AmeriHealth Caritas Louisiana

National Imaging Associates, Inc.	
Clinical guidelines **BRAIN (HEAD) MRI** **BRAIN (HEAD) MRI with IAC (Internal Auditory Canal)**	**Original Date: September 1997**
CPT Codes: **70551, 70552, 70553 – Brain MRI** **70540, 70542, 70543 - IAC**	**Last Revised Date: May 2020**
Guideline Number: NIA_CG_001	**Implementation Date: ~~January 2021~~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.

INDICATIONS FOR BRAIN MRI:

For evaluation of headache:
(ACR, 2019; Holle, 2013; Quinones-Hinojosa, 2003; Schafer, 2007; Wilbrink, 2009)
~~(Holle, 2013; Schaefer, 2007; Wilbrink, 2009; ACR, 2019, Quinones-Hinojosa, 2003)~~

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity, or duration).
- 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) OR
  - < 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
- New onset of headache ~~and~~with any of the following (ACR, 2019; Micieli, 2020; Mitsikostas, 2016): ~~(ACR, 2019; Mitsikostas, 2016; Micieli, 2020):~~

- 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)

  - History of cancer or significantly immunocompromised
  - Fever
  - Subacute head trauma
  - Pregnancy or puerperium (Hamilton, 2020; Shobeiri, 2019)
  - Age > 50
  - ~~Temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery.~~
  - 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 progressively worsening during a course of physician directed treatment (ACR, 2019; Kuruvilla, 2015; Martin, 2011) ~~(Kuruvilla, 2015; Martin, 2011)~~

- Special considerations in the pediatric population with persistent headache (Trofimova, 2018):
  - Occipital location
  - Age < 6 years
  - Symptoms indicative of intracranial pressure, such as recurring headaches after waking with or without associated nausea/vomiting
  - Documented absence of ~~No~~ 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)

- 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

~~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, 2019; Jauch, 2013)
~~(Jauch, 2013; ACR 2017; ACR 2019)~~

- 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
- Suspected stroke with a personal or family history (brother, sister, parent or child) of aneurysm or known coagulopathy or on anticoagulation.
- Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms)
- Evaluation of 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 (Mackin, 2014; Thust, 2014)~~Thust, 2014; Mackin, 2014)~~

For evaluation of known or suspected trauma:
((~~Lee, 2005; Jagoda, 2008;~~ ACR, 2019, Jagoda, 2008; ~~-~~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 positive x-ray.
- 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:
(Kerjnick, 2008; NCCN, 2019)~~NCCN, 2019; Kerjnick, 2008)~~

- 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 or~~ brain metastasis or intracranial involvement in patients with a ~~prior~~ history of cancer based on neurological symptoms or examination findings (may include new or changing lymph nodes)

Suspected Pituitary Tumors:
(ACR, 2018; GHRS, 2000; Kannan, 2013; Majumdar, 2013; Shalender, 2018)

- Wi~~Suspected pituitary tumor wi~~th the following: ~~(ACR Neuroendocrine, 2018; GHRS, 2000; Kannan, 2013; Shalender, 2018; Majumdar, 2013)~~
    - Neurologic findings (e.g. visual field deficit suggesting compression of the optic chiasm)
    - Suspected hypofunctioning pituitary gland based on hormonal testing e.g.~~i.e~~., hypo pituitarism, growth hormone deficiency, hypogonadotropic hypogonadism [i.e. low gonadotropins (FSH/LH) and sex hormones*]~~)~~
      * S~~s~~evere secondary hypogonadism with total testosterone persistently < 150 and low or normal LH/FSH ~~or~~ OR
      * T~~t~~estosterone levels below normal range with low or normal LH/FSH; ~~and~~ AND
        - N~~n~~eurological sign and symptoms; OR
        - Other pituitary hormonal abnormalities; OR
        - Consideration ~~and exclusion~~ of ~~all other~~ reversible functional causes of gonadotropin suppression (e.g., obesity, opioid use, or comorbid illness)
    - Suspected hyperfunctioning pituitary gland based on hormonal testing i.e., central hyperthyroidism (high TSH), Cushing disease (high ACTH), acromegaly/gigantism (high GH/ IGF-1) or elevated prolactin (≥~~>~~ 250~~100~~ ng/mL or persistently elevated in the absence of another cause e.g., stress, pregnancy, hypothyroidism, medication)
    - Central Diabetes Insipidus (low ADH)
    - Precocious puberty in a child (male < 9; female < 8), with hormonal studies suggesting a central cause and evidence of an accelerated bone age on X-ray ——(Faizah, 2012)
    - Pituitary apoplexy with sudden onset of neurological and hormonal symptoms
    - ~~—~~

For evaluation of known brain tumor, mass, or metastasis: ~~(Kerjnick, 2008)~~

- Follow up of known malignant brain tumor
- Suspected recurrence with prior history of CNS cancer 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 ~~benign~~non-malignant brain tumor/lesion if symptomatic, new/changing signs or symptoms or complicating factors
- Follow up of known meningioma (NHS, 2018)
    - 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)
- Follow-up known of pituitary adenoma
    - New signs or symptoms
    - Functioning adenoma - to assess response to treatment and 1-year follow-up after drug holiday (Stoller, 2012)

- Asymptomatic Macroadenoma (≥ 10mm) follow up every 6-18 months, post-surgical follow up 1-2 years after surgery (Dekkers, 2008)
- Asymptomatic, non-functioning Microadenoma < 10mm repeat in one year; if stable, repeat every 2-3 years (Lake, 2013)

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

- Tumor evaluation and monitoring in neurocutaneous syndromes – see background
- Follow of known pineal cyst (≥ 5mm) if there are atypical features or symptoms (e.g., headaches, gaze paresis, ataxia, papilledema, nausea/vomiting) (~~Jussila 2017;~~ Cauley, 2009; Jussila 2017)
- Follow of known arachnoid cyst (~~Mustansir, 2018;~~ Al-Holou, 2010, 2013; Mustansir, 2018)
  - < 4 years old, serial imaging is warranted
  - > 4 years old, repeat imaging only if symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction.

For screening for known Non-CNS Cancer - see background
(NCN~~CN~~CN, 201~~9~~20~~), see background)~~

- Default screening for
  - Kidney cancer
  - Lung cancer
  - Merkel cell carcinoma
  - Mucosal melanoma of the head and neck, especially of the oral cavity
  - Poorly differential neuroendocrine cancer (Large or Small cell/Unknown primary of neuroendocrine origin)
- Screening with preconditions
  - AML…… Suspicion of leukemic meningitis
  - Cutaneous melanoma……–…… Stage IIIC or higher
  - Testicular cancer-Seminoma…… High risk
  - Gestational Trophoblastic Neoplasia…… Pulmonary metastasis
  - Bladder cancer…… High risk, i.e., small cell
- All other cancer if CNS symptoms present

For screening of Hereditary Cancer Syndromes

- Li Fraumeni syndrome- Annually (Cureus, 2018)
- Von Hippel Lindau – ~~Annually~~Every 2 years, starting at age of 8 years (Rednam, 2017).
- Tuberous Sclerosis – Every 1-3 years, until the age of 25 years (Kreuger, 2013)
- MEN1 – Every 3-5 years, starting at the age of 5 years (Brandi, 2001)
- NF-2- Brain IAC: Annually starting, from age of 10 years (Evans, 2017)
- Sturge Weber Syndrome: Once, after age 1 to rule out intracranial involvement after; in patients <1 year, only if symptomatic (Comi, 2011).

Indications for combination studies for the initial pre-therapy staging of cancer, OR active monitoring for recurrence as clinically indicated, OR evaluation of suspected metastases: (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:
(ACR, 2019; Cendes, 2016; ~~Krumholz, 2007;~~ Gaillard, 2009; ~~Ramli, 2015) (ACR Sz, 2019; Cendes, 2016;~~ Ho, 2013; Krumholz, 2007;~~)~~ Ramli, 2015)

- New onset of an unprovoked seizure in adults
- Newly identified change in seizure activity/pattern
- Known seizure disorder without previous imaging
- Medically refractory epilepsy
- Imaging indications for new onset seizures in the pediatric population (Hirtz, 2000; Kimia, 2012; Sadeq, 2016; Sahikj, 2019~~; Hirtz, 2000; Kimia, 2012~~)
  - Abnormal neurological exam, especially a postictal focal deficit
  - Significant developmental delay
  - Focal onset
  - EEG shows focal or suspected structural abnormalities
  - <1 year of age

Note: Imaging is not indicated in simple febrile seizures

For evaluation of suspected multiple sclerosis (MS):
(CMSC, 2018; Thompson, 2017; Traboulsee, 2016~~; Thompson, 2017~~)

- For evaluation of patient with neurologic symptoms or deficits suspicious for MS with
  - A clinically isolated syndrome (optic neuritis, transverse myelitis or brain stem syndrome); **OR**
  - Recurrent episodes of variable neurological signs or symptoms not attributable to another cause
- To demonstrate dissemination in time for diagnosis (6-12 months for high risk, 12-24 months for low risk)

For evaluation of known multiple sclerosis (MS):
(CMSC, 2018)

- To establish a new baseline (no recent imaging, postpartum, or 6-12 months after switching disease modifying therapy)
- Prior to starting or switching disease-modifying therapy
- Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years
- New signs or symptoms suggested of an exacerbation or unexpected clinical worsening
- Progressive Multifocal ~~L~~Leukoencephalopathy (PML) ~~-~~surveillance for patients on natalizumab

For evaluation of known or suspected **infectious or** inflammatory disease (e.g., meningitis or abscess) (Lummel, 2016; Oliveira, 2014)

- Suspected intracranial abscess or brain infection with acute altered mental status or with 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 with 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~~or positive lab findings (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 (D'Souza, 2016; Diamantopoulos, 2014; Klink, 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

  ~~Note: vascular imaging is preferred for evaluation of the large vessels~~
- 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.

For evaluation of clinical assessment documenting cognitive impairment of unclear cause: (Harvey 2012; ~~Narayanan, 2016;~~ HQO, 2014; ~~Harvey 2012~~Narayanan, 2016)

- ~~Change in mental status~~M~~ with a m~~ental 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 known or suspected seizure disorder:**~~
~~(Krumholz, 2007; Gaillard, 2009; Ramli, 2015)~~
- ~~New onset of a seizure.~~
- ~~Newly identified change in seizure activity/pattern~~
- ~~Medically refractory epilepsy.~~

For evaluation of movement disorders:
(ACR, 2019a; Albanese, 2011; Mascalchi, 2012; McFarland, 2014; Pyatigorskaya, 2014; Sharifi, 2014)
- For evaluation of suspected Parkinson's with atypical feature or unresponsive to levodopa
- For evaluation of new non-Parkinson symptoms in known Parkinson's disease complicating the evaluation of the current condition.
- For the evaluation of other movement disorder to exclude a structural lesion (i.e., suspected Huntington disease, chorea, atypical parkinsonian syndromes, hemiballismus, atypical dystonia).

*Note: MRI not indicated in essential tremor or isolated focal dystonia (e.g., ~~blepharospam~~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)
- Optic neuritis
- Abnormal eye findings on physical or neurologic examination (papilledema, pathologic 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).
- Trigeminal Neuralgia – if <40 years of age or atypical features (ie bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain >2min, pain outside trigeminal nerve distribution, progression) (Cruccu, 2016)
- Bell's Palsy- if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset (Quesnel, 2010)
- Hemifacial spasm (Hermier, 2019)
- Other objective cranial nerve palsy (CN IX-XII) (ACR, 2017; Mumtaz, 2014; Policeni, 2017~~), ACR CN 2017))~~

~~**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:**~~
~~(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:**~~
~~(Lee, 2005; Jagoda, 2008; ACR, 2019, 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 positive x-ray.
- 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

1) For evaluation of headache:

(Holle, 2013; Edlow, 2008; Schaefer, 2007; Wilbrink, 2009; ACR, 2019, Gunner, 2007)

- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity, or duration).
- Once in patients with cluster headaches to eliminate secondary causes.
- 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 (ACR, 2019; 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.
History of cancer or significantly immunocompromised
Pregnancy
Temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery.
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 progressively 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:

(Kerjnick, 2008)

- 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
- 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 (Chase, 2011; NCCN, 2017).
- Known or suspected pituitary tumor with corroborating physical exam (i.e., galactorrhea or acromegaly) neurologic findings and/or lab abnormalities.
    - Asymptomatic Macroadenoma (≥ 10mm) follow up every 6-18 months, post-surgical follow up 1-2 years after surgery (Dekkers, 2008)
    - Asymptomatic, non-functioning Microadenoma < 10mm repeat in one year; if stable, repeat every 2-3 years (Lake, 2013)
- Tumor evaluation and monitoring in neurocutaneous syndromes – see background

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: (NCCN, 2017)

- ≤ 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)

- 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 (brother, sister, parent or child) of aneurysm

For evaluation of known or suspected inflammatory disease or infection (e.g., meningitis or abscess)
(Lummel, 2016; Oliveira, 2014)

- 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 a headache, altered mental status OR positive lab finding, (such as elevated WBC's).
- Endocarditis with suspected septic emboli.
- Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with positive lab findings.

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

(Ashwal, 2009; Vinocur, 2010)

- Known or suspected congenital abnormality with any ~~acute~~**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.
- Evaluation of microcephaly.
- ~~Suspected or known hydrocephalus.~~
- ~~Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms.~~
- ~~Initial imaging of a suspected or known Arnold Chiari malformation (ACM) (Meadows, 2000)~~
- ~~Initial evaluation for a known syrinx or syringomyelia~~
- Evaluation of craniosynostosis and other skull deformities. CT is preferred imaging to assess bony structures; MRI imaging is preferred to assess intracranial soft tissue
- Prior treatment OR treatment planned for congenital abnormality.
-

~~Acquired~~ **Cerebral Spinal Fluid (CSF) Abnormalities**

- **Suspected or known hydrocephalus***
- **Initial imaging of a suspected or known Arnold Chiari malformation ***
- **Initial evaluation for a known syrinx or syringomyelia***

- **Known or suspected normal pressure hydrocephalus (NPH) (Damasceno, 2015)**
  - ~~With symptoms of gait difficulty, cognitive disturbance and urinary incontinence~~
  - ~~Imaging of aquired hydrocephalus~~

  - ~~Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms.~~
  - **Follow up shunt evaluation (Kamenova, 2018; Pople, 2002, Reddy, 2014)** ~~(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.~~
- **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 (~~NORD, 2017;~~ Gordon 2019~~; NORD, 2017~~).**
- CSF flow study **for evaluation and management of CSF flow disorders (Bradley, 2016; Mohammad, 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.

~~**Indications for a Brain MRI with Internal Auditory Canal (IAC):**~~
~~(Labuguen, 2006)~~
- ~~Unilateral non-pulsatile tinnitus.~~
- ~~Pulsatile tinnitus.~~
- ~~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.~~
- ~~Suspected cholesteatoma.~~
- ~~Suspected glomus tumor.~~
- ~~Asymmetric sensorineural hearing loss on audiogram.~~

Other indications for a Brain MRI:
- Vertigo associated with any of the following **(Welgampola, 2019; Yamada, 2019**~~; Welgampola, 2019~~**)**~~:~~
    - 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 **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)**
- **Syncope with** ~~head injury,~~ **clinical concern for seizure or associated neurological signs or symptoms (Al-Nsoor, 2010; Strickberger, 2006)**

- Cyclical vomiting syndrome or abdominal migraine with ~~and with~~ any localizing neurological symptoms (~~Venkatesan, 2019; Li BUK, 2018;~~ Angus-Leppan, 2018; Li BUK, 2018; Venkatesan, 2019)
- Soft tissue mass of the head with nondiagnostic initial evaluation (ultrasound and/or radiograph) (ACR, 2017; Kim, 2019; Zhang, 2018) ~~(ACR, 2017; 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 (Ashwal, 2004; NICE, 2020) ~~(NICE, 2020, Ashwal, 200)~~
- 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

Indications for a Brain MRI with Internal Auditory Canal (IAC):
~~(Labuguen, 2006)~~

- Unilateral non-pulsatile tinnitus.
- Pulsatile tinnitus.
- 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.
- Suspected cholesteatoma.
- Suspected glomus tumor.
- Asymmetric sensorineural hearing loss on audiogram.
- 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)
- Bell's Palsy for evaluation of the extracranial nerve course -if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset (Quesnel, 2010)

Indications for combination studies: (ACR, 2017, 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 intracranial pathology.

- **Brain MRI/Neck MRA**
  - Recent ischemic stroke or transient ischemic attack
  - Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits

- **Brain MRI/Brain MRA**
  - Recent ischemic stroke or transient ischemic attack
  - ~~Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache~~
  - Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up (Whitehead, 2019, Yeh, 2010, Yuan, 2005):
    - Negative Brain CT; **AND**
    - ~~AND~~ Negative Lumbar Puncture
  - 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 MRV see background

- **Brain MRI/Brain MRA/Neck MRA**
  - Recent stroke or transient ischemic attack (TIA)
  - 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 vascular and intracranial pathology (Lawson, 2000).

- **Brain MRI/Cervical MRI**
  - For evaluation of Arnold Chiari Malformation.
  - Suspected MS with new or changing symptoms consistent with cervical spinal cord disease.
  - For follow-up of known multiple sclerosis (MS)
  - Follow up to the initiation or change in medication for patient with known Multiple Sclerosis

- **Brain MRI/Orbit MRI**
  - Unilateral papilledema 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 infitrative disorders (Behbehani, 2007)
  - ~~Bilateral optic disk swelling (papilledema) with visual loss (Margolin, 2019)~~
  -
  - Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset (CMSC, 2018)
  - Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent or bilateral optic neuritis (Wingerchuk, 2015)
  - ~~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").~~

- **Brain MRI/FACE/SINUS/NECK MRI**
  - Anosmia on objective testing (Policeni, 2017; Zaghouani, 2013)
  - Trigeminal neuralgia that meets the above criteria (**Hughes 2016;** Policeni, 2017~~, Hughes 2016~~)

- Bells/hemifacial spasm that meets above criteria
- Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course) (Mumtaz, 2014; Policeni, 2017)
- Granulomatosis with polyangiitis (Wegener's granulomatosis) disease (Pakalniskis, 2015)

BACKGROUND:
Brain (head) MRI is the procedure of choice for most brain disorders. It provides clear images of the brainstem and posterior brain, which are difficult to view on a CT scan. It is also useful for the diagnosis of demyelinating disorders (disorders such as multiple sclerosis (MS) that cause destruction of the myelin sheath of the nerve). The evaluation of blood flow and the flow of cerebrospinal fluid (CSF) is possible with this non-invasive procedure.

~~MRI for Headache -~~
MRI 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. Contrast enhanced MRI is performed for evaluation of inflammatory, infectious, neoplastic and demyelinating conditions.

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 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 headaches 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; Tyagi, 2012) ~~(Spierings, 2003; Jang 2019, IHS, 2018, ACR, 2012b, Tyagi, 2012)~~

Migraine with aura (Hadjikhani, 2019; IHS, 2018; Micieli, 2020) ~~(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.

MRI and 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 stoke evaluations take place in the inpatient setting. Admitting TIA patients is reasonable if they present within 72 hours and have an ABCD(2) score ≥~~>or=~~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 stoke 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.

MRI and Central Venous Thrombosis – a MV Venogram is indicted 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**).

MRI 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).**~~.~~ In neurocutaneous and hereditary cancer syndromes follow-up surveillance may also be indicted (see below).

Galactorrhea and MRI: Imaging is not indicated in isolated galactorrhea without elevated prolactin (normoprolactinemic) (Huang, 2012; Sridevi, 2018).

MRI and Meningioma (NHS, 2018) – For incidental meningiomas, most patients who progressed did 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 - MRI scan at 2½ years post-operatively
- Solitary skull base or falcine origin WHO Grade 1 meningiomas- MRI 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- MRI scan at 6 months, 1 then annually to 5 years. If a recurrence is detected continue annual scans.
- WHO Grade 3 meningiomas - 6-monthly MRI 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.

~~**MRI and staging in Non-CNS Cancers – as per NCCN guidelines**~~
~~-~~**MRI and staging screening in Non-CNS Cancers (NCCN, 2020)**

(NON BRAIN/CNS) CANCER	PRECONDITION
Cutaneous melanoma	Stage IIIC or higher, default staging screening

	≥~~>=~~ stage IIIC, surveillance with periodic brain MRI up to 3 years even if asymptomatic without prior brain mets; and if prior brain mets, surveillance every 3-6 months up to 3 years
Testicular cancer-Seminoma	If high risk such as beta HCG >5000IU/L, or multiple lung or visceral mets, choriocarcinoma, neurological symptoms, or AFP>10,000ng/ml
Merkel cell carcinoma	Default staging screening, but especially for high risk (≥~~>=~~stage IIIb, immunosuppression)
Lung cancer	Default staging screening ~~Brain MRI should also be done every 2 cycles of chemo and after end of therapy in extensive small cell with asymptomatic brain mets (receiving systemic therapy before whole brain radiation);~~ brain MRI also for surveillance in small cell every 3 months for 2 years if they have had no prophylactic cranial radiation

MRI and Neurocutaneous Syndromes – In ***NF-1***, clinical evaluation appears to be more useful to detect complications than is screening imaging in asymptomatic patients. Imaging is indicated in evaluation of suspected tumors based clinical evaluation and for follow-up of known intracranial tumors (Borofsky, 2013). Conversely in ***NF-2***, routine MR imaging screening is always indicated, given the high prevalence of CNS tumors especially vestibular schwannomas. In patients with NF-2, routine screening brain/IAC imaging is indicated annually starting from age 10 if asymptomatic or earlier with clinical signs/symptoms. Most individuals with NF2 eventually develop a spinal tumor, mostly commonly schwannomas, but meningioma and ependymomas are also seen Spinal imaging at baseline and every 2 to 3 years is also advised with more frequent imaging if warranted based on sites of tumor involvement (Evans, 2017). In patients with **Tuberous *Sclerosis***, Brain MRI should be obtained every 1-3 years up until age 25 for surveillance for CNS abnormalities (Krueger, 2013). In ***Von Hippel Lindau Syndrome,*** imaging of the brain and spinal cord for hemangioblastomas is recommended every 2 years (Rednam, 2017). In ***Sturge Weber Syndrome***, MRI can rule out intracranial involvement after only after age 1 and is recommended in patients <1 year only if symptomatic (Comi, 2011).

MRI and Positron Emission Tomography (PET) for Chronic Seizures – When MRI is performed in the evaluation of patients for epilepsy surgery, almost a third of those with electrographic evidence of temporal lobe epilepsy have normal MRI scans. Interictal positron emission tomography (PET) may be used to differentiate patients with MRI-negative temporal lobe epilepsy.

~~**MRI and Multiple Sclerosis –** Current advances in MRI improve the ability to diagnose, monitor and understand the pathophysiology of MS. Different magnetic resonance methods are sensitive to~~

~~different aspects of MS pathology and by the combining of these methods, an understanding of the mechanisms underlying MS may be increased.~~ **Multiple Sclerosis (Rovira, 2014;** ~~Thompson, 2017,~~ **Saguil, 2014; Thompson, 2017**~~, Rovira, 2014~~**)**

The diagnosis of MS requires demonstration of lesions in the CNS disseminated in time and space and the absence of fever, infection, or other more likely etiologies. There is an expanding amount of available disease-modifying treatments which are effective in slowing down disease progression especially in the early stages. Though they are expensive and can have serious side effects. Therefore, the accurate and expeditious diagnosis of MS is critical

The diagnosis of MS can be made on clinical presentation alone with 2 clinical attacks and objective clinical evidence of more than 2 lesions. Attacks may be patient-reported or objectively observed and must last for a minimum of 24 hours and be 30 days apart. However, corroborating magnetic resonance imaging (MRI) is the diagnostic standard and is used as well to rule out other disorders. Additionally, MRI findings can replace certain clinical criteria in a substantial number of patients. In the revised MC Donald Criteria, MRI findings can be used to establish dissemination in both time and space.

In the presence of a clear clinically isolated syndrome such as optic neuritis, transverse myelitis or brain stem syndrome brain MRI is the next diagnostic step. MS can also have variable and often subjective symptoms that come and go (see below). If there are recurrent episodes of variable neurological signs or symptoms not attributable to another cause with clinical concern for MS imaging is warranted as well.

Symptoms	Signs
Depressed mood	Ataxia
Memory loss/cognitive changes	Dysmetria
Dizziness or vertigo	Decreased sensation (pain, vibration, position)
Fatigue	Decreased strength
Hearing loss and tinnitus	Hyperreflexia, spasticity
Heat sensitivity (Uhthoff Phenomenon)	Nystagmus
Incoordination and gait disturbances	Lhermitte's sign
Pain	Visual defects (internuclear ophthalmoplegia, optic disc pallor, red color desaturation, reduced visual acuity)
Sensory disturbances (dysesthesias, numbness, paresthesias)	
Urinary symptoms	
Visual disturbances (diplopia, oscillopsia)	
Weakness	

MRI and Neuromyelitis optica spectrum disorders (NMOSD) (Wingerchuk, 2015) - NMOSD are inflammatory disorders of the central nervous system characterized by severe, immune-mediated demyelination and axonal damage predominantly affecting the optic nerves and spinal cord, but also the brain and brainstem. NMOSD can be distinguished from multiple sclerosis and other inflammatory disorders by the presence of the aquaporin-4 (AQP4) antibody. Features of NMOSD include attacks of bilateral or sequential optic neuritis ~~acute~~**acute** transverse myelitis and the area postrema syndrome (with intractable hiccups or nausea and vomiting). The evaluation of suspected NMOSD entails brain and spinal cord neuroimaging. In contrast to MS (in which spinal cord involvement tends to be incomplete and asymmetric), NMOSD have a longer extent of spinal cord demyelination generally involving three or more vertebral segments.

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.

MRI and Movement disorders - Atypical parkinsonian syndromes include progressive supranuclear palsy (PSP), multiple system atrophy (MSA), corticobasal degeneration (CBD), and dementia with Lewy bodies.

Anosmia - Nonstructural causes of anosmia include post viral symptoms, medications (Amitiptyline, Enalapril, Nifedipine, Propranolol, Penicillamine, Sumatriptan, Cisplatin, Triflouperazine, Propylthiouracil). These should be considered prior to advanced imaging to look for a structural cause **(Geyer, 2008)**~~.~~

MRI 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).

~~**MRI 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 y.o., whereas in older children >5 y.o, disability is quantifiable with IQ testing.~~

MRI 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 (Damasceno, 2015).

MRI 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.

MRI and developmental delay – Significant d~~evelopmental~~evelopmental 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~~.o.~~, whereas in older children >5 years~~.o~~, disability is quantifiable with IQ testing.

Low risk brief resolved unexplained event (BRUE) formerly apparent life-threatening event (ALTE) requires all the following:

- **Age > 60 days**
- **Gestational age ≥ ~~>~~32 weeks or older and corrected gestational age > 45 weeks**
- **First brief event**
- **Event lasting < 1 minute**
- **No CPR required by the trained medical provider**
- **No concerning historical features or physical examination findings.**

Combination MRI/MRA of the Brain – This is one of the most misused combination studies and other than what is indicated above these examinations should be ordered in sequence, not together. Vascular abnormalities can be visualized on the brain MRI.

Patients presenting with a new migraine with aura (especially an atypical or complex aura) can mimic a transient ischemic attack or an acute stroke. If there is a new neurologic deficit, imaging should be guided by concern for cerebrovascular disease, not that the patient has a headache (Whitehead, 2019).

POLICY HISTORY
Review Date: August 2019
Review Summary:

- For evaluation of patient with neurologic symptoms or deficits suspicious for MS: Added: "clinically isolated syndrome OR recurrent episodes of variable neurological signs or symptoms not attributable to another cause; And Removed time frame of 'within the last 4 weeks'
- Removed: Stable condition with no prior imaging within the past ten (10) months or within the past six (6) months if patient has relapsing disease
- Removed**:** Exacerbation of symptoms or change in symptom characteristics such as frequency or type and demonstrated compliance with medical therapy.
- For evaluation of MS, added:
    - To establish a new baseline (no recent imaging, postpartum, or 6-12 months after switching disease modifying therapy)
    - Prior to starting or switching disease-modifying therapy
    - Every 1-2 years while on disease-modifying therapy to assess for subclinical disease activity, less frequently when stable for 2-3 years
    - New signs or symptoms suggested of an exacerbation or unexpected clinical worsening
    - PML surveillance for patients on natalizumab
- For evaluation of known or suspected seizure disorder, added:
    - Newly identified change in seizure activity/pattern
- Renamed Parkinson's section to: Movement disorders and added:

    - For the evaluation of other movement disorder to exclude a structural lesion (i.e., suspected Huntington disease, chorea, atypical parkinsonian syndromes, hemiballismus, secondary dystonia).
    - * MRI not indicated in essential tremor or primary dystonia
    - For suspected Parkinson's, added 'with atypical feature or unresponsive to levodopa
- 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
- For evaluation of headache, added or removed:
    - Prior history of stroke or intracranial bleed with sudden onset of severe headache (moved)
    - New headache and signs of increased intracranial pressure
    - Related to activity or event (sexual activity, exertion, position) (new or progressively worsening)
    - New headache 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
- 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; and tumor evaluation and monitoring in neurocutaneous syndromes
    - 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'
- For known or suspected normal pressure hydrocephalus (NPH):
  - Added - With symptoms of gait difficulty, cognitive disturbance and urinary incontinence
- Other Indications:
  - Added detail to Vertigo 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:
    - Horner's syndrome with symptoms localizing the lesion to the central nervous system
    - Trigeminal Neuralgia – if <40 years of age or atypical features (ie bilateral, hearing loss, dizziness/vertigo, visual changes, sensory loss, numbness, pain >2min, pain outside trigeminal nerve distribution, progression)
    - Bell's Palsy- if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset.
    - Psychological changes with neurological deficits on exam or after completion of a full neurological assessment that suggests a possible neurologic cause
    - New onset anisocoria
  - Removed Objective cranial nerve palsy; and Cholesteatoma (duplicated)

- For Brain MRI/Neck MRA: deleted 'confirmed carotid occlusion > 60%, surgery or angioplasty candidate' and added 'Suspected carotid or vertebral artery dissection with focal or lateralizing neurological deficits'

- Added Brain MRI/Brain MRA section, including: Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache; and Suspected venous thrombosis (dural sinus thrombosis)

- Added Brain MRI/Brain MRA/Neck MRA 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 *vascular* and intracranial pathology

- For Brain MRI/Cervical MRI, added: Suspected MS with new or changing symptoms consistent with cervical spinal cord disease; and Follow up to the initiation or change in medication for patient with known Multiple Sclerosis

- For Brain MRI/Orbit MRI, added: Bilateral papilledema with visual loss; and Known or suspected neuromyelitis optica spectrum disorder with severe, recurrent or bilateral optic neuritis; 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

- Added section for Brain MRI/Face/Sinus/Neck MRI, including: Anosmia on objective testing; and Trigeminal neuralgia or cranial nerve palsy that meets the above criteria

- 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**
- **For evaluation of known or suspected stroke or vascular disease:**
- **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**

Clarified:

- 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
- New onset of an unprovoked seizure in adults
- 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

Clarified:

- Anosmia (loss of smell) documented by objective testing that is persistent and of unknown origin
- Chiari malformation/syrinx Often congenital, but can present later in life; or less commonly acquired secondary to tumor, stroke, trauma, infection etc.
- 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)

Added:

- 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

Added:

- Suspected Pituitary Tumors:
  - With the following:
    - Neurologic findings (e.g. visual field deficit suggesting compression of the optic chiasm)
    - Suspected hypofunctioning pituitary gland based on hormonal testing e.g., hypo pituitarism, growth hormone deficiency, hypogonadotropic hypogonadism [i.e. low gonadotropins (FSH/LH) and sex hormones*]

    * severe secondary hypogonadism with total testosterone persistently < 150 and low or normal LH/FSH OR

    * testosterone levels below normal range with low or normal LH/FSH AND
      - neurological sign and symptoms OR
      - other pituitary hormonal abnormalities OR
      - consideration of reversible functional causes of gonadotropin suppression (e.g. obesity, opioid use, or comorbid illness)

Added:

  - Suspected hyperfunctioning pituitary gland based on hormonal testing i.e., central hyperthyroidism (high TSH), Cushing disease (high ACTH), acromegaly/gigantism (high GH/IGF-1) or elevated prolactin (>250 ng/mL or persistently elevated in the absence of another cause eg. stress, pregnancy, hypothyroidism, medication)
  - Note: Galactorrhea without elevated prolactin, imaging is not indicated
  - Central Diabetes Insipidus (low ADH)
  - Precocious puberty in a child (male < 9; female < 8), with hormonal studies suggesting a central cause and evidence of an accelerated bone age on X-ray
  - Pituitary apoplexy with sudden onset of neurological and hormonal symptoms
- Suspected recurrence with prior history of CNS cancer based on neurological symptoms or examination

Added:

- Follow up of known meningioma

- 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)

- Follow-up known of pituitary adenoma
  - New signs or symptoms
  - Functioning adenoma - to assess response to treatment and 1-year follow-up after drug holiday

Added:

- Follow of known pineal cyst (> 5mm) if there are atypical features or symptoms (e.g., headaches, gaze paresis, ataxia, papilledema, nausea/vomiting)
- Follow of known arachnoid cyst
  - < 4 years old, serial imaging is warranted
  - > 4 years old, repeat imaging only if symptomatic i.e. headaches, increased intracranial pressure, hydrocephalus, local mass effect, seizures, visual/endocrine dysfunction
- For screening for known Non-CNS Cancer
  - Default screening for
    - Kidney cancer
    - Lung cancer
    - Merkel cell carcinoma

Added:

  - Mucosal melanoma of the head and neck, especially of the oral cavity
  - Poorly differential neuroendocrine cancer (Large or Small cell/Unknown primary of neuroendocrine origin)

- Screening with preconditions
  - AML — Suspicion of leukemic meningitis
  - Cutaneous melanoma — Stage IIIC or higher
  - Testicular Cancer-Seminoma — High risk
  - Gestational Trophoblastic Neoplasia — Pulmonary metastasis
  - Bladder cancer — High risk, i.e. small cell
  - All other cancer if CNS symptoms present

Added:

- For screening of Hereditary Cancer Syndromes
  - Li Fraumeni syndrome- Annually
  - Von Hippel Lindau – Every 2 years, starting at age of 8 years
  - Tuberous Sclerosis – Every 1-3 years, until the age of 25 years
  - MEN1 – Every 3-5 years, starting at the age of 5 years
  - NF-2- Brain IAC: Annually starting, from age of 10 years

    - Sturge Weber Syndrome: Once, after age 1 to rule out intracranial involvement after; in patients <1 year, only if symptomatic
- Known seizure disorder without previous imaging

Added:

- Imaging indications for new onset seizures in the pediatric population
    - Abnormal neurological exam, especially a postictal focal deficit
    - Significant developmental delay
    - Focal onset
    - EEG shows focal or suspected structural abnormalities
    - <1 year of age

  Note: Imaging is not indicated in simple febrile seizures
- Suspected temporal arteritis in a patient > 50 with temporal headache, abrupt visual changes, jaw claudication, temporal artery tenderness, constitutional symptoms or elevated ESR 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

Added:

- MRI indicted for atypical dystonia. Note: MRI not indicated in essential tremor or isolated focal dystonia (e.g., blepharospasm, cervical dystonia, laryngeal dystonia, oromandibular dystonia, writer's dystonia)
- Binocular diplopia with concern for intracranial pathology
- Hemifacial spasm
- Other objective cranial nerve palsy (CN IX-XII)
- 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

Added:

- Suspected spontaneous intra-cranial hypotension with distinct postural headache other symptoms include: nausea, vomiting, dizziness, tinnitus, diplopia neck pain or imbalance
- CSF flow study for evaluation and management of CSF flow disorders
- 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)

Added:

- 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
- Under Indications for a Brain MRI with Internal Auditory Canal (IAC):
  - CSF otorrhea (MRI for intermittent leak, CT for active leaks)
  - 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)
  - Bell's Palsy for evaluation of the extracranial nerve course - if atypical signs, slow resolution beyond three weeks, no improvement at four months, or facial twitching/spasms prior to onset

Added:

- Combo Brain MRI/MRA
  - Thunderclap headache with continued concern for underlying vascular abnormality after initial negative work-up
    - Negative Brain CT;
    - AND Negative Lumbar Puncture
  - Acute, sudden onset of headache with personal history of a vascular abnormality or first-degree family history of aneurysm
- Combo Brain MRI/Orbit MRI
    - Optic Neuritis if atypical presentation, severe visual impairment or poor recovery following initial onset or treatment onset
- Combo Brain MRI/Face/Sinus/Neck MRI
  - Bells/hemifacial spasm that meets above criteria
  - Objective cranial nerve palsy (CN IX-XII) (for evaluation of the extracranial nerve course
  - Granulomatosis with polyangiitis (Wegener's granulomatosis) disease

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 or suspected pituitary tumor with corroborating physical exam (i.e., galactorrhea or acromegaly) neurologic findings and/or lab abnormalities.

- **Known brain tumor and new onset of headache.**
- **Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms**
- **From combo Brain MRI/MRA Clinical suspicion of subarachnoid hemorrhage (SAH) ie thunderclap headache**

REFERENCES

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.~~

~~Agostoni E, Aliprandi A, Logoni, M. Cerebral venous thrombosis. *Expert Rev Neurother*. April 2009; 9(4):553-564.~~

~~ACR Appropriateness Criteria® - Acute Mental Status Change, Delirium, and New Onset Psychosis. 2019b.~~**Al-Holou WN, Terman S, Kilburg C, Garton HJ, Muraszko KM, Maher CO. Prevalence and natural history of arachnoid cysts in adults. J Neurosurg. 2013 Feb; 118(2):222-31. Epub 2012 Nov 9.**

Al-Holou WN, Yew AY, Boomsaad ZE, Garton HJ, Muraszko KM, Maher CO. Prevalence and natural history of arachnoid cysts in children. *J Neurosurg Pediatr*. 2010 Jun; 5(6):578-85. doi: 10.3171/2010.2.PEDS09464.

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.

American Association of Neurological Surgeons (AANS). 2020 May 20. https://www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/Brain-Tumors.

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

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

American College of Radiology ACR Appropriateness Criteria® - Cerebrovascular Disease–Child 2019.

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

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

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

~~ACR Appropriateness Criteria® - Headache. 2019.~~

~~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.~~

~~American College of Radiology ACR Appropriateness Criteria® - Cerebrovascular Disease 2017.~~

~~American College of Radiology ACR Appropriateness Criteria® - Cerebrovascular Disease-Child 2019.~~

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® - Focal Neurologic Deficit. https://acsearch.acr.org/list. 2012a.

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

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

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

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

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

~~American College of Radiology ACR Appropriateness Criteria® Cranial Neuropathy 2017https://acsearch.acr.org/docs/69509/Narrative~~

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.

Ashwal S, Russman BS, Blasco PA, et al. Practice parameter: Diagnostic assessment of the child with cerebral palsy: report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. Neurology. 2004; 62(6):851.

Atluri S, Sarathi V, Goel A, et al. Etiological profile of galactorrhoea. *Indian J Endocrinol Metab*. 2018 Jul-Aug; 22(4):489-93.

Battaglia A. Neuroimaging studies in the evaluation of developmental delay/mental retardation. *Am J Med Genet C Semin Med Genet.* 2003 Feb 15; 117C(1):25-30.

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

Bhasin S, Brito JP, Cunningham GR, et al. Testosterone Therapy in Men with Hypogonadism: An Endocrine Society Clinical Practice Guideline. J Clin Endocrinol Metab. 2018 May; 103(5):1715–1744. doi: 10.1210/jc.2018-00229.

Borofsky S, Levy LM. Neurofibromatosis: Types 1 and 2. *Am J Neuroradiol*. 2013 Dec; 34(12): **2250-2251.**

Brandi ML, Gagel RF, Angeli A, et al. Consensus: Guidelines for diagnosis and therapy of MEN type 1 and type 2. *J Clin Endocrinol Metab*. 2001; 86(12):5658–5671.

Bradley WG Jr. Magnetic resonance imaging of normal pressure hydrocephalus. *Semin Ultrasound CT MR*. 2016; 37(2):120-128.

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

Casanueva FF, Molitch ME, Schlechte JA, et al. Guidelines of the Pituitary Society for the diagnosis and management of prolactinomas. *Clin Endocrinol (Oxf).* 2006; 65(2):265.

Cauley KA, Linnell GJ, Braff SP, et al. Serial follow-up MRI of indeterminate cystic lesions of the pineal region: experience at a rural tertiary care referral center. *AJR Am J Roentgenol*. 2009; 193(2):533.

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.

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

Comi AM. Presentation, diagnosis, pathophysiology, and treatment of the neurological features of Sturge-Weber syndrome. *Neurologist*. 2011; 17(4):179.

Consortium of Multiple Sclerosis Centers (CMSC). 2018 Revised Guidelines of the Consortium of MS Centers MRI Protocol for the Diagnosis and Follow-Up of MS. 2018.

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

Cruccu G, Finnerup NB, Jensen TS, et al. Trigeminal neuralgia: New classification and diagnostic grading for practice and research. *Neurology*. 2016; 87(2):220–228.

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

Dekkers OM, Pereira AM, Romijn JA. Treatment and follow-up of clinically nonfunctioning pituitary macroadenomas. *J Clin Endocrinol Metab*. 2008; 93(10): 3717–3726.

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.

Doty RL. Olfactory dysfunction and its measurement in the clinic. World J Otorhinolaryngol Head Neck Surg. 2015 Sep; 1(1):28e33.

D'Souza NM, Morgan ML, Almarzouqi SJ, et al. Magnetic resonance imaging findings in giant cell arteritis. *Eye (Lond).* 2016; 30(5):758-762. doi:10.1038/eye.2016.19.

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.

Evans DGR, Salvador H, Chang VY, et al. Cancer and Central Nervous System Tumor Surveillance in Pediatric Neurofibromatosis 2 and Related Disorders. *Clin Cancer Res*. 2017; 23(12):e54.

Faizah M, Zuhanis A, Rahmah R, et al. Precocious puberty in children: A review of imaging findings. *Biomed Imaging Interv J*. 2012 ;8(1):e6. doi:10.2349/biij.8.1.e6.

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.

~~Edlow JA, Panagos PD, Godwin SA, et al. Clinical policy: Critical issues in the evaluation and management of adult patients presenting to the emergency department with acute headache. *Ann Emerg Med*. 2008; 52(4):407-36. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC3002614/.~~

~~Evans DGR, Salvador H, Chang VY, et al. Cancer and Central Nervous System Tumor Surveillance in Pediatric Neurofibromatosis 2 and Related Disorders. *Clin Cancer Res*. 2017; 23(12):e54.~~

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.

Freda P, Beckers AM, Katznelson L, et al. Pituitary Incidentaloma: An Endocrine Society Clinical Practice Guideline. *J Clin Endocrinol Metab*. 2011 Apr 1; 96(4):894–904. https://doi.org/10.1210/jc.2010-1048.

Gaillard WD, Chiron C, Cross JH, et al. Guidelines for imaging infants and children with recent-onset epilepsy. *Epilepsia*. 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).

Gofshteyn J, Stephenson DJ. Diagnosis and Management of Childhood Headache. *Curr Prob Pediatr Adolesc Health Care*. 2016; 46:36-51.

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

Growth Hormone Research Society (GHRS). Consensus guidelines for the diagnosis and treatment of growth hormone (GH) deficiency in childhood and adolescence: summary statement of the GH Research Society. *J Clin Endocrinol Metab*. 2000; 85(11):3990.

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.

Hamilton K. Secondary Headaches During Pregnancy and the Postpartum Period. *Pract Neurol*. 2020 May; 63.

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

~~Gilden DH. Clinical practice. Bell's palsy. *N Engl J Med*. 2004 Sep 23; 351(13):1323-31.~~

~~Goh BT, Poon CY, Peck RH. The importance of routine magnetic resonance imaging in trigeminal neuralgia diagnosis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2001 Oct; 92(4):424-9.~~

~~Gunner KB, Smith HD. Practice guideline for diagnosis and management of migraine headaches in children and adolescents: Part one. *J Pediatr Health Care*. October 2007. http://www.jpedhc.org/article/S0891-5245(07)00218-0/abstract.~~

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.* 2014; 14(1):1-64. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3937983/4 Feb 1. Accessed June 18, 2017.

Heckmann JG, Heckmann SM, Lang CJG, et al. Neurological Aspects of Taste Disorders. *Arch Neurol*. 2003; 60(5):667–671. doi:10.1001/archneur.60.5.667.

Hermier M. Imaging of hemifacial spasm. Neurochirurgie. 2018 May; 64(2):117-123. Epub 2018 Apr 26.

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.

Hirtz D, Ashwal S, Berg A, et al. Practice parameter: Evaluating a first nonfebrile seizure in children: Report of the quality standards subcommittee of the American Academy of Neurology, the Child Neurology Society, and the American Epilepsy Society. *Neurology*. 2000 Sep 12; 55;616-623.

Ho K, Lawn N, Bynevelt M, et al. Neuroimaging of first-ever seizure: Contribution of MRI if CT is normal. *Neurol Clin Pract*. 2013; 3(5):398–403. doi:10.1212/CPJ.0b013e3182a78f25.

Holle D, Obermann, M. The role of neuroimaging in the diagnosis of headaches disorders. *Ther Advances in Neurol Disorders*. 2013; 6(6):369-74.

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.

~~Holle D, Obermann, M. The role of neuroimaging in the diagnosis of headaches disorders. *Ther Advances in Neurol Disorders*. 2013; 6(6):369-74.~~Huang W, Molitch ME. Evaluation and Management of Galactorrhea. *Am Fam Physician*. 2012 Jun 1; 85(11):1073-1080.

Hughes MA, Frederickson AM, Branstetter BF, et al. MRI of the trigeminal nerve in patients with trigeminal neuralgia secondary to vascular compression. *Am J Roentgenol*. 2016; 206:595-600.

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

International Headache Society (HIS). 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.

Jafrani R, Raskin JS, Kaufman A, et al. Intracranial arachnoid cysts: Pediatric neurosurgery update. Surg Neurol Int. 2019 Feb 6; 10:15. Epub 2019.

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; 52:714-748. 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.

Jasmin M. Dao1 & William Qubty. Headache Diagnosis in Children and Adolescents. Curr Pain Headache Rep. 2018; 22:17.

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.

Jussila MP, Olsén P, Salokorpi N, et al. Follow-up of pineal cysts in children: Is it necessary? *Neuroradiol*. 2017 Dec; 59(12):1265-1273.

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.

Kannan S, Kennedy L. Diagnosis of acromegaly: State of the art. Expert Opin Med Diagn. 2013; 7(5):443. Epub 2013 Jul 31.

Kaplowitz PB. Do 6-8 year old girls with central precocious puberty need routine brain imaging? *Int J Pediatr Endocrinol*. 2016; 2016:9. doi: 10.1186/s13633-016-0027-5.

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.

Kimia AA, Ben-Joseph E, Prabhu S, et al. Yield of emergent neuroimaging among children presenting with a first complex febrile seizure. *Pediatr Emerg Care*. 2012 Apr; 28(4):316-21.

Klink T, Geiger J, Both M, et al. Giant cell arteritis: Diagnostic accuracy of MR imaging of superficial cranial arteries in initial diagnosis-results from a multicenter trial. *Radiology*. 2014; 273(3):844-852. doi:10.1148/radiol.14140056.

Krueger DA, Northrup H. International Tuberous Sclerosis Complex Consensus Group. Tuberous sclerosis complex surveillance and management: Recommendations of the 2012 International Tuberous Sclerosis Complex Consensus Conference. *Pediatr Neurol*. 2013; 49(4):255.

~~Krueger DA, Northrup H, International Tuberous Sclerosis Complex Consensus Group. Tuberous sclerosis complex surveillance and management: Recommendations of the 2012 International Tuberous Sclerosis Complex Consensus Conference. *Pediatr Neurol*. 2013; 49(4):255.~~

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.

Kumar P, Gill RM, Phelps A, et al. Surveillance Screening in Li-Fraumeni Syndrome: Raising Awareness of False Positives. *Cureus*. 2018 Apr; 10(4): e2527.

Kuruvilla 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).

~~Lee B, Newberg A. Neuroimaging in traumatic brain imaging. *NeuroRx*. April 2005; 2(2):372-383.~~

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*. March 11, 2014; 82(10):835-841. doi: 10.1212/WNL.0000000000000188.

Majumdar A, Mangal NS. Hyperprolactinemia. *J Hum Reprod Sci*. 2013; 6(3):168-175. doi:10.4103/0974-1208.121400.

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

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 Feb; 35(2):239-56.

McFarland NR. Diagnostic approach to atypical parkinsonian syndromes. *Continuum (Minneap Minn).* 2016 Aug; 22(4 Movement Disorders):1117-42.

Micieli A, Kingston W. An Approach to Identifying Headache Patients That Require Neuroimaging. *Front Public Health*. 2019 Mar 15; 7:52.

~~Meadows J, Kraut M, Guarnieri M, et al. Asymptomatic Chiari type I malformations identified on magnetic resonance imaging. *J Neurosurg*. 2000; 92:920-926.~~

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.

Mohammad SA, Osman NM, Ahmed KA. The value of CSF flow studies in the management of CSF disorders in children: A pictorial review. *Insights Imaging*. 2019; 10:3.

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

Mumtaz S, Jensen MB. Facial neuropathy with imaging enhancement of the facial nerve: A case report. *Future Neurol*. 2014; 9(6):571-576. doi:10.2217/fnl.14.55.

Mustansir F, Bashir S, Darbar A. Management of Arachnoid Cysts: A Comprehensive Review. Cureus. 2018; 10(4):e2458. Published 2018 Apr 10. doi:10.7759/cureus.2458.

Nahas SJ, Whitehead MT. New Guidelines on headache imaging - NEJM J Watch. *J Am Coll Radiol*. 2019 Nov.

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 ~~2017~~**2020**. Accessed ~~June~~ **May 20**~~18~~, ~~2017~~**2020**.

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/.

National Organization for Rare Disorders (NORD). Rare Disease Database – Spontaneous Intracranial Hypotension. 2017. https://rarediseases.org/rare-diseases/spontaneous-intracranial-hypotension/.

Oliveira CR, Morriss MC, Mistrot JG, et al. Brain magnetic resonance imaging of infants with bacterial meningitis. *J Pediatr*. July 2014; 165(1):134-139.

Pakalniskis MG, Berg AD, Policeni BA, et al. The many faces of granulomatosis with polyangiitis: A review of the head and neck imaging manifestations. *Am J Roentgenol.* 2015; 205:W619-W629.

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. *Ahhn 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 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.

~~Polinder, S et al A Multidimensional Approach to Post-concussion Symptoms in Mild Traumatic Brain Injury. Front. Neurol., 19 December 2018 | https://doi.org/10.3389/fneur.2018.01113~~

Pyatigorskaya N, Gallea C, Garcia-Lorenzo D, et al. A review of the use of magnetic resonance imaging in Parkinson's disease. *Ther Adv Neurol Disord*. July 2014; 7(4):206-220.

Quesnel AM, Lindsay RW, Hadlock TA. When the bell tolls on Bell's palsy: Finding occult malignancy in acute-onset facial paralysis. Am J Otolaryngol. 2010 Sep-Oct; 31(5):339-42. Epub 2009 Jun 24.

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.

Rednam SP, Erez A, Druker H, et al. von hippel-lindau and hereditary pheochromocytoma/paraganglioma syndromes: Clinical features, genetics, and surveillance recommendations in childhood. *Clin Cancer Res*. 2017; 23(12):e68.

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.

Rovira À, Wattjes M, Tintoré M, et al. MAGNIMS consensus guidelines on the use of MRI in multiple sclerosis—clinical implementation in the diagnostic process. Nat Rev Neurol. 2015; 11: 471–482. https://doi.org/10.1038/nrneurol.2015.106.

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.

Sadeq H, Karim J, Marwan Y, et al. Neuroimaging Evaluation for First Attack of Unprovoked Nonfebrile Seizure in Pediatrics: When to Order? *Med Princ Pract*. 2016; 25:56-60. doi: 10.1159/000441847.

Saguil A, Kane S, Farnell E. Multiple sclerosis: A primary care perspective. *Am Fam Physician*. 2014; 90(9):644-652.

Salehi AI. 2016 ACR Revised Criteria for Early Diagnosis of Giant Cell (Temporal) Arteritis. Autoimmune Diseases and Therapeutic Approaches. *Open Access*. 2016; 3:119-122.

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.

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/.

Shaikh Z, Torres A, Takeoka M. Neuroimaging in Pediatric Epilepsy. *Brain Sci.* 2019; 9(8):190.

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.

Shobeiri E, Torabinejad B. Brain magnetic resonance imaging findings in postpartum headache. *Neuroradiol J*. 2019; 32(1):4-9. doi:10.1177/1971400918804193.

Silberstein SD. Practice parameter: Evidence-based guidelines for migraine headache (an evidence-based review): Report of the Quality Standards Subcommittee of the American Academy of Neurology. *Neurology*. 2000; 55(6):754. http://www.neurology.org/content/55/6/754.long.

~~Silva GS, Vicari P, Figueiredo S, et al. Brain magnetic resonance imaging abnormalities in adult patients with sickle cell disease: Correlation with transcanial Doppler findings. [Published online ahead of print May 14, 2009]. Stroke. 2009. doi: 10.1161/STROKEAHA.108.537415.~~

Smith R, Leonidas JC, Maytal J SO. The value of head ultrasound in infants with macrocephaly. *Pediatr Radiol*. 1998; 28(3):143.

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

Stoller JK, Nielsen C, Buccola J, et al. The Cleveland Clinic Intensive Review of Internal Medicine. Pituitary Tumor. 6th Ed; 2015 Wolters Kluwer.

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*. January 17, 2006; 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.

Thangam V, 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. 2019 Mar. DOI: 10.1111/nmo.13604.

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

Thompson AJ, Banwell BL, Barkhof F, et al. Diagnosis of multiple sclerosis: 2017 revisions of the McDonald criteria. *Lancet Neurol*. 2018; 17:162-73.

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.**

Traboulsee A, Simon JH, Stone L, et al. Revised recommendation of the Consortium of MS Centers Task Force for a standardized MRI protocol and clinical guidelines for the diagnosis and follow-up of multiple sclerosis. *Am J Neuroradiol*. 2016 Mar; 37(3):398-401.

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

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

~~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.~~

~~Valvassori GE, Palacios E. Magnetic resonance imaging of the internal auditory canal. *Top Magn Reson Imaging*. 2000; 11:52-65.~~

Vinocur DN and 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.

Wallace AN, McConathy J, Menias CO, et al. Imaging evaluation of CSF shunts. *Am J Roentgenol*. 2014; 202:38-53. 10.2214/AJR.12.10270.

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

Whitehead MT, Cardenas AM, Corey AS, et al. ACR Appropriateness Criteria® - Headache. *J Am Coll Radiol.* 2019; 16:S364-S377.

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.

Wingerchuk DM, Banwell B, Bennett JL, et al. International consensus diagnostic criteria for neuromyelitis optica spectrum disorders. *Neurology*. 2015; 85:177.

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.

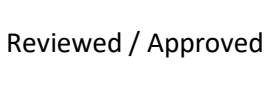
Yamada S, Yasui K, Kawakami Y, et al. DEFENSIVE Stroke Scale: Novel diagnostic tool for predicting posterior circulation infarction in the emergency department. *J Stroke Cerebrovasc Dis*. 2019 Jun; 28(6):1561-70.

Yeh YC, Fuh JL, Chen SP, et al. Clinical features, imaging findings and outcomes of headache associated with sexual activity. Cephalalgia. 2010 Nov; 30(11):1329-35.

Yuan MK, Lai PH, Chen JY, et al. Detection of subarachnoid hemorrhage at acute and subacute/chronic stages: Comparison of four magnetic resonance imaging pulse sequences and computed tomography. J Chin Med Assoc. 2005 Mar; 68(3):131-7.

Zaghouani H, Slim I, Zina NB, et al. Kallmann syndrome: MRI findings. *Indian J Endocrinol Metab*. 2013; 17(Suppl 1):S142–S145.

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.

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

~~Reviewed / Approved by~~  ~~Patrick Browning, VP, Medical Director~~

~~New References~~

~~Adam N. Wallace, Jonathan McConathy, Christine O. Menias, Sanjeev Bhalla, Franz J. Wippold. Review. Imaging Evaluation of CSF Shunts. *American Journal of Roentgenol*ogy. 2014;202:38-53. 10.2214/AJR.12.10270~~

~~Al-Holou WN, Terman S, Kilburg C, Garton HJ, Muraszko KM, Maher CO. Prevalence and natural history of arachnoid cysts in adults. J Neurosurg. 2013 Feb;118(2):222-31. Epub 2012 Nov 9.~~

~~Al-Holou WN1, Yew AY, Boomsaad ZE, Garton HJ, Muraszko KM, Maher CO. Prevalence and natural history of arachnoid cysts in children. *J Neurosurg Pediatr*. 2010 Jun;5(6):578-85. doi: 10.3171/2010.2.PEDS09464.~~

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

~~American Association of Neurological Surgeons. 5/20/20 https://www.aans.org/Patients/Neurosurgical-Conditions-and-Treatments/Brain-Tumors~~

~~American College of Radiology ACR Appropriateness Criteria® Soft Tissue Masse 2017 https://acsearch.acr.org/docs/69434/Narrative/~~

~~American College of Radiology ACR Appropriateness Criteria® Neuroendocrine Imaging 2018~~

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

~~Angus-Leppan Heather, Saatci Defne, Sutcliffe Alastair, Guiloff Roberto J. Abdominal migraine BMJ 2018; 360 :k179~~

~~Brandi ML, Gagel RF, Angeli A, et al. Consensus: Guidelines for diagnosis and therapy of MEN type 1 and type 2. J Clin Endocrinol Metab 2001;86(12):5658–5671.~~

~~Casanueva FF, Molitch ME, Schlechte JA, Abs R, Bonert V, Bronstein MD, Brue T, Cappabianca P, Colao A, Fahlbusch R, Fideleff H, Hadani M, Kelly P, Kleinberg D, Laws E, Marek J, Scanlon M,~~

Sobrinho LG, Wass JA, Giustina A. Guidelines of the Pituitary Society for the diagnosis and management of prolactinomas. Clin Endocrinol (Oxf). 2006;65(2):265

Cauley KA, Linnell GJ, Braff SP, Filippi CG. Serial follow-up MRI of indeterminate cystic lesions of the pineal region: experience at a rural tertiary care referral center. AJR Am J Roentgenol. 2009;193(2):533.

Cendes F, Theodore WH, Brinkmann BH, Sulc V, Cascino GD. Neuroimaging of epilepsy. Handb Clin Neurol 2016;136:985-1014.

Comella Cynthia L., MD, Cervical Dystonia. Rare Disease Database 2019

Consensus guidelines for the diagnosis and treatment of growth hormone (GH) deficiency in childhood and adolescence: summary statement of the GH Research Society. GH Research Society. Growth Hormone Research Society J Clin Endocrinol Metab. 2000;85(11):3990.

Cureus. 2018 Apr; 10(4): e2527. Surveillance Screening in Li-Fraumeni Syndrome: Raising Awareness of False Positives Prerna Kumar, 1 Ryan M Gill,2 Andrew Phelps,3 Asmin Tulpule,4 Katherine Matthay,1 and Theodore Nicolaides5

Doty* Richard Olfactory dysfunction and its measurement in the clinic. World Journal of Otorhinolaryngology-Head and Neck Surgery (2015) 1, 28e33

Easton JD, Saver JL, Albers GW, Alberts MJ, Chaturvedi S, Feldmann E, Hatsukami TS, Higashida RT, Johnston SC, Kidwell CS, Lutsep HL, Miller E, Sacco RL. 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. Crossref. PubMed.

Evans DGR, Salvador H, Chang VY, et al. Cancer and Central Nervous System Tumor Surveillance in Pediatric Neurofibromatosis 2 and Related Disorders. Clin Cancer Res. 2017; 23(12):e54.

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

Freda, Pamela. Albert M. Beckers, Laurence Katznelson, Mark E. Molitch, Victor M. Montori, Kalmon D. Post, Mary Lee Vance . Pituitary Incidentaloma: An Endocrine Society Clinical Practice Guideline. The Journal of Clinical Endocrinology & Metabolism, Volume 96, Issue 4, 1 April 2011, Pages 894–904, https://doi.org/10.1210/jc.2010-1048

Geyer, M., Nilssen E. Evidence-based management of a patient with anosmia. *Clinical Otolaryngology*. 2008, Vol 33. Issue 5.

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

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

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

Heckmann JG, Heckmann SM, Lang CJG, Hummel T. Neurological Aspects of Taste Disorders. Arch Neurol. 2003;60(5):667–671. doi:10.1001/archneur.60.5.667

Ho K, Lawn N, Bynevelt M, Lee J, Dunne J. Neuroimaging of first-ever seizure: Contribution of MRI if CT is normal. Neurol Clin Pract. 2013;3(5):398–403. doi:10.1212/CPJ.0b013e3182a78f25

Hong KS, Yegiaian S, Lee M, Lee J, Saver JL. 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. Review. PubMed PMID: 21536995; PubMed Central PMCID: PMC3118516.

https://rarediseases.org/rare-diseases/chiari-malformations/ Chiari Malformations Rare Disease Database NORD 2014

https://rarediseases.org/rare-diseases/spontaneous-intracranial-hypotension/ NORD 2017

Hughes MA, Frederickson AM, Branstetter BF, et al. MRI of the trigeminal nerve in patients with trigeminal neuralgia secondary to vascular compression. Am J Roentgenol. 2016; 206:595-600.

Iliescu Daniela Adriana, Timaru Cristina Mihaela, Alexe Nicolae, Gosav Elena, De Simone Algerino, Batras Mehdi, Stefan Cornel Management of diplopia Romanian Journal of Ophthalmology, Volume 61, Issue 3, July-September 2017. pp:166-170

Jussila MP1,2, Olsén P2,3, Salokorpi N4,5, Suo-Palosaari M6,7. Follow-up of pineal cysts in children: is it necessary? Neuroradiology. 2017 Dec;59(12):1265-1273

Kamenova M, Rychen J, Guzman R, Mariani L, Soleman J. Yield of early postoperative computed tomography after frontal ventriculoperitoneal shunt placement. PLoS One. 2018;13(6):e0198752. Published 2018 Jun 19. doi:10.1371/journal.pone.0198752

Kannan S, Kennedy L Expert Opin Med Diagn. Diagnosis of acromegaly: state of the art 2013;7(5):443. Epub 2013 Jul 31.

Kernan WN, Ovbiagele B, Black HR, Bravata DM, Chimowitz MI, Ezekowitz MD, Fang MC, Fisher M, Furie KL, Heck DV, Johnston SC, Kasner SE, Kittner SJ, Mitchell PH,Rich MW, Richardson D, Schwamm LH, Wilson JA; American Heart Association Stroke Council, Council on Cardiovascular and Stroke Nursing, Council on ClinicalCardiology, and Council on Peripheral Vascular Disease.

Stroke. 2014 Jul;45(7):2160-236. doi: 10.1161/STR.0000000000000024. Epub 2014 May 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

Kim, Hyoung Seop MD , Jin Kyung An, MD* , Jeong Joo Woo, MD, Ra Gyoung Yoon, MD Superficially Palpable Masses of the Scalp and Face: A Pictorial Essay. J Korean Soc Radiol 2019;80(2):283-293 https://doi.org/10.3348/jksr.2019.80.2.283 pISSN 1738-2637 / eISSN 2288-2928

Krueger DA, Northrup H, International Tuberous Sclerosis Complex Consensus Group. Tuberous sclerosis complex surveillance and management: Recommendations of the 2012 International Tuberous Sclerosis Complex Consensus Conference. Pediatr Neurol. 2013; 49(4):255.

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

M. Wintermark, P.C. Sanelli, G.W. Albers, J. Bello, C. Derdeyn, S.W. Hetts, M.H. Johnson, C. Kidwell, M.H. Lev, D.S. Liebeskind, H. Rowley, P.W. Schaefer, J.L. Sunshine, G. Zaharchuk and C.C. Meltzer American Journal of Neuroradiology November 2013, 34 (11) E117-E127; DOI: https://doi.org/10.3174/ajnr.A3690 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

Majumdar A, Mangal NS. Hyperprolactinemia. J Hum Reprod Sci. 2013;6(3):168-175. doi:10.4103/0974-1208.121400

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

Mohammad et al. Insights into Imaging (2019) 10:3 https://doi.org/10.1186/s13244-019-0686-x The value of CSF flow studies in the management of CSF disorders in children: a pictorial review

Mumtaz S, Jensen MB. Facial neuropathy with imaging enhancement of the facial nerve: A case report. Future Neurol. 2014; 9(6):571-576. doi:10.2217/fnl.14.55

Mustansir F, Bashir S, Darbar A. Management of Arachnoid Cysts: A Comprehensive Review. Cureus. 2018;10(4):e2458. Published 2018 Apr 10. doi:10.7759/cureus.2458

Hermier M1.Neurochirurgie. 2018 May;64(2):117-123. doi: 10.1016/j.neuchi.2018.01.005. Epub 2018 Apr 26. Imaging of hemifacial spasm.

Hiremath SB, Gautam AA, Sasindran V, Therakathu J, Benjamin G. 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

Pakalniskis MG, Berg AD, Policeni BA, et al. The many faces of granulomatosis with polyangiitis: A review of the head and neck imaging manifestations. Am J Roentgenol. 2015; 205:W619-W629.

Patel KM, Almutairi A, Mafee MF. Acute otomastoiditis and its complications: Role of imaging. Operative Techniques in Otolaryngology. 2014; 25:21-28.

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. https://acsearch.acr.org/docs/69509/Narrative/. Published 2017.

Pople IK HYDROCEPHALUS AND SHUNTS: WHAT THE NEUROLOGIST SHOULD KNOW Journal of Neurology, Neurosurgery & Psychiatry 2002;73:i17-i22.

Protocol for follow-up scanning in patient with a cranial meningioma v1 April 2018 Coversheet for Cancer Alliance Expert Advisory Group Agreed Documentation

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-Danguin 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; Article ID 203805.

Rovira, À., Wattjes, M., Tintoré, M. et al. MAGNIMS consensus guidelines on the use of MRI in multiple sclerosis—clinical implementation in the diagnostic process. Nat Rev Neurol 11, 471–482 (2015). https://doi.org/10.1038/nrneurol.2015.106

Ryan Jafrani, Jeffrey S. Raskin, Ascher Kaufman, Sandi Lam. Intracranial arachnoid cysts: Pediatric neurosurgery update. 06-Feb-2019;10:15

Sacco RL, Kasner SE, Broderick JP, Caplan LR, Connors JJ, Culebras A, Elkind MS, George MG, Hamdan AD, Higashida RT, Hoh BL, Janis LS, Kase CS, Kleindorfer DO, Lee JM, Moseley ME, Peterson ED, Turan TN, Valderrama AL, Vinters HV; on behalf of the American Heart Association Stroke Council, Council on Cardiovascular Surgery and Anesthesia, Council on Cardiovascular Radiology and Intervention, Council on Cardiovascular and Stroke Nursing, Council on Epidemiology and Prevention, Council on Peripheral Vascular Disease, and Council on Nutrition, Physical Activity and Metabolism. 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. Crossref. PubMed.

Saguil A, Kane S, Farnell E. Multiple sclerosis: a primary care perspective. Am Fam Physician. 2014;90(9):644-652.

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/

Shalender Bhasin,1 Juan P. Brito,2 Glenn R. Cunningham,3 Frances J. Hayes,4 Howard N. Hodis,5 Alvin M. Matsumoto,6 Peter J. Snyder,7 Ronald S. Swerdloff,8 Frederick C. Wu,9 and Maria A. Yialamas10. Testosterone Therapy in Men With Hypogonadism: An Endocrine Society* Clinical Practice Guideline. J Clin Endocrinol Metab, May 2018, 103(5):1715–1744 doi: 10.1210/jc.2018-00229

Stoller, James, K. The Cleveland Clinic Intensive Review of Internal Medicine. Pituitary Tumor (BOOK) Franklin A. Michota, Brian F. Mandell

Thangam Venkatesan1 | David J. Levinthal2 | Sally E. Tarbell3 | Safwan S. Jaradeh4 |William L. Hasler5 | Robert M. Issenman6 | Kathleen A. Adams7 | Irene Sarosiek8 |Christopher D. Stave4 | Ravi N. Sharaf9 | Shahnaz Sultan10 | B U. K. Li11Guidelines on management of cyclic vomiting syndrome in adults by the American Neurogastroenterology and Motility Society and the Cyclic Vomiting Syndrome Association Received: 6 March 2019 | Revised: 17 March 2019 | Accepted: 18 March 2019 DOI: 10.1111/nmo.13604

Welgampola MS1, Young AS1, Pogson JM1, Bradshaw AP1, Halmagyi GM2. Dizziness demystified. Pract Neurol. 2019 Jul 20. pii: practneurol-2019-002199. doi: 10.1136/practneurol-2019-002199. [Epub ahead of print]

WENYU HUANG, MD, and MARK E. MOLITCH, MD, Northwestern University Feinberg School of Medicine, Chicago, Illinois. Evaluation and Management of Galactorrhea. Am Fam Physician. 2012 Jun 1;85(11):1073-1080.

Yamada, S. J Stroke Cerebrovasc Dis. 2019 Jun;28(6):1561-1570. doi: 10.1016/j.jstrokecerebrovasdis.2019.03.005. Epub 2019 Mar 28. DEFENSIVE Stroke Scale: Novel Diagnostic Tool for Predicting Posterior Circulation Infarction in the Emergency Department.

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

D'Souza NM, Morgan ML, Almarzougi SJ, Lee AG. Magnetic resonance imaging findings in giant cell arteritis. Eye (Lond). 2016;30(5):758-762. doi:10.1038/eye.2016.19

Diamantopoulos AP, Haugeberg G, Hetland H, Soldal DM, Bie R, Myklebust G. 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

Klink T, Geiger J, Both M, et al. Giant cell arteritis: diagnostic accuracy of MR imaging of superficial cranial arteries in initial diagnosis-results from a multicenter trial. Radiology. 2014;273(3):844-852. doi:10.1148/radiol.14140056

Salehi Abari, Iraj. (2016). 2016 ACR Revised Criteria for Early Diagnosis of Giant Cell (Temporal) Arteritis. Autoimmune Diseases and Therapeutic Approaches Open Access. 3. 119-122.

Sadeq H, Karim J, Marwan Y, AlSaleem T: Neuroimaging Evaluation for First Attack of Unprovoked Nonfebrile Seizure in Pediatrics: When to Order? Med Princ Pract 2016;25:56-60. doi: 10.1159/000441847

Shaikh Z, Torres A, Takeoka M. Neuroimaging in Pediatric Epilepsy. Brain Sci. 2019;9(8):190. Published 2019 Aug 7. doi:10.3390/brainsci9080190

D. Hirtz, S. Ashwal, A. Berg, D. Bettis, C. Camfield, P. Camfield, P. Crumrine, R. Elterman, S. Schneider and S. Shinnar. Neurology Society, and the American Epilepsy Society Quality Standards Subcommittee of the American Academy of Neurology, the Child Practice parameter: Evaluating a first nonfebrile seizure in children: Report of the Neurology 2000;55;616-623

*Yield of emergent neuroimaging among children presenting with a first complex febrile seizure. Kimia AA, Ben-Joseph E, Prabhu S, Rudloe T, Capraro A, Sarco D, Hummel D, Harper M Pediatr Emerg Care. 2012 Apr;28(4):316-21*Policeni B, Corey AS, Burns J, et al. American College of Radiology (ACR) Appropriateness Criteria. Expert Panel on Neurologic Imaging: Cranial Neuropathy. https://acsearch.acr.org/docs/69509/Narrative/. Published 2017.

Practice parameter: diagnostic assessment of the child with cerebral palsy: report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. AU Ashwal S, Russman BS, Blasco PA, Miller G, Sandler A, Shevell M, Stevenson R, Quality Standards Subcommittee of the American Academy of Neurology, Practice Committee of the Child Neurology Society SO Neurology. 2004;62(6):851.

~~NICE guideline: Cerebral palsy in under 25s: assessment and management, 2017. Available at: https://www.nice.org.uk/guidance/ng62/resources/cerebral-palsy-in-under-25s-assessment-and-management-1837570402501~~

~~Stephanie J. Nahas, MD reviewing Whitehead MT et al. J Am Coll Radiol 2019 Nov New Guidelines on Headache Imaging January 8, 2020~~
~~NEJM Journal Watch~~

~~Micieli Andrew, Kingston William An Approach to Identifying Headache Patients That Require Neuroimaging~~
~~Frontiers in Public Health VOLUME=7 YEAR=2019 PAGES=52~~
~~URL=https://www.frontiersin.org/article/10.3389/fpubh.2019.00052~~
~~DOI=10.3389/fpubh.2019.00052~~
~~ISSN=2296-2565~~

~~Shobeiri E, Torabinejad B. Brain magnetic resonance imaging findings in postpartum headache. Neuroradiol J. 2019;32(1):4-9. doi:10.1177/1971400918804193~~

~~Hamilton, Katherine. Secondary Headaches During Pregnancy and the Postpartum Period. MAY 2020 PRACTICAL NEUROLOGY 63~~

~~Headache Classification Committee of the International Headache Society (IHS) (2018) The international classification of headache disorders, 3rd edition. Cephalalgia 38(1):1–211~~

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

~~Atluri Sridevi, Sarathi Vijaya, Goel Amit, Boppana Rakesh, Shivaprasad C Etiological profile of galactorrhoea Year : 2018 | Volume: 22 | Issue Number: 4 | Page: 489-493~~

~~Jacqueline .Gofshteyn,MD,andDonnaJ.Stephenson,MD Diagnosis andManagementofChildhoodHeadache~~
~~Curr ProblPediatrAdolescHealthCare2016;46:36-51~~

~~Headache Diagnosis in Children and Adolescents~~
~~Jasmin M. Dao1 & William Qubty1~~
~~Current Pain and Headache Reports (2018) 22: 17~~
~~https://doi.org/10.1007/s11916-018-0675-7~~

~~Spontaneous intracerebral hemorrhage due to coagulation disorders~~
~~Alfredo Quinones-Hinojosa M.D., Mittul Gulati M.D., Vineeta Singh M.D. and Michael T. Lawton M.D. DOI: https://doi.org/10.3171/foc.2003.15.4.3~~

Kaplowitz PB. Do 6-8 year old girls with central precocious puberty need routine brain imaging? Int J Pediatr Endocrinol. 2016;2016:9. doi: 10.1186/s13633-016-0027-5.

Faizah M, Zuhanis A, Rahmah R, et al. Precocious puberty in children: A review of imaging findings. Biomed Imaging Interv J. 2012;8(1):e6. doi:10.2349/biij.8.1.e6.

Joel S. Tieder, Joshua L. Bonkowsky, Ruth A. Etzel, Wayne H. Franklin, David A. Gremse, Bruce Herman, Eliot S. Katz, Leonard R. Krilov, J. Lawrence Merritt, Chuck Norlin, Jack Percelay, Robert E. Sapién, Richard N. Shiffman, Michael B.H. Smith and SUBCOMMITTEE ON APPARENT LIFE THREATENING EVENTS
Pediatrics May 2016, 137 (5) e20160591; DOI: https://doi.org/10.1542/peds.2016-0591

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

Acute, subacute, and chronic headache
I Egilius L.H Spierings MD, PhDDepartment of Neurology, Brigham and Women's Hospital, Harvard Medical School, 75 Francis Street, Boston, MA 02115, USA

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

Hughes MA, Frederickson AM, Branstetter BF, et al. MRI of the trigeminal nerve in patients with trigeminal neuralgia secondary to vascular compression. *Am J Roentgenol.* 2016; 206:595-600.