
- Binocular diplopia with concern for intracranial pathology (Iliescu, 2017) ‡
- Childhood strabismus with development delay or abnormal fundoscopic exam to rule out intracranial abnormalities (Yoon, 2019; Kadom, 2008; Yoon, 2019) ‡
- Horner's syndrome with symptoms localizing the lesion to the central nervous system (Lee, 2007) ‡
- Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base or when MRI is contraindicated or cannot be performed (ACR, 2017**b**)

For evaluation of known or suspected congenital abnormality (such as ~~hydrocephalus,~~ craniosynostosis, neural tube defects)

(Ashwal, 2009; Marchese, 2017; Vinocur, 2010)

- Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes-
- Evaluation of macrocephaly in an infant/~~child~~ child <18 with previously abnormal US, abnormal neurodevelopmental examination (Tan, 2018), signs of increased ICP or closed anterior fontanelle ‡
- Microcephaly in an infant/child < 18 ‡
- Evaluation of the corticomedullary junction in Achondroplasia (Dougherty, 2018; Kubota, 2021) ‡
- Craniosynostosis and other head deformities-
- Prior treatment or planned treatment for congenital abnormality-

Note: For evaluation of known or suspected hydrocephalus please see section on CSF abnormalities.

Cerebral Spinal Fluid (CSF) Abnormalities

- Evaluation of suspected hydrocephalus with any acute, new, or fluctuating neurologic, motor, or mental status changes
- ~~Known hydrocephalus~~ ‡ ~~Suspected or known hydrocephalus*~~
- Known or suspected normal pressure hydrocephalus (NPH) (Damasceno, 2015)
 - With symptoms of gait difficulty, cognitive ~~disturbance~~ disturbance, and urinary incontinence
- Follow-up shunt evaluation (Kamenova, 2018; Pople, 2002; Reddy, 2014)
 - Post operativity if indicated based on underlying disease and pre-operative radiographic findings and/or
 - 6-12 months after placement and/or
 - With neurologic symptoms that suggest shunt malfunction
- Evaluation of known or suspected cerebrospinal fluid (CSF) leakage (Severson, 2019)
- Cisternography for intermittent and complex CSF rhinorrhea/otorrhea. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay)- (Selcuk, 2010; Kułakowska, 2011; Selcuk, 2010)

- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance (Gordon, 2019) \pm , \pm *Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection etc (NORD, 2014)

Pre-operative/procedural evaluation for brain/skull surgery

~~—Pre-operative evaluation for a planned surgery or procedure~~ Pre-operative evaluation for a planned surgery or procedure if the imaging provides diagnostic information that is not available on prior studies (provider should be referred to the health plan for nondiagnostic surgical planning studies)

Post-operative/procedural evaluation

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

Other Indications

(~~ACR, 2019~~; DeFoer, 2006; Kattah, 2009; Tarrant, 2008; Thust, 2014; Kattah, 2009) $\}$

- Vertigo associated with any of the following: \pm
 - Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness or a change in sensation) (Welgampola, 2019; Yamada, 2019)
 - Progressive unilateral hearing loss
 - Risk factors for cerebrovascular disease with concern for stroke
 - —After full neurologic examination and vestibular testing with concern for central vertigo (i.e., skew deviation, vertical nystagmus, head thrust test, videonystagmography (VNG)/electronystagmography (ENG))~~testing ENT work up with concern for central vertigo~~
- ○
- Diagnosis of central sleep apnea on polysomnogram \pm
 - Children > 1 year (Felix, 2016)
 - Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam (Malhotra, 2010)
- Syncope with clinical concern for seizure or associated neurological signs or symptoms (ACP, 2012; AFP, 2020; Al-Nsoor, 2010; Strickberger, 2006) \pm
- Cyclical vomiting syndrome or abdominal migraine with ~~and with~~ any localizing neurological symptoms (Angus-Leppan, 2018; Li-~~BUK~~, 2018; Venkatesan, 2019) \pm
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) (ACR, 2017~~c~~; Kim, 2019; Zhang, 2018) \pm
- Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause (ACR, 2019b) \pm

- Global developmental delay or developmental delay with abnormal neurological examination in a child < 18 years (Ali, 2015; Momen, 2011) ‡
- Cerebral palsy if etiology has not been established in the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder (Ashwal, 2004; NICE, 2020)
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam (Tieder, 2016) ‡
Note: Imaging is not indicated in low-low-risk patients
- Prior to lumbar puncture in patients with suspected increased intracranial pressure or at risk for herniation-
- ~~Syncopal event with clinical concern for seizure or associated neurological signs or symptoms (ACP, 2012; AFP, 2020; Al Nsoor, 2010; Strickberger, 2006)~~

Indications for Combination Studies

(ACR, 2017a, 2019a)

- • Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology (Lawson, 2000)-

• Brain CT/Neck CTA

- Recent ischemic stroke or transient ischemic attack
- Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

• Brain CT/Brain CTA

- Recent ischemic stroke or transient ischemic attack
- Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
- Headache associated with exercise or sexual activity (IHS-3, 2018) ‡
- ~~—~~
- Suspected venous thrombosis (dural sinus thrombosis) – Brain CTV (see background) ‡

• Brain CT/Brain CTA/Neck CTA

- Recent stroke or transient ischemic attack (TIA)
- Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

• ~~Brain CT/Cervical CT~~

- ~~For evaluation of Arnold Chiari Malformation~~

• Brain CT/Orbit CT

- Optic neuropathy or unilateral optic disk swelling of ~~Unilateral optic disk swelling/optic neuropathy of~~ unclear etiology to distinguish between a compressive lesion of the optic

nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion, or optic nerve infiltrative disorders (Behbehani, 2007) [±]

- Bilateral optic disk swelling (papilledema) with visual loss (Margolin, 2019) [±]

BACKGROUND

Computed tomography (CT) is an imaging technique used to view the structures of the brain and is useful in evaluating pathologies in the brain. It provides more detailed information on head trauma, brain tumors, stroke, and other pathologies in the brain than regular radiographs.

CT scan for Headache – Generally, magnetic resonance imaging is the preferred imaging technique for evaluating the brain parenchyma, and CT is preferable for evaluating subarachnoid hemorrhage. CT is faster and more readily available than MRI and is often used in urgent clinical situations. Neurologic imaging is warranted in patients with headache disorders along with abnormal neurologic examination results or predisposing factors for brain pathology.

Headache timeframes and other characteristics – Generally, acute headaches are present from hours to days, subacute from days to weeks, and chronic headaches for more than 3 months. Acute severe headaches are more likely to be pathological (e.g., SAH, cerebral venous thrombosis) than non-acute (e.g., migraine, tension-type). Headaches can also be categorized as new onset or chronic/recurrent. Non-acute, new onset headaches do not require **imaged-imaging** unless there is a red flag as delineated above. Incidental findings lead to additional medical procedures and expense that do not improve patient well-being. Primary headache syndromes, such as migraine and tension headaches, are often episodic with persistent or progressive headache not responding to treatment, requiring further investigation (e.g., new daily persistent headache). Imaging is indicated in chronic headaches if there is a change in the headache frequency (number of headache episodes/month), duration of each episode, severity of the headaches or new characteristics, such as changing aura or associated symptoms (ACR, ~~2012b~~ **2019c**; IHS ~~2015~~, 2018; Jang, 2019; Spierings, 2003; Tyagi, 2012).

Migraine with Aura

(Hadjikhani, 2019; IHS, 2018; Micieli, 2020) [–]

The headache phase of a migraine is preceded and/or accompanied by transient neurological symptoms referred to as aura in at least a third of migraine attacks. The most common aura consists of positive and/or negative visual phenomena, present in up to 99% of the patients. Somatosensory is the secondary most common type of aura (mostly paraesthesias in an upper limb and/or hemiface). Language/speech (mainly paraphasia and anomia) can also be affected. These neurological symptoms typically evolve over a period of minutes and may last up to 20 minutes or more. The gradual evolution of symptoms is thought to reflect spreading of a neurological event across the visual and somatosensory cortices. Characteristically, the aura usually precedes and terminates prior to headache, usually within 60 minutes. In others, it may persist or begin during the headache phase. ICHD-3 definition of the aura of migraine with typical aura consists of visual and/or sensory and/or speech/language symptoms, but no motor, brainstem or retinal symptoms and is characterized by gradual development, duration of each symptom no longer than one hour, a mix of positive and negative features and complete reversibility. Atypical or complex aura includes motor, brainstem,

monocular visual disturbances, or ocular cranial nerve involvement (hemiplegic migraine, basilar migraine/brainstem aura, retinal migraine, ophthalmoplegic migraine) and secondary causes need to be excluded. Additional features of an aura that raise concern for an underlying vascular etiology include: late age of onset, short duration, evolution of the focal symptoms, negative rather than positive visual phenomenon, and history of vascular risk factors.

Imaging for Stroke – Patients presenting with symptoms of acute stroke should receive prompt imaging to determine whether they are candidates for treatment with tissue plasminogen activator. Non-contrast CT can evaluate for hemorrhage that would exclude the patient from reperfusion therapy. Functional imaging can be used to select patients for thrombolytic therapy by measuring the mismatch between “infarct core” and “ischemic penumbra” and may define ischemic areas of the brain with the potential to respond positively to reperfusion therapy. Contrast-enhanced CT angiography (CTA) may follow the non-contrast CT imaging to identify areas of large vessel stenosis or occlusion which may be a target for therapy.

Recent stroke or transient ischemic attack – k

A stroke or central nervous system infarction is defined as “brain, spinal cord, or retinal cell death attributable to ischemia, based on neuropathological, neuroimaging, and/or clinical evidence of permanent injury. ... Ischemic stroke specifically refers to central nervous system infarction accompanied by overt symptoms, whereas silent infarction causes no known symptoms” (Sacco, 2013). If imaging or pathology is not available, a clinical stroke is diagnosed by symptoms persisting for more than 24 hours. Ischemic stroke can be further classified by the type and location of ischemia and the presumed etiology of the brain injury. These include large-artery atherosclerotic occlusion (extracranial or intracranial), cardiac embolism, small-vessel disease and less commonly dissection, hypercoagulable states, sickle cell disease and undetermined causes (Kernan, 2014). TIAs in contrast, “are a brief episode of neurological dysfunction caused by focal brain or retinal ischemia, with clinical symptoms typically lasting less than one hour, and without evidence of acute infarction on imaging” (Easton, 2009). On average, the annual risk of future ischemic stroke after a TIA or initial ischemic stroke is 3–4%, with an incidence as high as 11% over the next 7 days and 24–29% over the following 5 years. This has significantly decreased in the last half century due to advances in secondary prevention (Hong, 2011).

Therefore, when revascularization therapy is not indicated or available in patients with an ischemic stroke or TIA, the focus of the work-up is on secondary prevention. This includes noninvasive vascular imaging to identify the underlying etiology and to assess immediate complications and risk of future stroke. The majority of stroke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD (2) score ≥ 3 , indicating high risk of early recurrence, or the evaluation cannot be rapidly completed on an outpatient basis (Easton, 2009). Minimally, both stroke and TIA should have an evaluation for high-risk modifiable factors, such as carotid stenosis atrial fibrillation, as the cause of ischemic symptoms (Kernan, 2014). Diagnostic recommendations include: neuroimaging evaluation as soon as possible, preferably with magnetic resonance imaging, including DWI; noninvasive imaging of the extracranial vessels should be performed, and noninvasive imaging of intracranial vessels is reasonable (Wintermark, 2013).

Patients with a history of stroke and recent work-up with new signs or symptoms indicating progression or complications of the initial CVA should have repeat brain imaging as an initial study. Patients with remote or silent strokes discovered on imaging should be evaluated for high-risk modifiable risk factors based on the location and type of the presumed etiology of the brain injury.

CT and Central Venous Thrombosis – a CTV or MRV is indicated for the definite evaluation of a central venous thrombosis/dural sinus thrombosis. The most frequent presentations are isolated headache, intracranial hypertension syndrome, seizures, focal neurological deficits, and encephalopathy. Risk factors are hypercoagulable states inducing genetic prothrombotic conditions, antiphospholipid syndrome and other acquired prothrombotic diseases (such as cancer), oral contraceptives, pregnancy, puerperium (6-weeks postpartum), infections, and trauma. Since venous thrombosis can cause SAH, infarctions, and hemorrhage, parenchymal imaging with MRI/CT is also appropriate. (Bushnell, 2014; Courinho, 2015; Ferro, 2016).

Imaging of Cavernomas – Ms: MRI is the study of choice for detecting cavernous malformations (CCM). Follow-up imaging of known CCM should be done only to guide treatment decisions or to investigate new symptoms. First-degree relatives of patients with more than one family member with a CCM should have a screening MRI as well as genetic counseling (Akers, 2017; Velz, 2018; Zyck, 2021; Akers, 2017).

CT scan for Head Trauma – Most types of head injury are minor injuries; clinical signs and symptoms help predict the need for brain CT following injury. CT has advantages in evaluating head injury due to its sensitivity for demonstrating mass effect, ventricular size and configuration, bone injuries, and acute hemorrhage. A patient who presents with certain clinical risk factors may be more likely to benefit from CT imaging. Some of the clinical risk factors that may be used as a guide to predict the probability of abnormal CT following minor head injury are vomiting, skull fracture, and age greater than 60 years. Patients with a Glasgow Coma Scale of 15 or less who also have been vomiting or have a suspected skull fracture are likely to show abnormal results on CT scan. CT is also useful in detecting delayed hematoma, hypoxic-ischemic lesions, or cerebral edema in the first 72 hours after head injury.

CT and benign tumors (e.g., schwannomas, choroid plexus papilloma, pineocytoma, gangliocytoma) – A single follow-up study is appropriate after the initial diagnosis to ensure stability. Follow-up of known benign tumor is indicated if symptomatic, new/changing signs or symptoms or complicating factors (Gupta, 2017). MRI is the ideal modality to follow-up meningioma, pituitary tumors, neurocutaneous syndromes and staging/surveillance for non-CNS cancers.

Meningioma and CT (NHS, 2018) – CT should only be used when MRI is contraindicated or unable to be obtained. For incidental meningiomas, most patients who progressed do so within 5 years of diagnosis (Islim, 2019). Small (<2cm) meningiomas rarely grow sufficiently to produce symptoms within 5 years. Heavily calcified meningiomas rarely grow. Patients with multiple meningiomas should have annual scans indefinitely, despite treatment because of the possibility of further meningiomas developing.

For surveillance post-treatment:

- Solitary convexity WHO Grade 1 meningiomas - scan at 2½ years post-operatively
- Solitary skull base or falx origin WHO Grade 1 meningiomas- scans at 1 year, 2 years, 3½ years and 5 years post-operatively. If a recurrence is detected, continue annual scans.
- WHO Grade 2 meningiomas- scan at 6 months, 1 year then annually to 5 years. If a recurrence is detected, continue annual scans.
- WHO Grade 3 meningiomas - 6-monthly scans for 3 years, then annual scans to 5 years. If a recurrence is detected, continue annual scans.
- Patients who have had radiosurgery, including those being treated for a recurrence, should have scans at 6 months, then annually for 3 years, a scan at 5 years and a final scan at 10 years.

CT scan and Meningitis – In suspected bacterial meningitis, CT with contrast may be performed before lumbar puncture to show preliminary meningeal enhancement. It is important to evaluate for a mass lesion or cause of elevated ICP that would contraindicate an LP. CT may be used to define the pathology of the base of the skull and that may require therapeutic intervention and surgical consultation. Some causes of an intracranial infection include fractures of the paranasal sinus and inner ear infection.

MMSE – The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The MMSE has been the most commonly used measure of cognitive function in dementia research, but researchers have recognized that it is relatively insensitive and variable in mildly impaired individuals. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is therefore practical to use repeatedly and routinely.

MoCA – The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. MoCA differs from the MMSE mainly by including tests of executive function and abstraction, and by putting less weight on orientation to time and place. Ten of the MMSE's 30 points are scored solely on the time-place orientation test, whereas the MoCA assigns it a maximum of six points. The MoCA also puts more weight on recall and attention-calculation performance, while de-emphasizing language skill. Time to administer the MoCA is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal.

CT for evaluation of the cranial nerves – Magnetic resonance imaging (MRI) is considered the gold standard in the study of the cranial nerves. Computed tomography (CT) allows, usually, an indirect view of the nerve and is useful to demonstrate the intraosseous segments of cranial nerves, the foramina through which they exit skull base, and their pathologic changes. MRI is the study of choice in the evaluation of the cranial nerves. In optic neuritis, CT has limited utility. Contrast-enhanced CT scanning of the orbits may be able to help exclude other orbital pathology. CT scanning of the brain, regardless of whether intravenous contrast material is administered or not, does not yield prognostic and treatment-altering information. In Bell's Palsy temporal bone CT is useful in the evaluation of the caliber and the course of the IAC and bony facial nerve canal in the temporal bone. When using CT to

evaluate the facial nerve, pathology often can only be inferred by visualization of erosion or destruction of the adjacent bony facial nerve canal. In contrast, MRI visualizes soft tissues well and so is better suited for evaluating soft tissue facial nerve abnormalities.

Anosmia —a— Nonstructural causes of anosmia include post-viral symptoms, medications (~~Amitriptyline~~ ~~Amitriptyline~~, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Trifluoperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause.

Anosmia and dysgeusia have been reported as common early symptoms in patients with COVID-19, occurring in greater than 80 percent of patients. For isolated anosmia, imaging is typically not needed once the diagnosis of COVID has been made, given the high association. As such, COVID testing should be done prior to imaging (Geyer, 2008; Lechien, 2020; Saniasiaya, 2020).

Evaluation of olfactory function is essential to determine the degree of chemosensory loss and confirm the patient's complaint. It also allows monitoring of olfactory function over time, ~~helps to detect~~ ~~detectomg~~ malingers, and ~~to establish~~ ~~establishing~~ compensation for disability. There are two general types of olfactory testing: psychophysical and electrophysiologic testing. Psychophysical tests are used for clinical evaluation of olfactory loss; whereas, electrophysiologic tests such as electro-olfactogram (EOG) or odor event-related potentials (OERPs) are used for research purposes only.

Olfactory threshold tests rely on measuring detection thresholds of a specific odorant, such as phenyl ethyl alcohol (PEA) or butyl alcohol. Odor identification tests are quantitative tests in which ~~p~~patients are asked to identify the odorants at the suprathreshold level. ~~E~~examples include: *The Connecticut odor identification*, *The University of Pennsylvania Identification Test (UPSIT)* and ~~the~~ *the Cross-Cultural Smell Identification Test (CC-SIT)*. In Europe, a commonly used test is a threshold- and odorant-identification forced-choice test that uses odorant-impregnated felt-tipped pens (Sniffin' Sticks). A simple olfactory screening test using a 70% isopropyl alcohol pad as a stimulant has also been well described in the literature (Wrobel, 2004).

CT scan for congenital abnormalities ~~s~~—s— While MRI is preferred to CT for evaluation of most congenital CNS abnormalities, in some clinical situations CT is preferred (craniosynostosis) or equivalent to MRI. CT is appropriate in the follow-up of hydrocephalus or VP shunt function where the etiology of hydrocephalus has been previously determined or in patients for which MRI evaluation would require general anesthesia.

CT for Macrocephaly ~~y~~—y— Consider ultrasound in infants with macrocephaly and a normal neurological examination, no evidence of increased ICP, and an open anterior fontanelle. If head US is normal, the infant should be monitored closely (Smith, 1998). The anterior fontanelle generally closes between 10 and 24 months of age, with 3% closing between 5-9 months and 11% after 24 months (Pindrik, 2014).

CT and [Normal Pressure Hydrocephalus \(NPH\)](#) — Although diagnosis can be made based on CT findings alone, MRI is more accurate for disclosing associated pathologies (such as cerebrovascular disease), excluding other potential etiologies, and for detecting NPH typical signs of prognostic value. A CT scan can exclude NPH and is appropriate for screening purposes and in patients who cannot undergo MRI.

CT and Vertigo — The most common causes of vertigo seen are benign paroxysmal positional vertigo (BPPV), vestibular neuronitis (VN) and Ménière’s disease. These peripheral causes of vertigo are benign, and treatment involves reassurance and management of symptoms. Central causes of vertigo, such as cerebrovascular accidents (CVAs), tumors and multiple sclerosis (MS), need to be considered if the patient presents with associated neurological symptoms, such as weakness, diplopia, sensory changes, ataxia or confusion. Magnetic resonance imaging is appropriate in the evaluation of patients with vertigo who have neurologic signs and symptoms, progressive unilateral hearing loss or risk factors for cerebrovascular disease. MRI is more appropriate than CT for diagnosing vertigo due to its superiority in visualizing the posterior portion of the brain, where most central nervous system disease that causes vertigo is found. A full neurologic and otologic evaluation including provocative maneuvers, vestibular function testing and audiogram can help evaluate vertigo of unclear etiology and differentiate between central and peripheral vertigo.

CT and developmental delay — Significant developmental delay is defined as significant delay (more than two standard deviations below the mean) in one or more developmental domains: gross/fine motor, speech/language, cognition, social/personal, and activities of daily living. Isolated delay in social/language development is characteristic of autism spectrum disorders or hearing loss. Isolated delay in motor development is characteristic of cerebral palsy (a static encephalopathy) or myopathy. Global developmental delay (GDD) [is](#) a subset of developmental delay defined as significant delay (by at least 2 SD’s) in two or more developmental categories. Note that the term “GDD” is usually reserved for children < 5 years old, whereas in older children > 5 years, disability is quantifiable with IQ testing.

POLICY HISTORY

Date	Summary
April <u>July</u> 2021	<p>Reordered Indications</p> <p>Updated references</p> <p>Updated background section</p> <p>Added</p> <ul style="list-style-type: none"> • Brain MR/MRA are not approvable simultaneously unless they meet the criteria described below in the Indications for Brain MR/Brain MRA combination studies section. • ≠ Designates when CT is indicated only when MRI is contraindicated or cannot be performed • Added ≠ after appropriate indications

- Cluster headaches or other trigeminal-autonomic cephalgias i.e. paroxysmal hemicrania, hemicrania continua, short-lasting unilateral neuralgiform headache attacks (SUNCT/SUNA) imaging is indicated once to eliminate secondary causes (IHS, 2018)
- Langerhans cell histiocytosis with visual, neurological, or endocrine abnormality; polyuria or polydipsia; suspected craniofacial bone lesions, aural discharge, or suspected hearing impairment/mastoid involvement
- Langerhans cell histiocytosis - To assess treatment response and surveillance of known brain/skull lesions
- similar mental status instruments */formal neuropsychological
*Other examples include Ottawa 3DY (O3DY), Brief Alzheimer's Screen (BAS), Blessed Dementia Scale (BDS), caregiver-completed AD8 (cAD8), Brief Cognitive Rating Scale (BCRS), Clinical Dementia Rating (CDR) (Carpenter, 2011; McDougall, 1990)
- Optic atrophy as an abnormal eye finding
- Childhood strabismus with development delay or abnormal fundoscopic exam to rule out intracranial abnormalities
- Evaluation of the corticomedullary junction in Achondroplasia
- Evaluation of suspected hydrocephalus with any acute, new, or fluctuating neurologic, motor, or mental status changes (separated this from known hydrocephalus)
- Cisternography for intermittent and complex CSF rhinorrhea/otorrhea. CSF fluid should always be confirmed with laboratory testing (Beta-2 transferrin assay).
- Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits to Brain CT/Brain CTA/Neck CTA combo
- Headache associated with exercise or sexual activity (Brain CT/Brain CTA combo)
- Pre-operative evaluation for a planned surgery or procedure

Clarified

- Symptoms indicative of *increased* intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
- Suspected stroke with a personal or *first-degree* family history (brother, sister, parent, or child) of aneurysm or known coagulopathy or on anticoagulation
- Symptoms of transient ischemic attack (TIA) (*episodic neurologic symptoms such as sensory deficits, limb weakness, speech difficulties, visual loss, lack of coordination, or mental status changes*)

	<ul style="list-style-type: none"> • <u>Known or suspected skull fracture by physical exam and/or prior imaging</u> • <u>Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with abnormal inflammatory markers or autoimmune antibodies</u> • <u>Suspected primary CNS vasculitis based on neurological signs and symptoms with completed infectious/inflammatory lab work-up</u> • <u>Anosmia or dysosmia on objective testing that is persistent and of unknown origin (also in combo section)</u> • <u>Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base or when MRI is contraindicated or cannot be performed</u> • <u>Clarified age < 18 for imaging of microcephaly and macrocephaly</u> • <u>After full neurologic examination and vestibular testing with concern for central vertigo (i.e. skew deviation, vertical nystagmus, head thrust test, videonystagmography (VNG)/electronystagmography (ENG))</u> • <u>Clarified age < 18 for imaging of developmental delay</u> • <u>Optic neuropathy or unilateral optic disk swelling of unclear etiology (Brain CT/Orbit CT)</u> <p><u>Deleted</u></p> <ul style="list-style-type: none"> • <u>Brain CT/Cervical CT - for evaluation of Arnold Chiari Malformation</u> <p><u>See policy hx word doc</u></p>
<p><u>May 2020</u></p>	<p><u>Clarified:</u></p> <ul style="list-style-type: none"> • <u>New onset headache with (neurologic deficit) or with signs of increased intracranial pressure (papilledema)</u> • <u>Special additional considerations in the pediatric population with persistent headache</u> <ul style="list-style-type: none"> ○ <u>Documented absence of family history of headache</u> • <u>Suspected brain tumor</u> • <u>Suspected brain metastasis or intracranial involvement in patients with a history of cancer based on neurological symptoms or examination findings</u> • <u>Follow up of known malignant brain tumor</u> • <u>Patient with history of CNS cancer (either primary or secondary) and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years</u> • <u>Follow up of known non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors</u> • <u>Suspected intracranial abscess or brain infection</u>

- Suspected Encephalitis with headache and altered mental status or follow-up as clinically warranted
- Mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments/neuropsychological testing
- Vertigo associated with any of the following
 - Risk factors for cerebrovascular disease with concern for stroke
 - After full neurologic examination and vestibular testing with concern for central vertigo
- Combo Brain MRI/Orbit MRI
 - Reworded: Unilateral optic disk swelling/optic neuropathy of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders
 - Bilateral optic disk swelling (papilledema) with vision loss

Added:

- Visual loss (as a neurological deficit) Not explained by underlying ocular diagnosis, glaucoma or macular degeneration
- Under New acute headache, sudden onset:
 - With a personal or family history of brain aneurysm or AVM (arteriovenous malformation)
 - Known coagulopathy or on anticoagulation
- Under New onset of headache and any of the following
 - Fever
 - Subacute head trauma
 - Age > 50
 - Neurological deficits - Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)
- Special additional considerations in the pediatric population with persistent headache
 - Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
 - Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g.; immune deficiency, sickle cell disease neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease)
- Suspected stroke with a personal or family history (brother, sister, parent or child) of aneurysm or known coagulopathy/anticoagulation

- Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination
- Binocular diplopia with concern for intracranial pathology
- Follow up shunt evaluation (Pople, 2002, Reddy, 2014, Kamenova, 2018)
 - Post operatively if indicated based on underlying disease and pre-operative radiographic findings and/or
 - 6-12 months after placement and/or
 - With neurologic symptoms that suggest shunt malfunction
- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance
- Diagnosis of central sleep apnea on polysomnogram
 - Children > 1 year
 - Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam
- Syncope with clinical concern for seizure or associated neurological signs or symptoms
- Cyclical vomiting syndrome or abdominal migraine with any localizing neurological symptoms
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph)
- Cerebral palsy if etiology has not been established the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder
- Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam
- Note: Imaging is not indicated in low risk patients

Deleted:

- Under New onset of headache and any of the following
 - Temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery.
- Known brain tumor and new onset of headache.
- Removed the statement when MRI is contraindicated or cannot be performed throughout the document and
- Replaced with Important Note: Brain MRI is preferred to Brain CT in most circumstances where the patient can tolerate MRI and sufficient time is available to schedule the MRI examination. Assessment of subarachnoid hemorrhage, acute trauma or bone

	<p><u>abnormalities of the calvarium (fracture, etc.) may be better imaged with CT. CT is also appropriate in an urgent situation where MRI is not readily available (stroke, increased ICP, CNS infection).</u></p> <p><u>Clarified:</u></p> <ul style="list-style-type: none"> • <u>Cluster headaches- imaging is indicated once to eliminate secondary causes</u> • <u>Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base</u> <p><u>Added:</u></p> <ul style="list-style-type: none"> • <u>For evaluation of movement disorders</u> <ul style="list-style-type: none"> ○ <u>Acute onset of a movement disorder with concern for stroke or hemorrhage</u> ○ <u>For evaluation of Parkinson’s disease with atypical feature or other movement disorder (i.e., suspected Huntington disease, chorea, parkinsonian syndromes, hemiballismus, atypical dystonia) to exclude an underlying structural lesion</u> <p><u>Notes: CT has limited utility in the chronic phases of disease. Imaging is not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer’s dystonia)</u></p> <ul style="list-style-type: none"> • <u>Combo Brain CT/CTA</u> <ul style="list-style-type: none"> ○ <u>Recent ischemic stroke or transient ischemic attack</u> ○ <u>Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm</u> <p><u>Deleted:</u></p> <ul style="list-style-type: none"> • <u>Combo Brain CT/CTA</u> <ul style="list-style-type: none"> ○ <u>Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache</u>
<p><u>August 2019</u></p>	<ul style="list-style-type: none"> • <u>For evaluation of neurologic symptoms or deficits, added: visual loss</u> • <u>For trauma, added:</u> <ul style="list-style-type: none"> ○ <u>On anticoagulation</u> ○ <u>Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed</u> ○ <u>Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit and cannot have an MRI</u> • <u>For evaluation of headache, added:</u> <ul style="list-style-type: none"> ○ <u>Prior history of stroke or intracranial bleed with sudden onset of severe headache(moved)</u>

- Related to activity or event (sexual activity, exertion, position) (new or progressively worsening)
- New headaches and persistent or progressively worsening during a course of physician directed treatment
- Special considerations in the pediatric population with persistent headache:
 - Occipital location
 - Age < 6 years
 - No family history of headache
- Specified when MRI is contradicted for cluster headaches to eliminate secondary causes
- For evaluation of brain tumor:
 - Specified 'malignant' for f/u of known tumor
 - Added: Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors; Follow up of known meningioma if MRI is contraindicated
 - Removed: Known lung cancer or rule out metastasis and/or preoperative evaluation, Metastatic melanoma (not all melanomas)
- For evaluation of suspected stroke:
 - Moved 'patient with history of a known stroke with new and sudden onset of severe headache'
 - Separated: Family history of aneurysm
- For evaluation inflammatory disease or infections:
 - Changed meningitis with positive signs and symptoms from 'And' positive lab findings to 'OR' positive labs
 - For suspected encephalitis removed 'severe' headache
- For evaluation of congenital abnormality:
 - Modified the age restriction of > 6 months age for eval of macrocephaly to include 'in an infant/child with previously abnormal US, abnormal neurodevelopmental exam, signs of increased ICP or closed anterior fontanelle' and MRI is contraindicated
- For suspected normal pressure hydrocephalus added 'with symptoms of gait difficulty, cognitive disturbance, and urinary incontinence
- Other indications:
 - Added detail to Vertigo when MRI is contraindicated including:

	<ul style="list-style-type: none"> ▪ <u>Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness, or a change in sensation)</u> ▪ <u>Progressive unilateral hearing loss</u> ▪ <u>Risk factors for cerebrovascular disease</u> ▪ <u>After full neurologic examination and ENT work-up with concern for central vertigo</u> ○ <u>Modified developmental delay to include: Global developmental delay or developmental delay with abnormal neurological examination</u> ○ <u>Added:</u> <ul style="list-style-type: none"> ▪ <u>Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit etc).</u> ▪ <u>Horner's syndrome with symptoms localizing the lesion to the central nervous system</u> ▪ <u>Psychological changes with neurological deficits or a full neurological assessment completed that suggests a possible neurologic cause and MRI cannot be performed</u> • <u>For Brain CT/Neck CTA: added 'Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits'</u> <ul style="list-style-type: none"> ○ <u>Removed Confirmed carotid occlusion >60%, surgery or angioplasty candidate</u> • <u>Added Brain CT/Brain CTA section, including: Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache; AND Suspected venous thrombosis (dural sinus thrombosis)</u> • <u>Added Brain CT/Brain CTA/Neck CT section, including: Recent stroke or transient ischemic attack (TIA); AND Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology</u> • <u>For Brain CT/Orbit CT, added: Bilateral papilledema with visual loss; AND changed age restriction from 3 years to 8 years for children requiring anesthesia for the procedure with suspicion of concurrent orbital and intracranial pathology or tumor</u> • <u>Updated background information and references</u>
--	---

August 2019

- ~~For evaluation of neurologic symptoms or deficits, added: visual loss~~

- ~~For trauma, added:~~
 - ~~On anticoagulation~~
 - ~~Post concussive syndrome if persistent or disabling symptoms and imaging has not been performed~~
 - ~~Subacute or chronic traumatic brain injury with new cognitive and/or neurologic deficit and cannot have an MRI~~
- ~~For evaluation of headache, added:~~
 - ~~Prior history of stroke or intracranial bleed with sudden onset of severe headache(moved)~~
 - ~~Related to activity or event (sexual activity, exertion, position) (new or progressively worsening)~~
 - ~~New headaches and persistent or progressively worsening during a course of physician directed treatment~~
 - ~~Special considerations in the pediatric population with persistent headache:~~
 - ~~Occipital location~~
 - ~~Age < 6 years~~
 - ~~No family history of headache~~
 - ~~Specified when MRI is contradicted for cluster headaches to eliminate secondary causes~~
- ~~For evaluation of brain tumor:~~
 - ~~Specified 'malignant' for f/u of known tumor~~
 - ~~Added: Follow up of known benign tumor if symptomatic, new/changing signs or symptoms or complicating factors; Follow up of known meningioma if MRI is contraindicated~~
 - ~~Removed: Known lung cancer or rule out metastasis and/or preoperative evaluation, Metastatic melanoma (not all melanomas)~~
- ~~For evaluation of suspected stroke:~~
 - ~~Moved 'patient with history of a known stroke with new and sudden onset of severe headache'~~
 - ~~Separated: Family history of aneurysm~~
- ~~For evaluation inflammatory disease or infections:~~
 - ~~Changed meningitis with positive signs and symptoms from 'And' positive lab findings to 'OR' positive labs~~
 - ~~For suspected encephalitis removed 'severe' headache~~
- ~~For evaluation of congenital abnormality:~~
 - ~~Modified the age restriction of > 6 months age for eval of macrocephaly to include 'in an infant/child with previously abnormal US, abnormal neurodevelopmental exam, signs of increased ICP or closed anterior fontanelle' and MRI is contraindicated~~
- ~~For suspected normal pressure hydrocephalus added 'with symptoms of gait difficulty, cognitive disturbance, and urinary incontinence~~
- ~~Other indications:~~
 - ~~Added detail to Vertigo when MRI is contraindicated including:~~

- ~~Signs or symptoms suggestive of a CNS lesion (ataxia, visual loss, double vision, weakness, or a change in sensation)~~
- ~~Progressive unilateral hearing loss~~
- ~~Risk factors for cerebrovascular disease~~
- ~~After full neurologic examination and ENT work-up with concern for central vertigo~~
- ~~Modified developmental delay to include: Global developmental delay or developmental delay with abnormal neurological examination~~
- ~~Added:~~
 - ~~Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit etc).~~
 - ~~Horner's syndrome with symptoms localizing the lesion to the central nervous system~~
 - ~~Psychological changes with neurological deficits or a full neurological assessment completed that suggests a possible neurologic cause and MRI cannot be performed~~
- ~~For Brain CT/Neck CTA: added 'Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits'~~
 - ~~Removed Confirmed carotid occlusion >60%, surgery or angioplasty candidate~~
- ~~Added Brain CT/Brain CTA section, including: Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache; AND Suspected venous thrombosis (dural sinus thrombosis)~~
- ~~Added Brain CT/Brain CTA/Neck CT section, including: Recent stroke or transient ischemic attack (TIA); AND Approved indications as noted above and being performed in a child under 8 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial pathology~~
- ~~For Brain CT/Orbit CT, added: Bilateral papilledema with visual loss; AND changed age restriction from 3 years to 8 years for children requiring anesthesia for the procedure with suspicion of concurrent orbital and intracranial pathology or tumor~~
- ~~Updated background information and references~~

May 2020

Clarified:

- ~~New onset headache with (neurologic deficit) or with signs of increased intracranial pressure (papilledema)~~
- ~~Special additional considerations in the pediatric population with persistent headache~~
 - ~~Documented absence of family history of headache~~
- ~~Suspected **brain** tumor~~
- ~~Suspected **brain metastasis or intracranial involvement** in patients with a history of cancer based on neurological symptoms or examination findings~~
- ~~Follow up of known malignant **brain** tumor~~

- ~~Patient with history of CNS cancer (either primary or secondary) and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years~~
- ~~Follow up of known non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors~~
- ~~Suspected intracranial abscess or brain infection~~
- ~~Suspected Encephalitis with headache and altered mental status or follow-up as clinically warranted~~
- ~~Mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments/neuropsychological testing~~
- ~~Vertigo associated with any of the following~~
 - ~~Risk factors for cerebrovascular disease with concern for stroke~~
 - ~~After full neurologic examination and vestibular testing with concern for central vertigo~~
- ~~Combo Brain MRI/Orbit MRI~~
 - ~~Reworded: Unilateral optic disk swelling/optic neuropathy of unclear etiology to distinguish between a compressive lesion of the optic nerve, optic neuritis, ischemic optic neuropathy (arteritic or non-arteritic), central retinal vein occlusion or optic nerve infiltrative disorders~~
 - ~~Bilateral optic disk swelling (papilledema) with vision loss~~

Added:

- ~~Visual loss (as a neurological deficit) Not explained by underlying ocular diagnosis, glaucoma or macular degeneration~~
- ~~Under New acute headache, sudden onset:~~
 - ~~With a personal or family history of brain aneurysm or AVM (arteriovenous malformation)~~
 - ~~Known coagulopathy or on anticoagulation~~
- ~~Under New onset of headache and any of the following~~
 - ~~Fever~~
 - ~~Subacute head trauma~~
 - ~~Pregnancy or puerperium~~
 - ~~Age \geq 50~~
 - ~~Neurological deficits—Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)~~
- ~~Special additional considerations in the pediatric population with persistent headache~~
 - ~~Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting~~
 - ~~Severe headache in a child with an underlying disease that predisposes to intracranial pathology (e.g.; immune deficiency, sickle cell disease neurofibromatosis, history of neoplasm, coagulopathy, hypertension, congenital heart disease)~~

- ~~Suspected stroke with a personal or family history (brother, sister, parent or child) of aneurysm or known coagulopathy/anticoagulation~~
- ~~Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination~~
- ~~Binocular diplopia with concern for intracranial pathology~~
- ~~Follow up shunt evaluation (Pople, 2002, Reddy, 2014, Kamenova, 2018)~~
 - ~~Post operatively if indicated based on underlying disease and pre-operative radiographic findings and/or~~
 - ~~6-12 months after placement and/or~~
 - ~~With neurologic symptoms that suggest shunt malfunction~~
- ~~Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance~~
- ~~Diagnosis of central sleep apnea on polysomnogram~~
 - ~~Children > 1 year~~
 - ~~Adults in the absence of heart failure, chronic opioid use, high altitude, or treatment emergent central sleep apnea AND concern for a central neurological cause (Chiari malformation, tumor, infectious/inflammatory disease) OR with an abnormal neurological exam~~
- ~~Syncope with clinical concern for seizure or associated neurological signs or symptoms~~
- ~~Cyclical vomiting syndrome or abdominal migraine with any localizing neurological symptoms~~
- ~~Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph)~~
- ~~Cerebral palsy if etiology has not been established the neonatal period, there is change in the expected clinical or developmental profile or concern for progressive neurological disorder~~
- ~~Unexplained event (BRUE) formerly apparent life-threatening event (ALTE) in infants < 1 year with concern for neurological cause based on history and exam~~

~~Note: Imaging is not indicated in low risk patients~~

~~Deleted:~~

- ~~Under New onset of headache and any of the following~~
 - ~~Temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery.~~
- ~~Known brain tumor and new onset of headache.~~
- * ~~Removed the statement when MRI is contraindicated or cannot be performed throughout the document and~~
- * ~~Replaced with Important Note: Brain MRI is preferred to Brain CT in most circumstances where the patient can tolerate MRI and sufficient time is available to schedule the MRI examination. Assessment of subarachnoid hemorrhage, acute trauma or bone abnormalities of the calvarium (fracture, etc.) may be better imaged with CT. CT is also~~

~~appropriate in an urgent situation where MRI is not readily available (stroke, increased ICP, CNS infection).~~

Clarified:

- ~~Cluster headaches—imaging is indicated once to eliminate secondary causes~~
- ~~Evaluation of cranial neuropathy when thought to be due to tumor, stroke, or bony abnormalities of the skull base~~

Added:

- ~~For evaluation of movement disorders
 - ~~Acute onset of a movement disorder with concern for stroke or hemorrhage~~
 - ~~For evaluation of Parkinson's disease with atypical feature or other movement disorder (i.e., suspected Huntington disease, chorea, parkinsonian syndromes, hemiballismus, atypical dystonia) to exclude an underlying structural lesion~~~~

~~Notes: CT has limited utility in the chronic phases of disease. Imaging is not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia)~~

- ~~Combo Brain CT/CTA
 - ~~Recent ischemic stroke or transient ischemic attack~~
 - ~~Acute, sudden onset of headache with personal history of a vascular abnormality or first degree family history of aneurysm~~~~

Deleted:

- ~~Combo Brain CT/CTA
 - ~~Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache~~~~

REFERENCES

~~Abari IS. 2016 ACR revised criteria for early diagnosis of giant cell (temporal) arteritis: autoimmune diseases and therapeutic approaches. *Open Access*. 2016; 3:119-122.~~

Abuabara A. Cerebrospinal fluid rhinorrhoea: diagnosis and management. *Med Oral Patol Oral Cir Bucal* 2007;12:E397-400.

Akers A, Al-Shahi Salman R, A Awad I, et al. Synopsis of Guidelines for the Clinical Management of Cerebral Cavernous Malformations: Consensus Recommendations Based on Systematic Literature Review by the Angioma Alliance Scientific Advisory Board Clinical Experts Panel. *Neurosurgery*. 2017;80(5):665-680. doi:10.1093/neuros/nyx091.

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.

Ali AS, Syed NP, Murthy GS, et al. Magnetic resonance imaging (MRI) evaluation of developmental delay in pediatric patients. *J Clin Diagn Res*. 2015 Jan; 9(1):TC21-4. Epub 2015 Jan 1.

Al-Nsoor NM, Mhearat AS. Brain computed tomography in patients with syncope. *Neurosciences (Riyadh)*. 2010; 15(2):105-109.

Alrajhi KN, Perry JJ, Forster AJ. Intracranial bleeds after minor and minimal head injury in patients on warfarin. *J Emerg Med*. February 2015; 48(2):137-42.
<http://www.ncbi.nlm.nih.gov/pubmed/25440860>.

American Academy of Neurology (AAN). AAN Guideline Summary for Clinicians. Detection, Diagnosis and Management of Dementia. 2017.

American College of Physicians (ACP). Choosing Wisely – Five things physicians and patients should question. 2012 April 4. <https://www.choosingwisely.org/clinician-lists/american-college-physicians-brain-imaging-to-evaluate-simple-syncope/>.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Acute Mental Status Change, Delirium, and New Onset Psychosis. 2019b.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Cerebrovascular Disease. 2017a.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Cerebrovascular Disease—Child. 2019~~a~~.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Cranial Neuropathy. <https://www.acr.org/Quality-Safety/Appropriateness-Criteria/New-and-Revised>. 2017b. Accessed June 20, 2017.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Dementia and Movement Disorders. ~~2019a~~2019e.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Focal Neurologic Deficit. <https://acsearch.acr.org/list>. Published 2006. Updated 2012a.

American College of Radiology (ACR). Five Things Physicians and Patients Should Question. <http://www.choosingwisely.org/clinician-lists/american-college-radiology-imaging-for-uncomplicated-headache/>. Published 2012b.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Head Trauma. ~~2019a~~2019f.

American College of Radiology (ACR). ACR Appropriateness Criteria® - Headache. 2019~~c~~.

American College of Radiology (ACR). ACR Appropriateness Criteria® Neuroendocrine Imaging. 2018.

American College of Radiology ACR Appropriateness Criteria® Seizures and Epilepsy. 2019~~d~~.

American College of Radiology (ACR). ACR Appropriateness Criteria® Soft-Tissue Masse. 2017~~c~~. <https://acsearch.acr.org/docs/69434/Narrative/>.

American Family Physician (AFP). Choosing Wisely: Avoid CT of the head in asymptomatic adult patients in the emergency department with syncope, insignificant trauma, and a normal neurological evaluation. 2020. <https://www.aafp.org/afp/recommendations/viewRecommendation.htm?recommendationId=222#>.

Angus-Leppan H, Saatci D, Sutcliffe A, et al. Abdominal migraine. *BMJ*. 2018 Feb 19; 360:k179.

Arkuszewski M, Melhem ER, Krejza J. Neuroimaging in assessment of risk of stroke in children with sickle cell disease. *Adv Med Sci*. 2010; 55(2):115-129.

Ashwal S, Michelson D, Plawner L, et al. Practice parameter: Evaluation of the child with microcephaly (an evidence-based review). *Neurology*. 2009; 73(11):887-897. <http://www.neurology.org/content/73/11/887.full.html>. Accessed June 19, 2017.

Behbehani R. Clinical approach to optic neuropathies. *Clin Ophthalmol*. 2007; 1(3):233-246.

Bushnell C, Saposnik G. Evaluation and management of cerebral venous thrombosis. *Continuum (Minneapolis)*. 2014 Apr; 20(2 Cerebrovascular Disease):335-51.

Carpenter CR, Bassett ER, Fischer GM, Shirshekan J, Galvin JE, Morris JC. Four sensitive screening tools to detect cognitive dysfunction in geriatric emergency department patients: brief Alzheimer's Screen, Short Blessed Test, Ottawa 3DY, and the caregiver-completed AD8. *Acad Emerg Med*. 2011 Apr;18(4):374-84. doi: 10.1111/j.1553-2712.2011.01040.x.

Cendes F, Theodore WH, Brinkmann BH, et al. Neuroimaging of epilepsy. *Handb Clin Neurol*. 2016; 136:985-1014.

Chang VA, Meyer DM, Meyer BC. Isolated anisocoria as a presenting stroke code symptom is unlikely to result in alteplase administration. *J Stroke Cerebrovasc Dis*. 2019 Jan; 28(1):163-166. Epub 2018 Oct 13.

Chase M, Joyce NR, Carney E, et al. ED patients with vertigo: Can we identify clinical factors associated with acute stroke? *Am J Emerg Med*. May 2011; 30(4):587-91.
<http://www.ncbi.nlm.nih.gov/pubmed/21524878?dopt=Abstract>.

Comella CL. Cervical Dystonia. Rare Disease Database. 2019. <https://rarediseases.org/rare-diseases/cervical-dystonia/>.

Courinho JM. Cerebral venous thrombosis. *J Thromb Haemost*. 2015 Jun; 13 Suppl 1:S238-44.

Damasceno BP. Neuroimaging in normal pressure hydrocephalus. *Dement Neuropsychol*. 2015; 9(4):350-355.

DeFoer B, Vercruyssen JP, Pilet B, et al. Single-shot, turbo spin-echo, diffusion-weighted imaging versus spin-echo-planar, diffusion-weighted imaging in the detection of acquired middle ear cholesteatoma. *AJNR Am J Neuroradiol*. 2006; 27(7):1480-1482. <http://www.ajnr.org/content/27/7/1480.long>.

~~Diamantopoulos AP, Haugeberg G, Hetland H, et al. Diagnostic value of color Doppler ultrasonography of temporal arteries and large vessels in giant cell arteritis: A consecutive case series. *Arthritis Care Res (Hoboken)*. 2014; 66(1):113-119. doi:10.1002/acr.22178.~~Dougherty H, Shaunak M, Irving M, Thompson D, Cheung MS. Identification of Characteristic Neurological Complications in Infants with Achondroplasia by Routine MRI Screening. In: *ESPE Abstracts*. Vol 89. Bioscientifica; 2018. Accessed August 16, 2021. <https://abstracts.eurospe.org/hrp/0089/hrp0089rfc2.5>.

Easton JD, Saver JL, Albers GW, et al. Definition and evaluation of transient ischemic attack: A scientific statement for healthcare professionals from the American Heart Association/American Stroke Association Stroke Council; Council on Cardiovascular Surgery and Anesthesia; Council on Cardiovascular Radiology and Intervention; Council on Cardiovascular Nursing; and the Interdisciplinary Council on Peripheral Vascular Disease. *Stroke*. 2009; 40:2276-2293.

Felix O, Amaddeo A, Olmo Arroyo J, et al. Central sleep apnea in children: experience at a single center. *Sleep Med.* 2016; 25:24-28. doi:10.1016/j.sleep.2016.07.016.

Ferro JM, Canhão P, Aguiar de Sousa D. Cerebral venous thrombosis. *La Presse Med.* 2016 Dec; 45(12 Pt 2):e429-e450. Epub 2016 Nov 2.

Gaillard WD, Chiron C, Cross JH, et al. Guidelines for imaging infants and children with recent-onset epilepsy. *Epilepsia.* September 2009; 50:2147-2153. <http://www.ncbi.nlm.nih.gov/pubmed/19389145>.

[Geyer M, Nilssen E. Evidence-based management of a patient with anosmia. *Clin Otolaryngol.* 2008; 33\(5\).](#)

Gordon N. Spontaneous intracranial hypotension. *Dev Med Child Neurol.* 2009; 51(12):932-935. doi:10.1111/j.1469-8749.2009.03514.x.

Graham CB 3rd, Wippold FJ 2nd, Pilgram TK, et al. Screening CT of the brain determined by CD4 count in HIV-positive patients presenting with headache. *AJNR Am J Neuroradiol.* March 2000; 21(3):451-454. <http://www.ncbi.nlm.nih.gov/pubmed/10730634>.

[Godasi R, Bollu PC. Primary central nervous system vasculitis. \[Updated 2019 May 6\]. In: *StatPearls \[Internet\]. Treasure Island \(FL\): StatPearls Publishing; 2019 Jan-. https://www.ncbi.nlm.nih.gov/books/NBK482476/.*](#)

Gomez CK, Schiffman SR, Bhatt AA. Radiological review of skull lesions. *Insights Imaging.* 2018; 9(5):857-882. doi:10.1007/s13244-018-0643-0.

Gupta A, Dwivedi T. A Simplified Overview of World Health Organization Classification Update of Central Nervous System Tumors 2016. *J Neurosci Rural Pract.* 2017; 8(4):629-641. doi:10.4103/jnrp.jnrp_168_17.

Hadjikhani N, Vincent M. Neuroimaging clues of migraine aura. *J Headache Pain.* 2019; 20:32. <https://doi.org/10.1186/s10194-019-0983-2>.

Harvey PD. Clinical applications of neuropsychological assessment. *Dialogues Clin Neurosci.* 2012; 14(1):91-99.

[Haupt R, Minkov M, Astigarraga I, et al. Langerhans cell histiocytosis \(LCH\): guidelines for diagnosis, clinical work-up, and treatment for patients till the age of 18 years. *Pediatr Blood Cancer.* 2013;60\(2\):175-184. doi:10.1002/pbc.24367.](#)

Health Quality Ontario (HQO). The appropriate use of neuroimaging in the diagnostic work-up of dementia: An evidence-based analysis. *Ont Health Technol Assess Ser.* February 1, 2014; 14(1):1-64. <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3937983/> 4 Feb 1. Accessed June 18, 2017.

Hiremath SB, Gautam AA, Sasindran V, et al. Cerebrospinal fluid rhinorrhea and otorrhea: A multimodality imaging approach. *Diagn Interv Imaging*. 2019; 100(1):3-15.
doi:10.1016/j.diii.2018.05.003.

Holle D, Obermann M. The role of neuroimaging in the diagnosis of headaches disorders. *Ther Adv Neurol Disord*. 2013; 6(6):369-374.

Hong KS, Yegiaian S, Lee M, et al. Declining stroke and vascular. event recurrence rates in secondary prevention trials over the past 50 years and consequences for current trial design. *Circulation*. 2011 May 17; 123(19):2111-9. doi: 10.1161/CIRCULATIONAHA.109.934786. Epub 2011 May 2.

Iliescu DA, Timaru CM, Alexe N, et al. Management of diplopia. *Romanian J Ophthalmol*. 2017 Jul-Sep; 61(3):166-170.

International Headache Society ([IHS](#)). Headache Classification Committee of the International Headache Society (IHS) - The international classification of headache disorders, 3rd edition. *Cephalalgia*. 2018; 38(1):1–211.

[Islim AI, Mohan M, Moon RDC, et al. Incidental intracranial meningiomas: A systematic review and meta-analysis of prognostic factors and outcomes. *J Neurooncol*. 2019 Apr; 142\(2\):211-21.](#)

Jagoda AS, Bazarian JJ, Bruns JJ Jr, et al. Clinical policy: neuroimaging and decision making in adult mild traumatic brain injury in the acute setting. *Ann Emerg Med*. 2008; 52:714-48.
<http://www.acep.org/Clinical---Practice-Management/Clinical-Policy--Decisionmaking-in-Adult-Mild-Traumatic-Brain-Injury-in-the-Acute-Setting/>.

Jang YE, Cho EY, Choi HY, Kim SM, Park HY. Diagnostic Neuroimaging in Headache Patients: A Systematic Review and Meta-Analysis. *Psychiatry Investig*. 2019; 16(6):407-417.
doi:10.30773/pi.2019.04.11.

Jauch EC, Saver JL, Adams HP Jr, et al. Guidelines for the early management of patients with acute ischemic stroke: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2013; 44:870-947.
<http://stroke.ahajournals.org/content/44/3/870.full>.

[Kadom N. Pediatric strabismus imaging. *Current Opinion in Ophthalmology*. 2008;19\(5\):371-378. doi:10.1097/ICU.0b013e328309f165.](#)

Kamenova M, Rychen J, Guzman R, et al. Yield of early postoperative computed tomography after frontal ventriculoperitoneal shunt placement. *PLoS One*. 2018;13(6):e0198752. Published 2018 Jun 19.

[Kattah JC, Talkad AV, Wang DZ, Hsieh YH, Newman-Toker DE. HINTS to diagnose stroke in the acute vestibular syndrome: three-step bedside oculomotor examination more sensitive than early MRI diffusion-weighted imaging. *Stroke*. 2009;40:3504–3510.](#)

Kerjnick DP, Ahmed F, Bahra A, et al. Imaging patients with suspected brain tumor: Guidance for primary care. *Br J Gen Pract*. 2008; 58(557):880-885.
<http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2593538/pdf/bjgp58-880.pdf>.

Kernan WN, Ovbiagele B, Black HR, et al. Guidelines for the prevention of stroke in patients with stroke and transient ischemic attack: A guideline for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2014 Jul;45(7):2160-236. Epub 2014 May. doi: 10.1161/STR.0000000000000024.

Kim HS, An JK, Woo JJ, et al. Superficially palpable masses of the scalp and face: A pictorial essay. *J Korean Soc Radiol*. 2019; 80(2):283-293.

Krumholz A, Wiebe S, Gronseth G, et al. Practice Parameter: Evaluating an apparent unprovoked first seizure in adults (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology and the American Epilepsy Society. *Neurology*. 2007; 69(21):1996.

[Kubota T, Adachi M, Kitaoka T, et al. Clinical Practice Guidelines for Achondroplasia. *Clin Pediatr Endocrinol*. 2020;29\(1\):25-42. doi:10.1297/cpe.29.25.](#)

[Kuřakowska A, Ganslandt O, Kemon H, Szmitkowski M, Drozdowski W, Zimmermann R, Kornhuber J, Lewczuk P. Cerebrospinal fluid leakage--reliable diagnostic methods. *Clin Chim Acta*. 2011 May 12;412\(11-12\):837-40. doi: 10.1016/j.cca.2011.02.017.](#)

Kuruville DE, Lipton RB. Appropriate Use of Neuroimaging in Headache. *Curr Pain Headache Rep*. 2015; 19:17.

~~[Labuguen RH. Initial evaluation of vertigo. *Am Fam Physician*. January 15, 2006; 73\(2\):244-251. <http://www.aafp.org/afp/20060115/244.html>.](#)~~

Lake MG, Krook LS, Cruz SV. Pituitary adenomas: An overview. *Am Fam Physician*. 2013; 88(5):319-327.

Lawson, GR. Sedation of children for magnetic resonance imaging. *Archives Dis Childhood*. 2000; 82(2).

[Lechien JR, Chiesa-Estomba CM, De Siati DR, et al. Olfactory and gustatory dysfunctions as a clinical presentation of mild-to-moderate forms of the coronavirus disease \(COVID-19\): a multicenter European study. *Eur Arch Otorhinolaryngol*. 2020;277\(8\):2251-2261. doi:10.1007/s00405-020-05965-1.](#)

Lee JH, Lee HK, Lee DH, et al. Neuroimaging Strategies for Three Types of Horner Syndrome with Emphasis on Anatomic Location. *Am J Roentgenol*. 2007; 188(1):W74-W81.

Li BUK. Managing cyclic vomiting syndrome in children: Beyond the guidelines. *Eur J Pediatr*. 2018; 177(10):1435-1442. doi:10.1007/s00431-018-3218-7.

Lummel N, Koch M, Klein M, et al. Spectrum and prevalence of pathological intracranial magnetic resonance imaging findings in acute bacterial meningitis. [Published online ahead of print September 23, 2014]. *Clin Neuroradiol*. 2016. doi: 10.1007/s00062-014-0339-x.

Mackin RS, Insel P, Truran D, et al. Neuroimaging abnormalities in adults with sickle cell anemia. *Neurology*. 2014 Mar 11; 82(10):835-841. doi: 10.1212/WNL.0000000000000188.

Malhotra A, Owens RL. What is central sleep apnea? *Respir Care*. 2010; 55(9):1168-1178.

Marchese RF, Schwartz ES, Heuer GG, et al. Reduced radiation in children presenting to the ED with suspected ventricular shunt complication. *Pediatrics*. May 2017; 139(5):2016-2431. doi: 10.1542/peds.2016-2431.

Margolin E. Swollen optic nerve: an approach to diagnosis and management. *Pract Neurol*. 2019 Jun 13. pii: practneurol-2018-002057. [Epub ahead of print].

Martin VT. The diagnostic evaluation of secondary headache disorders. *Headache*. 2011 Feb; 51(2):346-52.

Mascalchi M, Vella A, Ceravolo R. Movement disorders: Role of imaging in diagnosis. *J Magn Reson Imaging*. 2012; 35:239-256. doi:10.1002/jmri.22825.

[McDougall GJ. A review of screening instruments for assessing cognition and mental status in older adults. *Nurse Pract*. 1990 Nov;15\(11\):18-28.](#)

Menditto VG, Lucci M, Polonara S, et al. Management of minor head injury in patients receiving oral anticoagulant therapy: A prospective study of a 24-hour observation protocol. *Ann Emerg Med*. 2012; 59(6):451-455. [http://www.annemergmed.com/article/S0196-0644\(11\)01887-7/pdf](http://www.annemergmed.com/article/S0196-0644(11)01887-7/pdf).

Micieli A, Kingston W. An approach to identifying headache patients that require neuroimaging frontiers in public health. 2019; 7:52. Epub 2019 Mar 15.

Mitsikostas DD, Ashina M, Craven A, et al. European headache federation consensus on technical investigation for primary headache disorders. *J Headache Pain*. 2015; 17:5.

Momen AA, Jelodar G, Dehdashti H. Brain magnetic resonance imaging findings in developmentally delayed children. *Int J Pediatr*. 2011; 2011:386984.

Narayanan L, Murray AD. What can imaging tell us about cognitive impairment and dementia? *World J Radiol*. 2016; 8(3):240-254.

National Comprehensive Cancer Network (NCCN). NCCN Guidelines and Clinical Resources.
https://www.nccn.org/professionals/physician_gls/f_guidelines.asp. Published 2020. Accessed May 20, 2020.
~~https://www.nccn.org/professionals/physician_gls/f_guidelines.asp. Published 2017. Accessed June 18, 2017.~~

National Health Services England (NHS). Protocol for follow-up scanning in patient with a cranial meningioma v1 - Coversheet for Cancer Alliance Expert Advisory Group Agreed Documentation. April 2018.

National Institute for Health and Care Excellence (NICE). Cerebral palsy in under 25s: Assessment and management. 2017 January 2. Available at:
<https://www.nice.org.uk/guidance/ng62/resources/cerebral-palsy-in-under-25s-assessment-and-management-1837570402501>.

National Organization for Rare Disorders (NORD). Rare Disease Database - Chiari Malformations. 2014.
<https://rarediseases.org/rare-diseases/chiari-malformations/>.

Patel KM, Almutairi A, Mafee MF. Acute otomastoiditis and its complications: Role of imaging. *Oper Tech Otolaryngol*. 2014; 25:21-28.

Pindrik J, Ye X, Ji BG, et al. Anterior fontanelle closure and size in full-term children based on head computed tomography. *Ahn Clin Pediatr (Phila)*. 2014; 53(12):1149. Epub 2014 Jun 11.

Platzek I, Kitzler HH, Gudziol V, et al. Magnetic resonance imaging in acute mastoiditis. *Acta Radiol Short Rep*. 2014 Feb; 3(2):2047981614523415.

Policeni B, Corey AS, Burns J, et al. American College of Radiology (ACR) Appropriateness Criteria. Expert Panel on Neurologic Imaging: Cranial Neuropathy. 2017.
<https://acsearch.acr.org/docs/69509/Narrative/>.

[Polinder S, Cnossen MC, Real RGL, et al. A multidimensional approach to post-concussion symptoms in mild traumatic brain injury. *Front Neurol*. 2018;9:1113. doi:10.3389/fneur.2018.01113.](#)

~~[Polinder S, Cnossen MC, Real RG, et al. A multidimensional approach to post-concussion symptoms in mild traumatic brain injury. *Front Neurol*. 2018 Dec 19.](#)~~

Pople IK. Hydrocephalus and shunts: What the neurologist should know. *J Neurol Neurosurg Psych*. 2002; 73:i17-i22.

Quinones-Hinojosa A, Gulati M, Singh V, et al. Spontaneous intracerebral hemorrhage due to coagulation disorders. *Neurosurg Focus*. 2003 Oct 15; 15(4):E3.

Ramli N, Rahmat K, Lim KS, et al. Neuroimaging in refractory epilepsy. Current practice and evolving trends. *Eur J Radiol*. September 2015; 84(9):1791-800.

Reddy GK, Bollam P, Caldito G. Long-term outcomes of ventriculoperitoneal shunt surgery in patients with hydrocephalus. *World Neurosurg*. 2014; 81(2):404-410. doi:10.1016/j.wneu.2013.01.096.

Rouby C, Thomas-Danquin T, Vigouroux M, et al. The Lyon clinical olfactory test: Validation and measurement of hyposmia and anosmia in healthy and diseased populations. *Int J Otolaryngol*. 2011; 203805.

Sacco RL, Kasner SE, Broderick JP, et al. An updated definition of stroke for the 21st century: A statement for healthcare professionals from the American Heart Association/American Stroke Association. *Stroke*. 2013; 44:2064–2089.

Sanellia PC, Sykesa JB, Ford AL, et al. Imaging and treatment of patients with acute stroke: An evidence-based review. *AJNR Am J Neuroradiol*. 2014; 35:1045-1051.
<http://www.ajnr.org/content/35/6/1045.abstract>.

Saniasiaya J, Islam MA, Abdullah B. Prevalence of olfactory dysfunction in coronavirus disease 2019 (COVID-19): a meta-analysis of 27,492 patients. *Laryngoscope*. 2021;131(4):865-878. doi:10.1002/lary.29286.

Schaefer PW, Miller JC, Signhal AB, et al. Headache: When is neurologic imaging indicated? *J Am Coll Radiol*. 2007; 4(8):566-569. [http://www.jacr.org/article/S1546-1440\(06\)00579-5/abstract](http://www.jacr.org/article/S1546-1440(06)00579-5/abstract).

Selcuk H, Albayram S, Ozer H, et al. Intrathecal gadolinium-enhanced MR cisternography in the evaluation of CSF leakage. *AJNR Am J Neuroradiol*. 2010;31(1):71-75. doi:10.3174/ajnr.A1788.

Severson M, Strecker-McGraw MK. Cerebrospinal Fluid Leak. [Updated 2019 Mar 16]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2020 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK538157/>.

Sharifi S, Nederveen AJ, Booij J, et al. Neuroimaging essentials in essential tremor: A systematic review. *Neuroimage Clin*. 2014 May 9; 5:217-31. ~~eCollection 2014.~~

Smith R, Leonidas JC, Maytal J. The value of head ultrasound in infants with macrocephaly. *Pediatr Radiol*. March 1998; 28(3):143-146. <http://www.ncbi.nlm.nih.gov/pubmed/9561530>.

Spierings EL. Acute, subacute, and chronic headache. *Otolaryngol Clin North Am*. 2003 Dec; 36(6):1095-1097.

Strickberger SA, Benson DW, Biaggioni I, et al. AHA/ACCF Scientific Statement on the evaluation of syncope: From the American Heart Association Councils on Clinical Cardiology. *Circulation*. 2006 Jan 17; 113(2):316-327. <http://circ.ahajournals.org/content/113/2/316.full>.

Tan AP, Mankad K, Goncalves FG, et al. Macrocephaly: Solving the diagnostic dilemma. *Top Magn Reson Imaging*. 2018 Aug; 27(4):197-217.

Tarrant A, Garel C, Germanaud D, et al. Microcephaly: A radiological review. *Pediatr Radiol*. August 2009; 39(8):772-780.

Thust SC, Burke C, Siddiqui A. Neuroimaging findings in sickle cell disease. [Published online ahead of print July 1, 2014]. *Br J Radiol*. 2014. doi: 10.1259/bjr.20130699.

Tieder JS, Bonkowsky JL, Etzel RA, et al. Subcommittee on apparent life threatening events. *Pediatrics*. 2016 May; 137(5):e20160591. DOI: <https://doi.org/10.1542/peds.2016-0591>.

Trofimova A, Vey BL, Mullins ME. Imaging of children with nontraumatic headaches. *Am J Roentgenol*. 2018 Jan; 210(1):8-17.

Tunkel AR, Glaser CA, Block KC, et al. The management of encephalitis: Clinical practice guidelines by the Infectious Diseases Society of America *Clin Infect Dis*. 2008; 47(3):303-327.

Tyagi A. New daily persistent headache. *Ann Indian Acad Neurol*. 2012; 15(Suppl 1):S62-S65. doi:10.4103/0972-2327.100011.

[Velz J, Stienen MN, Neidert MC, Yang Y, Regli L, Bozinov O. Routinely Performed Serial Follow-Up Imaging in Asymptomatic Patients With Multiple Cerebral Cavernous Malformations Has No Influence on Surgical Decision Making. *Front Neurol*. 2018;9:848. Published 2018 Oct 11. doi:10.3389/fneur.2018.00848.](#)

Venkatesan T, Levinthal DJ, Tarbell SE, et al. Guidelines on management of cyclic vomiting syndrome in adults by the American Neurogastroenterology and Motility Society and the Cyclic Vomiting Syndrome Association. *Neurogastroenterol Motility*. 2019 Jun 26. DOI: 10.1111/nmo.13604.

Vinocur DN, Medina LS. Imaging in the evaluation of children with suspected craniosynostosis. In: Medina LS, Applegate KE, Blackmore CC, eds. *Evidence-Based Imaging in Pediatrics*. New York: Springer-Verlag; 2010:43-52. DOI 10.1007/978-1-4419-0922-0_4.

Welgampola MS, Young AS, Pogson JM, et al. Dizziness demystified. *Pract Neurol*. 2019 Jul 20; pii:practneurol-2019-002199.

Wilbrink LA, Ferrari MD, Kruit MC, et al. Neuroimaging in trigeminal autonomic cephalgias: When, how, and of what? *Curr Opin Neurol*. 2009; 22(3): 247-53. doi: 10.1097/WCO.0b013e32832b4bb3.

Wintermark M, Sanelli PC, Albers GW, et al. Imaging Recommendations for Acute Stroke and Transient Ischemic Attack Patients: A Joint Statement by the American Society of Neuroradiology, the American College of Radiology, and the Society of NeuroInterventional Surgery. *Am J Neuroradiol*. 2013 Nov; 34(11):E117-127.

[Wrobel BB, Leopold DA. Clinical assessment of patients with smell and taste disorders. *Otolaryngol Clin North Am*. 2004;37\(6\):1127-1142. doi:10.1016/j.otc.2004.06.010.](#)

Yamada S, Yasui K, Kawakami Y, et al. DEFENSIVE Stroke Scale: Novel diagnostic tool for predicting posterior circulation infarction in the emergency department. *J Stroke Cerebrovasc Dis*. 2019 Jun; 28(6):1561-70.


[Yoon L, Kim H-Y, Kwak MJ, et al. Utility of magnetic resonance imaging \(MRI\) in children with strabismus. *J Child Neurol*. 2019;34\(10\):574-581. doi:10.1177/0883073819846807.](#)

Zhang J, Li Y, Zhao Y, et al. CT and MRI of superficial solid tumors. *Quant Imaging Med Surg*. 2018; 8(2):232-251. doi:10.21037/qims.2018.03.03.

[Zuccoli G, Pipitone N, Haldipur A, et al. Imaging findings in primary central nervous system vasculitis. *Clin Exp Rheumatol*. 2011; 29\(1 Suppl 64\):S104-109.](#)

[Zyck S, Gould GC. Cavernous Venous Malformation. \[Updated 2021 Apr 2\]. In: *StatPearls \[Internet\]. Treasure Island \(FL\): StatPearls Publishing; 2021 Jan-.* Available from: <https://www.ncbi.nlm.nih.gov/books/NBK526009/>.](#)

[Reviewed / Approved by NIA Clinical Guideline Committee](#)

Reviewed / Approved by  M. Atif Khalid, M.D., Medical Director, Radiology

GENERAL INFORMATION

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

Disclaimer: Magellan Healthcare service authorization policies do not constitute medical advice and are not intended to govern or otherwise influence the practice of medicine. These policies are not meant to supplant your normal procedures, evaluation, diagnosis, treatment and/or care plans for your patients. Your professional judgement must be exercised and followed in all respects with regard to the treatment and care of your patients. These policies apply to all Magellan Healthcare subsidiaries including, but not limited to, National Imaging Associates (“Magellan”). The policies constitute only the reimbursement and coverage guidelines of Magellan. Coverage for services varies for individual members in accordance with the terms and conditions of applicable Certificates of Coverage, Summary Plan Descriptions, or contracts with governing regulatory agencies. Magellan reserves the right to review and update the guidelines at its sole discretion. Notice of such changes, if necessary, shall be provided in accordance with the terms and conditions of provider agreements and any applicable laws or regulations.