

## AmeriHealth Caritas Louisiana

National Imaging Associates, Inc.*	
Clinical guidelines BRAIN (HEAD) CT	Original Date: September 1997
CPT Codes: 70450 70460 70470	Last Revised Date: May 2020
Guideline Number: NIA_CG_002	Implementation Date: <del>January 2021</del> TBD

### 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. All prior relevant imaging results, and the reason that alternative imaging (gold standard, protocol, contrast, etc.) cannot be performed must be included in the documentation submitted.

### REDUCING RADIATION EXPOSURE:

**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).

### INDICATIONS FOR BRAIN CT:

#### For evaluation of headache:

(ACR, 2019; Frischberg, 2000; Graham, 2000; Schafer, 2007; Edlow, 2008; Gunner, 2007; ACR, 2019; Holle, 2013; Kerjnick, 2008; Quinones-Hinojosa, 2003; Schafer, 2007; Wilbrink, 2009; Quinones-Hinojosa, 2003)

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration) and MRI is contraindicated or cannot be performed.
- Once in patients with cCluster headaches- imaging is indicated once to eliminate secondary causes when, and MRI is contraindicated or cannot be performed.
- New acute headache, sudden onset:

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- Acute, sudden onset of headache with a personal or family history (brother, sister, parent, or child) of brain aneurysm or AVM (arteriovenous malformation).
  - New onset (< 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.
  - Prior history of stroke or intracranial bleed
  - Known coagulopathy or on anticoagulation with sudden onset of severe headache
  - New onset of headache and with any of the following and MRI is contraindicated or cannot be performed (ACR, 2019; Mitsikostas, 2016; 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  
Note: Neuroimaging warranted for atypical/complex migraine aura, but not for a typical migraine aura (see background)
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- History of cancer, or significantly immunocompromised
  - Fever
  - Subacute head trauma
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- ~~New temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery and MRI is contraindicated or cannot be performed.~~
- Age > 50
  - New severe unilateral headache with radiation to or from the neck. 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 directed treatment (ACR, 2019; Kuruvilla, 2015; Martin, 2011)
- Special considerations in the pediatric population with persistent headache (Trofimova, 2018):
  - Occipital location
  - Age < 6 years
  - ~~No family history of headache~~ Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
  - Documented absence of family history of headache
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- 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)

- 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::

(~~Jauch, 2013; Smith, 1998~~ ACR 2017, ; ACR 2019; 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

Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms.)

- Suspected stroke with fFamily history of aneurysm (brother, sister, parent, or child) or known coagulopathy or on anticoagulation.
- Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms.)
- Suspected acute subarachnoid hemorrhage (SAH).
- Follow up for known hemorrhage, hematoma, or vascular abnormalities.
- Suspected central venous thrombosis - see background (ACR, 2017, Bushnell, 2014)
- Evaluation of neurological signs or symptoms in sickle cell disease (~~Arkuszewski, 2010; Thust, 2014; Mackin, 2014; Thust, 2014~~ Arkuszewski, 2010)

For evaluation of known or suspected trauma:

(ACR, 2019a; 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.
- 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 ~~AND cannot have a Brain MRI~~

For evaluation of ~~known or suspected~~ brain tumor, mass, or metastasis:

(~~NCCN, 2019; Kerjnick, 2008; ACR Neuroendocrine, 2018; Kerjnick, 2008; NCCN, 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.

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

- Suspected ~~recurrence~~ brain metastasis in or intracranial involvement patients with a history of cancer based on symptoms or examination findings (may include new or changing lymph nodes)  
~~— Suspected pituitary tumors if MRI is contraindicated~~

For evaluation of known brain tumor, mass, or metastasis:

- Follow up of known brain malignant tumor.
- Suspected recurrence with prior history of CNS cancer (either primary or secondary) based on neurological symptoms or examination findings
- 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)

- Follow up of known non-malignant tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors

~~— Follow up of known meningioma if MRI is contraindicated (NHS, 2018)~~

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~~— Follow up known of pituitary adenoma if MRI is contraindicated (Lake, 2013)~~

~~— Known tumor and new onset of headache.~~

~~— Suspected 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.~~

~~— Suspected recurrence or metastasis in patients with a history of cancer [based on symptoms or examination findings (may include new or changing lymph nodes)].~~

~~— Patient with history of cancer and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years.~~

- Bone tumor or abnormality of the skull (Gomez, 2018).

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:

(Sanellia, 2014) NCCN, 2019)

- < 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; Gaillard, 2009; Ramli, 2015, Cendes, 2013)

- ~~— New onset of seizures or newly identified change in seizure activity/pattern AND cannot have a Brain MRI.~~

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For evaluation of neurologic symptoms or deficits:

(ACR, 2019)

- ~~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.~~

**For evaluation of clinical assessment documenting cognitive impairment of unclear cause:**

(AAN; Narayanan, 2016; HQO, 2014)

- ~~Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments 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).~~

For evaluation of known or suspected trauma:

(ACR, 2019a; Alrajhi, 2015; Jagoda, 2008; Menditto, 2012; Lee, 2005; 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.~~
- ~~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 AND cannot have a Brain MRI~~
- 

**For evaluation of headache:**

(Frischberg, 2000; Graham, 2000; Schafer, 2007; Edlow, 2008; Gunner, 2007; ACR, 2019; Kerjnick, 2008)

- ~~Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration) and MRI is contraindicated or cannot be performed.~~
- ~~Once in patients with cluster headaches to eliminate secondary causes, and MRI is contraindicated or cannot be performed.~~
- ~~Acute, sudden onset of headache with a family history (brother, sister, parent or child) of brain aneurysm or AVM (arteriovenous malformation).~~
- ~~New onset (< 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.~~

- ~~Prior history of stroke or intracranial bleed with sudden onset of severe headache~~
- ~~New onset of headache and any of the following and MRI is contraindicated or cannot be performed~~
  - ~~Acute, new, or fluctuating neurologic deficits such as sensory deficits, limb weakness, speech difficulties, lack of coordination, or mental status changes or with signs of increased intracranial pressure.~~
  - ~~History of cancer, or significantly immunocompromised~~
  - ~~New temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery and MRI is contraindicated or cannot be performed.~~
  - ~~New severe unilateral headache with radiation to or from the neck. 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 directed treatment (ACR, 2019; Kuruvilla, 2015; Martin, 2011)~~
  - ~~Special considerations in the pediatric population with persistent headache (Trofimova, 2018):~~
    - ~~Occipital location~~
    - ~~Age < 6 years~~
    - ~~No family history of headache~~

**For evaluation of known or suspected brain tumor, mass, or metastasis:**  
(NCCN, 2019)

- ~~Follow up of known malignant tumor.~~
- ~~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~~
- ~~Known tumor and new onset of headache.~~
- ~~Suspected 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.~~
- ~~Suspected recurrence or metastasis in patients with a history of cancer [based on symptoms or examination findings (may include new or changing lymph nodes)].~~
- ~~Patient with history of cancer and a recent course of chemotherapy, radiation therapy (to the brain), or surgical treatment within the last two (2) years.~~
- ~~Bone tumor or abnormality of the skull.~~

**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:**  
(Sanellia, 2014)

- ~~≤ 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 stroke:

(Jauch, 2013; Smith, 1998)

- 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
- Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms.)
- Family history of aneurysm (brother, sister, parent or child)

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 positive lab finding (such as elevated WBC's).
- Endocarditis with suspected septic emboli.
  - Suspected temporal arteritis in a patient > 50 with temporal headache, abrupt visual changes, jaw claudication, temporal artery tenderness, constitutional symptoms or elevated ESR (Diamantopoulos, 2014; Salehi, 2016) AND
    - Negative initial work-up (color Doppler ultrasonography or biopsy) OR
    - Atypical features or failure to response to treatment with concern for large vessel involvement
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with positive lab findings.
  - 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);
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For evaluation of clinical assessment documenting cognitive impairment of unclear cause:

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

- Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status instruments /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).

For evaluation of movement disorders when MRI is contraindicated or cannot be performed (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

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) (Alabanese, 2011; Comella, 2019; Sharfi, 2014, Comella, 2019)

For evaluation of cranial nerve and visual abnormalities:

- Anosmia (loss of smell) (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)

- 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 the cranial nerves~~ when looking for bony abnormalities ~~in~~ of the skull base, otherwise MRI is the study of choice (ACR, 2017)

**For evaluation of known or suspected congenital abnormality (such as hydrocephalus, craniosynostosis):**

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

- Known or suspected congenital abnormality with any acute, new, or fluctuating neurologic, motor, or mental status changes.
- Evaluation of macrocephaly in an infant/child with previously abnormal US, abnormal neurodevelopmental examination (Tan, 2018), signs of increased ICP or closed anterior fontanelle ~~and MRI is contraindicated or cannot be performed~~
- Microcephaly ~~and MRI is contraindicated or cannot be performed~~
- ~~Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms.~~
- Craniosynostosis and other head deformities.
- ~~Suspected or known hydrocephalus.~~
- Prior treatment or planned treatment for congenital abnormality.

**Cerebral Spinal Fluid (CSF) Abnormalities**

- Suspected or known hydrocephalus\*

~~Initial imaging of a suspected or known Arnold Chiari malformation when MRI cannot be performed~~  
\*

~~Initial evaluation for a known syrinx or syringomyelia when MRI cannot be performed \*~~

- Known or suspected normal pressure hydrocephalus (NPH) (Damasceno, 2015)



- With symptoms of gait difficulty, cognitive disturbance and urinary incontinence
- Follow up shunt evaluation (Kamenova, 2018; Pople, 2002, Reddy, 2014, Kamenova, 2018)
  - 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)
- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance (Gordon, 2019).

\*Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection etc. (NORD, 2014)

**Known or suspected normal pressure hydrocephalus, (NPH):**  
(Damasceno, 2015)

- ~~With symptoms of gait difficulty, cognitive disturbance and urinary incontinence~~

**Pre-operative evaluation for brain/skull surgery.**

**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 for a Brain CT: when MRI is contraindicated or cannot be performed**  
(ACR, 2019; DeFoer, 2006; Tarrant, 2008; Thust, 2014; Arkuszewski, 2010; Agostoni, 2009; DeFoer, 2006; ACR, 2019)

- ~~Suspected acute subarachnoid hemorrhage (SAH).~~
- ~~Follow up for known hemorrhage, hematoma, or vascular abnormalities.~~
- ~~Suspected central venous thrombosis—see background~~
- ~~Evaluation of neurological signs or symptoms in sickle cell disease.~~
- **Vertigo associated with any of the following ~~and MRI is contraindicated~~:**
  - 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 ~~otologic~~ vestibular testing evaluation ENT work-up with concern for central vertigo
- Diagnosis of central sleep apnea on polysomnogram
  - 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)

- Cyclical vomiting syndrome or abdominal migraine with and with any localizing neurological symptoms (Angus-Leppan, 2018; Venkatesan, 2019; Li BUK, 2018; Angus-Leppan, 2018; Venkatesan, 2019)
  - Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) (ACR, 2017; Kim, 2019; Zhang, 2018; Kim, 2019)
  - Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause (ACR, 2019b)
  - Global developmental delay or developmental delay with abnormal neurological examination (Ali, 2015; Momen, 2011)
  - 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 (NICE, 2020; 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 risk patients

Risk factors for cerebrovascular disease

Evaluation of known or suspected cerebrospinal fluid (CSF) leakage.

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.

Global developmental delay or developmental delay with abnormal neurological examination (Ali, 2015; Momen, 2011) where MRI cannot be performed.

- ~~Anosmia (loss of smell) (documented by objective testing).~~
- ~~Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, new onset anisocoria, visual field deficit, etc.) (Chang, 2019).~~
- ~~Horner's syndrome with symptoms localizing the lesion to the central nervous system (Lee, 2007).~~
- ~~Prior to lumbar puncture in patients with suspected increased intracranial pressure or at risk for herniation.~~
- ~~Suspected cholesteatoma.~~
- ~~Evaluation of the cranial nerves when looking for bony abnormalities in the skull base, otherwise MRI is the study of choice.~~
- ~~Psychological changes with neurological deficits or a full neurological assessment completed that suggests a possible neurologic cause and MRI cannot be performed~~

Other indications for a Brain CT:

- Prior to lumbar puncture in patients with suspected increased intracranial pressure or at risk for herniation.
- Syncope with head injury, clinical concern for seizure or associated neurological signs or symptoms (ACP, 2012; AFP, 2020; Al-Nsoor, 2010; Strickberger, 2006)

**Indications for Combination Studies: (ACR, 2017, 2019)**

- 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 –**
  - ~~Sus~~Recent ischemic stroke or transient ischemic attack when MRI cannot be performed
  - Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits
- **Brain CT/Brain CTA -**
  - ~~Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache~~
  - Recent ischemic stroke or transient ischemic attack when MRI cannot be performed
  - Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
  - Suspected venous thrombosis (dural sinus thrombosis) – Brain CTV see background
- **Brain CT/Brain CTA/Neck CTA-**
  - Recent stroke or transient ischemic attack (TIA) when MRI cannot be performed
  - ~~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/Cervical CT –**
  - For evaluation of Arnold Chiari Malformation when MRI cannot be performed
- **Brain CT/Orbit CT – when MRI cannot be performed**
  - ~~For 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 orbital and intracranial pathology or tumor (e.g. “trilateral retinoblastoma”).~~
  - Unilateral ~~papilledema~~ optic disk swelling/optic neuropathy of unclear etiology ~~papilledema~~ to distinguish between a compressive lesion ~~on of~~ the optic nerve, ~~or optic disc swelling associated with acute demyelinating optic neuritis,~~ ischemic optic neuropathy (arteritic or non-arteritic), ~~s in multiple sclerosis from nonarteritic anterior ischemic optic neuropathy (NAION),~~ central retinal vein occlusion, or optic nerve infiltrative disorders (Behbehani, 2007).
  - Bilateral optic disk swelling (papilledema) with visual loss (Margolin, 2019)
  - For 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 orbital and intracranial pathology or tumor (e.g. “trilateral retinoblastoma”).

- Indications for a Brain CT /Internal Auditory Canal (IAC) CT (Labuguen, 2006)
- Pulsatile tinnitus.
- Unilateral non-pulsatile tinnitus when MRI cannot be performed
- Suspected acoustic neuroma (Schwannoma) or cerebellar pontine angle tumor with any of the following signs and symptoms: unilateral hearing loss by audiometry, headache, disturbed balance or gait, unilateral tinnitus, facial weakness, or altered sense of taste when MRI cannot be performed
- Suspected cholesteatoma.
- Suspected glomus tumor.
- Asymmetric sensorineural hearing loss on audiogram when MRI cannot be performed
- CSF otorrhea (MRI cisternography for intermittent leak, CT for active leaks) (Hiremath, 2019)
- Clinical Suspicion of acute mastoiditis as a complication of acute otitis media with intracranial complications (i.e. meningeal signs, cranial nerve deficits, focal neurological findings, altered mental status) (Patel, 2014; Platzek, 2014) when MRI cannot be performed

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## 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 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; HIS, 2018; Jang, 2019; Spierings, 2003; Jang 2019, IHS, 2018, ACR, 2012b, Tyagi, 2012)

Migraine with ~~A~~aura (~~Hadjikhani, 2019~~; IHS, 2018; ~~Hadjikhani, 2019~~; 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 anomic aphasia) 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, 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

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, 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  $\geq 3$ , 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. (Ferro, 2016; Bushnell, 2014; Courinho, 2015; Ferro, 2016).

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 vomiting or 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 (~~meningioma~~ e.g., schwannomas, choroid plexus papilloma, ~~glioma~~, pineocytoma, gangliocytoma) A single follow up study is appropriate after the initial diagnosis to ensure stability. Follow up of known benign tumor 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.



**CT and Meningioma**—Although there is no consensus on optimal management, most patients who progressed did so within 5 years of diagnosis (Islam, 2019).

### **MRI and staging in Non-CNS Cancers—as per NCCN guidelines**

**CT scan for congenital abnormalities**—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 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.

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**CT scan 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.

**CT scan and Meningitis**—In suspected bacterial meningitis, ~~contrast~~ CT **with contrast** may be performed before lumbar puncture to show ~~beginning initial~~ **preliminary** meningeal enhancement. ~~It may rule out causes for swelling. 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 ~~the infection~~ **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.

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~~CT and Meningioma – Although there is no consensus on optimal management, most patients who progressed did so within 5 years of diagnosis (Islim, 2019)~~

**CT for Macrocephaly** - 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 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 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): 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 yo., whereas in older children > 5 yo, disability is quantifiable with IQ testing.

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**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): 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.

~~**MRI and staging in Non-CNS Cancers** – as per NCCN guidelines~~

## **POLICY HISTORY:**

**Review Date:** August 2019

### **Review Summary:**

- 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

**Review Date:** May 2020

**Review Summary:**

**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 > 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

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~~Acute, subacute, and chronic headache~~

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