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CLINICAL APPROPRIATENESS GUIDELINES

ADVANCED IMAGING

Appropriate Use Criteria: Imaging of the Brain

Proprietary

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Description and Application of the Guidelines

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

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

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

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

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

The Guidelines do not address coverage, benefit or other plan specific issues. Applicable federal and state coverage mandates take precedence over these clinical guidelines. If requested by a health plan, Carelon will review requests based on health plan medical policy/guidelines in lieu of the Carelon Guidelines.

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

General Clinical Guideline

Clinical Appropriateness Framework

Critical to any finding of clinical appropriateness under the guidelines for a specific diagnostic or therapeutic intervention are the following elements:

- Prior to any intervention, it is essential that the clinician confirm the diagnosis or establish its pretest likelihood based on a complete evaluation of the patient. This includes a history and physical examination and, where applicable, a review of relevant laboratory studies, diagnostic testing, and response to prior therapeutic intervention.
- The anticipated benefit of the recommended intervention should outweigh any potential harms that may result (net benefit).
- Current literature and/or standards of medical practice should support that the recommended intervention offers the greatest net benefit among competing alternatives.
- Based on the clinical evaluation, current literature, and standards of medical practice, there exists a reasonable likelihood that the intervention will change management and/or lead to an improved outcome for the patient.

If these elements are not established with respect to a given request, the determination of appropriateness will most likely require a peer-to-peer conversation to understand the individual and unique facts that would supersede the requirements set forth above. During the peer-to-peer conversation, factors such as patient acuity and setting of service may also be taken into account.

Simultaneous Ordering of Multiple Diagnostic or Therapeutic Interventions

Requests for multiple diagnostic or therapeutic interventions at the same time will often require a peer-to-peer conversation to understand the individual circumstances that support the medical necessity of performing all interventions simultaneously. This is based on the fact that appropriateness of additional intervention is often dependent on the outcome of the initial intervention.

Additionally, either of the following may apply:

- Current literature and/or standards of medical practice support that one of the requested diagnostic or therapeutic interventions is more appropriate in the clinical situation presented; or
- One of the diagnostic or therapeutic interventions requested is more likely to improve patient outcomes based on current literature and/or standards of medical practice.

Repeat Diagnostic Intervention

In general, repeated testing of the same anatomic location for the same indication should be limited to evaluation following an intervention, or when there is a change in clinical status such that additional testing is required to determine next steps in management. At times, it may be necessary to repeat a test using different techniques or protocols to clarify a finding or result of the original study.

Repeated testing for the same indication using the same or similar technology may be subject to additional review or require peer-to-peer conversation in the following scenarios:

- Repeated diagnostic testing at the same facility due to technical issues
- Repeated diagnostic testing requested at a different facility due to provider preference or quality concerns
- Repeated diagnostic testing of the same anatomic area based on persistent symptoms with no clinical change, treatment, or intervention since the previous study

- Repeated diagnostic testing of the same anatomic area by different providers for the same member over a short period of time

Repeat Therapeutic Intervention

In general, repeated therapeutic intervention in the same anatomic area is considered appropriate when the prior intervention proved effective or beneficial and the expected duration of relief has lapsed. A repeat intervention requested prior to the expected duration of relief is not appropriate unless it can be confirmed that the prior intervention was never administered.

Imaging of the Brain

General Information/Overview

Scope

These guidelines address advanced imaging of the brain in both adult and pediatric populations. For interpretation of the Guidelines, and where not otherwise noted, “adult” refers to persons age 19 and older, and “pediatric” refers to persons age 18 and younger. Where separate indications exist, they are specified as **Adult** or **Pediatric**. Where not specified, indications and prerequisite information apply to persons of all ages.

See the Coding section for a list of modalities included in these guidelines.

Technology Considerations

Advanced imaging is an umbrella term that refers to anatomy-based (structural), physiology-based (functional), and hybrid imaging methods that offer greater spatial and/or contrast resolution relative to conventional imaging methods in radiology such as radiography or ultrasound. Examples of advanced structural imaging include computed tomography (CT) and magnetic resonance imaging (MRI) and some technique variants. Advanced functional imaging includes positron emission tomography (PET) as well as those MRI/CT technique variants that create image contrast based on a physiological parameter (for example, functional magnetic resonance imaging (fMRI). Hybrid advanced imaging techniques optimize diagnostic accuracy by coupling structural and functional approaches (such as PET-CT or PET-MRI).

Computed tomography (CT) is preferred in the following situations: initial evaluation of craniocerebral trauma; evaluation of acute intracranial hemorrhage (parenchymal, subarachnoid, subdural, epidural); evaluation of calcified intracranial lesions; osseous assessment of the calvarium, skull base, and maxillofacial bones, including detection of calvarial and facial bone structures; and imaging of midline structures and ventricular system. CT is utilized less frequently in neuroimaging due to inferior resolution when compared to MRI. CT also has a tendency to result in beam-hardening artifact adjacent to the petrous bone, which may limit visualization in portions of the posterior fossa and brainstem. Standard anatomic coverage of head CT is from the base of the skull to its vertex, covering the entire calvarium and intracranial contents. Coverage may vary depending on the specific clinical indication. Disadvantages of CT include exposure to ionizing radiation and risks associated with infusion of iodinated contrast media, including allergic reactions or renal compromise.

Magnetic resonance imaging (MRI) is preferable to CT in most clinical scenarios. It is the study of choice for visualization of brain parenchyma and white matter tracts. It is also preferred for imaging of the posterior fossa and brainstem structures. Standard anatomic coverage of head MRI is from the base of the skull to the vertex, covering the entire calvarium and intracranial contents, including the internal auditory canals. Coverage may vary depending on the specific clinical indication. The presence of implantable devices such as pacemakers or defibrillators, a potential need for sedation in pediatric patients, and claustrophobia are the main limitations of MRI. Infusion of gadolinium may also confer an unacceptable risk in persons with advanced renal disease.

Diffusion-weighted imaging (DWI) is a specific MRI sequence that gathers information on the movements of water molecules in the brain. DWI is most commonly used to diagnose pathologies in which water molecules demonstrate less ability to move through the histologic structure of the brain. Common examples include acute ischemic stroke, abscess, and certain tumors. DWI can also be used to image structure of white matter tracts by a process called **diffusion tensor imaging (DTI)**, which uses the data from the scan to make calculations. DTI may also be useful in neurosurgical planning.

Functional MRI (fMRI) is primarily utilized for mapping primary brain activities related to motor, sensory, and language functions. Studies have demonstrated that fMRI is comparable to the intracarotid sodium amobarbital procedure (Wada test) and direct electrical stimulation for language localization. fMRI is

noninvasive, does not require ionizing radiation, and has a shorter time requirement for imaging and post-procedural recovery.

Positron emission tomography (PET or PET-CT) provides functional information about brain activity by mapping the relative concentrations of certain radiotracers within the parenchyma. PET brain imaging is primarily used to evaluate blood flow, metabolic changes, and neurotransmitter dynamics, and is f requently performed in conjunction with CT for anatomic localization. PET-CT can be used to evaluate many types of dementia and memory disorders, and it can also be used to localize epileptic seizures or stage brain tumors.

Magnetic resonance spectroscopy (MRS), usually performed with standard MRI, provides a biochemical profile of metabolic constituents in tissues. Alterations in specific metabolites such as choline and creatine are associated with certain disease states; this information can be used as an adjunct in cases where standard MRI fails to distinguish between diseased and healthy tissue. In neuroimaging, MRS is useful for differentiating between tumor, necrotic tissue, and certain types of infectious lesions.

Definitions

Phases of the care continuum are broadly defined as follows:

- **Screening** – testing in the absence of signs or symptoms of disease
- **Diagnosis** – testing based on a reasonable suspicion of a particular condition or disorder, usually due to the presence of signs or symptoms
- **Management** – testing to direct therapy of an established condition, which may include preoperative or postoperative imaging, or imaging performed to evaluate the response to nonsurgical intervention
- **Surveillance –** periodic assessment following completion of therapy, or for monitoring known disease that is stable or asymptomatic

Statistical terminology[1]

- **Confidence interval (CI) –** range of values which is likely to contain the cited statistic. For example, 92% sensitivity (95% CI, 89%-95%) means that, while the sensitivity was calculated at 92% on the current study, there is a 95% chance that, if a study were to be repeated, the sensitivity on the repeat study would be in the range of 89%-95%.
- **Diagnostic accuracy –** ability of a test to discriminate between the target condition and health. Diagnostic accuracy is quantified using sensitivity and specificity, predictive values, and likelihood ratios.
- **Hazard ratio –** odds that an individual in the group with the higher hazard reaches the outcome f irst. Hazard ratio is analogous to odds ratio and is reported most commonly in time-to-event analysis or survival analysis. A hazard ratio of 1 means that the hazard rates of the 2 groups are equivalent. A hazard ratio of greater than 1 or less than 1 means that there are differences in the hazard rates between the 2 groups.
- **Likelihood ratio –** ratio of an expected test result (positive or negative) in patients *with* the disease to an expected test result (positive or negative) in patients *without* the disease. Positive likelihood ratios, especially those greater than 10, help rule in a disease (i.e., they substantially raise the post-test probability of the disease, and hence make it very likely and the test very useful in identifying the disease). Negative likelihood ratios, especially those less than 0.1, help rule out a disease (i.e., they substantially decrease the post-test probability of disease, and hence make it very unlikely and the test very useful in excluding the disease).
- **Odds ratio –** odds that an outcome will occur given a particular exposure, compared to the odds of the outcome occurring in the absence of that exposure. An odds ratio of 1 means that the exposure does not affect the odds of the outcome. An odds ratio greater than 1 means that the exposure is associated with higher odds of the outcome. An odds ratio less than 1 means that the exposure is associated with lower odds of the outcome.

- **Predictive value –** likelihood that a given test result correlates with the presence or absence of disease. Positive predictive value is defined as the number of true positives divided by the number of test positives. Negative predictive value is defined as the number of true negatives divided by the number of test negative patients. Predictive value is dependent on the prevalence of the condition.
- **Pretest probability –** probability that a given patient has a disease prior to testing. May be divided into very low (less than 5%), low (less than 20%), moderate (20%-75%), and high (greater than 75%) although these numbers may vary by condition.
- **Relative risk –** probability of an outcome when an exposure is present relative to the probability of the outcome occurring when the exposure is absent. Relative risk is analogous to odds ratio; however, relative risk is calculated by using percentages instead of odds. A relative risk of 1 means that there is no difference in risk between the 2 groups. A relative risk of greater than 1 means that the outcome is more likely to happen in the exposed group compared to the control group. A relative risk less than 1 means that the outcome is less likely to happen in the exposed group compared to the control group.
- **Sensitivity –** conditional probability that the test is positive, given that the patient has the disease. Defined as the true positive rate (number of true positives divided by the number of patients with disease). Excellent or high sensitivity is usually greater than 90%.
- **Specificity –** conditional probability that the test is negative, given that the patient does not have the disease. Defined as the true negative rate (number of true negatives divided by the number of patients without the disease). Excellent or high specificity is usually greater than 90%.

Clinical Indications

The following section includes indications for which advanced imaging of the brain is considered medically necessary, along with prerequisite information and supporting evidence where available. Indications, diagnoses, or imaging modalities not specifically addressed are considered not medically necessary.

It is recognized that imaging often detects abnormalities unrelated to the condition being evaluated. Such findings must be considered within the context of the clinical situation when determining whether additional imaging is required.

Congenital and Developmental Conditions

Developmental delay (Pediatric only)

Advanced imaging is considered medically necessary for diagnosis and management of **EITHER** of the following conditions:

- Cerebral palsy
- Significant delay or loss of milestones in **ANY TWO (2)** of the following domains:
    - Activities of daily living
    - Cognition
    - Motor skills (gross/fine)
    - Social/personal
    - Speech/language

IMAGING STUDY

- CT brain

- MRI brain (preferred)

Congenital anomalies

Includes Chiari malformation, craniosynostosis, macrocephaly, microcephaly, ataxia-telangiectasia, fragile X syndrome, and congenital anomalies of the posterior fossa

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- Ultrasound required as the initial study to evaluate macrocephaly in patients under 5 months of age
- CT brain (preferred with 3D reconstruction for craniosynostosis)
- MRI brain (preferred for congenital cerebral anomalies)

Rationale

Congenital anomalies of the central nervous system can be classified[2] into disorders of dorsal/ventral induction such as myelomeningocele, holoprosencephaly, Dandy-Walker variant, or craniosynostosis, disorders of neural proliferation such as microcephaly and megalencephaly, disorders of neuronal migration such as schizencephaly and cortical heterotopias, and disorders of myelination such as adrenoleukodystrophy and Canavan disease. There are characteristic imaging patterns for each of these congenital abnormalities, making imaging an important diagnostic test. Repeat imaging and surveillance imaging are indicated only if neurological complications of these conditions are suspected such as hydrocephalus.

The American Academy of Neurology recommends neuroimaging in the diagnostic evaluation of a child with global developmental delay,[3] which is defined as a delay in 2 or more developmental domains—gross/fine motor control, speech/language, cognition, social/personal, and activities of daily living—that affect children under the age of 5 years.[4] While history and physical exam are sufficient to establish the diagnosis in up to a third of cases,[4] structural abnormalities on neuroimaging are seen in 14% of unselected patients and in 41% of patients with suggestive physical exam findings such as macrocephaly or focal neurological deficits.[3]

Cerebral palsy is the most common physical disability in childhood and refers to a syndrome of voluntary movement or posture that manifests before age 2.[5] MRI has a high sensitivity (86%-89%) for the condition[6] with 70%-90% of patients having identifiable structural abnormalities. Neuroimaging in general and MRI in particular are recommended by the American Academy of Neurology to help establish the diagnosis.[7]

MRI is the preferred imaging modality for evaluation of congenital and developmental abnormalities of the brain because it is more sensitive than CT for the detection of morphological abnormalities of the brain parenchyma and because it does not require ionizing radiation. Abnormalities on MRS have been associated with developmental delay, but have not consistently been show to improve diagnostic yield of change management as either an add-on or a replacement test to MRI.[4]

CT may be preferred to better characterize congenital abnormalities that primary involve the calvarium, such as craniosynostosis.[8] Ultrasound is also sensitive and should be considered in clinical practices with expertise in the technique.[9]

Ultrasound is an accurate and reliable initial modality for evaluating macrocephaly in neonates, and it can identify a small percentage (2%) of patients who require neurosurgical intervention.[10] Macrocephaly without focal neurological deficits has a very low (3.5%) incidence of congenital abnormalities, and add-on MRI or CT detection has a very low (0%) impact on management.[11]

Sickle cell disease (Pediatric only)

Advanced imaging is considered medically necessary for periodic screening and surveillance for silent cerebral infarcts in patients with sickle cell disease.

IMAGING STUDY

- MRI brain

Infectious Conditions

Infectious conditions – not otherwise specified

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Inflammatory Conditions

Multiple sclerosis (MS) and other white matter diseases

Also see Head and Neck Imaging, Spine Imaging

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Diagnosis
    - Neurological signs or symptoms of demyelinating disease
- Management
    - Evaluation of new or recurrent neurological signs or symptoms
    - Recent or current use of natalizumab
    - New baseline prior to starting or changing therapy
    - Following a change in disease-modifying therapy: Initial imaging at 3-6 months and follow up at 6-12 months
    - Periodic evaluation of white matter diseases other than multiple sclerosis
- Surveillance
    - Clinically isolated syndrome (CIS) or radiologically isolated syndrome (RIS): Imaging 3-6 months after presentation, 6-12 months after presentation, and annually thereafter
    - Annual evaluation in stable patients with multiple sclerosis who have had no change in therapy within the past one year

IMAGING STUDY

- MRI brain

Rationale

Multiple sclerosis (MS) is a chronic, disabling autoimmune disease of the central nervous system[12] and among the most common causes of neurological disability in young people, with an annual incidence ranging from 2 to 10 cases per 100,000 persons per year.[13] Its clinical manifestations typically occur between 20 and 40 years of age, with symptoms and signs involving different regions of the central nervous system: optic nerve, brainstem, cerebellum, cerebral hemispheres, and spinal cord. MS has a chronic course - relapses and disability progression evolving over 30 to 40 years are typical.[13]

The revised 2017 McDonald criteria are commonly accepted criteria establishing the diagnosis of MS and are used in both clinical and research contexts. The McDonald criteria incorporate clinical presentation as well as laboratory and imaging biomarkers and brain MRI plays a central role in the diagnosis of MS by establishing evidence for dissemination in space and in time in patients with both typical (optic neuritis, brainstem syndrome) and atypical clinical
presentations.[14] MRI may also inform the management of MS by confirming a disease flare when clinically suspected or by excluding other causes for the new neurological signs or symptoms.

Patients with clinically isolated syndrome present with a clinical attack typical for demyelinating disease (for example, optic neuritis) but do not meet the McDonald criteria. They are at increased risk for MS and MRI is indicated to determine whether these patients develop the disease.

While MS should not be diagnosed on the basis of MRI findings alone,[14,15] patients rarely present with white matter disease typical of multiple sclerosis (not nonspecific) without clinical symptoms. These patients are classified as having a radiologically isolated syndrome(RIS). Follow up imaging in RIS is controversial, but RIS patients appear to be at increased risk for conversion to MS.[16] Future research is likely to change recommendations for the diagnosis and management of RIS and additional studies have been identified as a high priority.[14]

There are over a dozen FDA-approved disease-modifying therapies (DMTs) for multiple sclerosis including interferon beta-1a, glatiramer acetate, fingolimod, and natalizumab and these therapies are recommended in patients with relapsing forms of MS with recent clinical relapses or MRI activity (strong recommendation based on moderat equality evidence).[17] For patients without new clinical findings, MRI may therefore be used in the management (immediately prior to or after changing DMTs) or in surveillance for subclinical disease in patients without clinical or recent therapy changes). More frequent MRI evaluation is recommended in patients with a recent therapy change as recurrences are more likely within the first year. Patients on natalizumab (Tysabri) have a higher relative risk for progressive multifocal leukoencephalopathy (PML) and may require more frequent imaging.

Management and surveillance intervals for MS, CIS and RIS are primarily consensus based but addressed in several evidence and practice based guidelines.[18 19 20 21]

CT is not recommended in the evaluation of demyelinating disease due to low sensitivity relative to MRI and other clinical and laboratory tests.[22] Likewise, several nonconventional technique variants of MRI (magnetization transfer, diffusion tensor, functional MRI) have been proposed as add-on diagnostic tests for MS but they have not been validated at the individual level[21] or incorporated into the McDonald criteria or other standardized MS imaging protocols and require further research before incorporation into routine clinical practice.[23]

Other demyelinating diseases of the central nervous system are rare and include autoimmune disseminated encephalomyelitis (ADEM) and neuromyelitis optica (NMO). Their clinical presentation can overlap with MS but clinical, laboratory, and MRI findings help to distinguish the etiologies. For instance, ADEM usually has an viral or vaccine prodrome and is more common in pediatric patients[24]; NMO typically presents with longitudinally extensive transverse myelitis and a positive serum NMO-IgG/Aquaporin 4 (AQP4) antibody test.[16, 25]

The McDonald criteria apply in pediatrics, although MS is rare in this population and hence data is limited.[20]

Inflammatory conditions – not otherwise specified

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Neurodegenerative Conditions

Movement disorders (Adult only)

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- For perioperative evaluation related to placement of a deep brain stimulator
- For initial evaluation of the following movement disorders, to exclude an underlying structural lesion:
    - Hemifacial spasm
    - Huntington’s disease
    - Multiple system atrophy
    - Parkinson’s disease with atypical features
    - Progressive supranuclear palsy
    - Secondary dystonia
    - Other focal or lateralizing movement disorder, such as hemiballismus, athetosis, or chorea

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

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Rationale

Structural imaging has a limited role in most movement disorder conditions. The most common of these are essential tremor, with a prevalence of 5% of individuals over the age of 65, and Parkinson's disease, with a prevalence of 1% in this population.

Structural MRI, as used in current clinical practice, does not reveal significant abnormalities in essential tremor. Diagnosis of essential tremor is based on clinical assessment of the phenomenological characteristics and its course.[26]

Parkinson's disease is a clinical and pathological diagnosis, with MRI limited to atypical presentations of the disorder. Patients should initially be referred to a specialist for diagnosis. Rates of incorrect diagnosis for specialists average ~7%, while those for non-specialists run between 25%-47%.

Typical presentation: resting tremor, cogwheel rigidity, bradykinesia, with delayed onset of postural instability. When clinical signs and symptoms and response to medication are typical of Parkinson's disease, neuroimaging is not required.[27]

Atypical features of Parkinson's disease[28] include the following: falls at presentation and early in the disease course; poor response to levodopa; symmetry at onset; rapid progression; lack of tremor; dysautonomia (urinary urgency/incontinence and fecal incontinence, urinary retention requiring catheterization, persistent erectile failure, or symptomatic orthostatic hypotension). Imaging may be indicated in cases of atypical Parkinson's disease to exclude treatable causes. Other movement disorders such as multiple systematrophy have characteristic imaging features that may be used to corroborate the diagnosis when clinically uncertain.[27,28,29]

Dystonia is characterized by sustained muscle contractions, frequently causing repetitive twisting movements or abnormal postures. The diagnosis is clinical and specialist referral is recommended.

Features of primary dystonia include the following: absence of associated neurological signs or symptoms other than tremor; absence of additional motor abnormalities (weakness, spasticity, etc.); early onset (< 21 years) starts in the limbs and may generalize; late onset(≥ 21 years) begins in the neck/arm/face and does not generalize.

Structural brain imaging is not routinely required when there is a confident diagnosis of primary dystonia in adults, but may be indicated to evaluate secondary forms of dystonia.[30]

Neurocognitive disorders (Adult only)

Includes mild cognitive impairment, dementia, and variants (e.g., vascular, Alzheimer's disease, frontotemporal degeneration spectrum, diffuse Lewy body).

Imaging is considered medically necessary to direct management in **ANY** of the following scenarios:

Imaging Study	Diagnosis	Management
MRI brain (preferred) or CT brain	One-time evaluation of documented cognitive abnormality to exclude a secondary cause when unexplained by clinical evaluation	Evaluation of rapidly progressive symptoms
FDG-PET/CT brain	One-time evaluation to differentiate between frontotemporal dementia and Alzheimer's disease when substantial diagnostic uncertainty remains after **ALL** of the following: • Neuropsychological testing • Evaluation by a physician experienced in neurodegenerative disease • Structural imaging (CT or MRI)	Not indicated
Amyloid PET imaging	When performed under Coverage with Evidence Development (CED) in Medicare beneficiaries	When performed under Coverage with Evidence Development (CED) in Medicare beneficiaries

Rationale

Neurocognitive disorder (previously known as dementia) is an umbrella term for a group of symptoms associated with a decline in memory, executive, and/or other cognitive functions. Alzheimer's disease is the most common, neurocognitive disorder.[31,32] Two kinds of advanced imaging, structural and functional, are available for further characterization of dementia. Structural imaging includes MRI and CT, and evaluates for masses and for morphologic changes in the brain parenchyma. Functional imaging includes PET/CT with FDG or Amyvid.

Structural imaging

Advanced structural imaging is recommended by multiple specialty society guidelines to exclude a treatable cause for dementia, such as neoplasm, hydrocephalus, or subdural hematoma.[33,34,35,36,37,38,39] The rationale for this recommendation is that no clinical prediction rule has sufficient accuracy to exclude treatable causes of dementia, [38] and appropriately 2.2% of patients presenting with dementia will have a treatable cause (such as subdural hematoma, hydrocephalus, or neoplasm) that advanced imaging can identify.[37]

MRI is the preferred advanced imaging modality for initial evaluation. It is more sensitive than CT for the evaluation of treatable causes and offers the secondary benefit of improved contrast between grey and white matter; hence MRI provides better assessment of patterns of parenchymal atrophy that characterize specific forms of dementia (for instance, supranuclear palsy, frontotemporal dementia, and primary progressive aphasia).[27,33,34]

Advanced structural imaging (MRI preferred) is indicated to exclude new treatable causes in a previously imaged patient with dementia, particularly when there is rapid (e.g., over 1 to 2 months) unexplained decline in cognition or function. [40,41] Advanced imaging should be undertaken in the assessment of a person with cognitive impairment and unsuspected cerebrovascular disease, if it would change the clinical management.[40]

Functional imaging

The American College of Radiology indicates that advanced imaging modalities such as FDG-PET are not routinely used in community or general practices for the diagnosis or differentiation of forms of dementia.[27] However, FDG-PET may be useful in select circumstances as a problem-solving technique to direct management. The European Federation of Neurological Societies recommends its use in those cases where the diagnosis remains in doubt after clinical and structural MRI workup and in particular clinical settings.[33] Gauthier et al.[42] indicate that FDG-PET may be useful in forming a differential diagnosis for a patient with dementia who has undergone the recommended baseline clinical and structural brain imaging evaluation and who has been evaluated by a dementia specialist, but whose underlying pathological process is still unclear, preventing adequate clinical management.

Evidentiary basis for the above recommendations includes several diagnostic accuracy studies of FDG-PET using clinical assessment as the reference standard. These studies found a diagnostic accuracy of 93% for differentiating Alzheimer's disease subjects from healthy subjects, with sensitivity of 96% and specificity of 90%. However, use of a clinical reference standard instead of histopathology limits internal validity. A multicenter analysis in 138 patients with histopathological diagnoses reported that FDG-PET correctly identified the presence or absence of Alzheimer's disease in 88% of the cases, with a sensitivity of 94% and a specificity of 73%.[33]

MRI variants including fMRI and MRS are not recommended by high quality evidence based guidelines for routine use in dementia imaging. These modalities do not have a role in the evaluation or monitoring of dementia,[33] and are intended only for specialized clinical and research settings.[40] Future studies with large number of participants and longer period of follow up are needed to allow firm conclusions on the value of fMRI as an add-on test to MRI, for instance, in early detection of dementia.[42]

Diffuse lewy body dementia (DLB) is a neurocognitive disorder characterized histopathologically by lewy body desposition, especially in the brainstem and nigrostriatal regions, progressing to the limbic system and cortex. DLB presents clinically with neurocognitive dysfunction and at least two additional clinical symptoms including delirium, visual hallucinations, REM sleep behavior disorder, or Parkinsonism.[43] Clinical features of DLB can overlap with Alzheimer's disease and Parkinson's in the early stages and advanced imaging is a biomarker to aid the diagnosis when clinical symptoms are insufficient and symptomatic treatment for the condition may differ. Structural imaging shows relative preservation of the mesial temporal lobe in DLB when compared to Alzheimer's[33] and a positive Dopaminergic SPECT has a good positive predictive value for DLB in this scenario and may be appropriate as it is recommended by multiple evidence-based guidelines.[27,33,44]

Amyloid imaging including Amyvid (florbetapir ^{18}F) and Vizamyl (flutemetamol ^{18}F) involves radiopharmaceuticals that measure amyloid deposition in the brain. Amyloid is known to be associated with the pathogenesis of Alzheimer's and may predict conversion from mild cognitive impairment to Alzheimer's although a range of diagnostic accuracies has been reported in the literature[45, 46] and the impact of testing on patient management and outcome is currently unknown. Aim 2 of the Imaging Dementia—Evidence for Amyloid Scanning (IDEAS) trial evaluates impact of Amyloid imaging on 12-month patient outcomes and is the largest study of its kind. Results are forthcoming.

Trauma

Trauma

ADULT

Advanced imaging is considered medically necessary in the diagnosis and management of head trauma in **EITHER** of the following scenarios:

- Acute trauma when **ANY** of the following risk factors are present:
  - Age 65 years or older
  - Retrograde amnesia
  - At least 2 episodes of emesis
  - Evidence of open, depressed, or basilar skull fracture
  - Focal neurologic findings
  - Glasgow coma scale less than 15 or altered mental status
  - High-risk mechanism of injury
  - Seizure
  - Bleeding diathesis/coagulopathy
  - Intracranial shunt
- Non-acute trauma in EITHER of the following scenarios:
  - Focal neurological signs or symptoms that are new, progressive, or unexplained by CT performed for acute trauma
  - Progressive nonfocal neurologic signs or symptoms (including postconcussive syndrome) refractory to therapy

PEDIATRIC

Advanced imaging is considered medically necessary in the diagnosis and management of head trauma in **EITHER** of the following scenarios:

- Acute trauma when ANY of the following risk factors are present:
  - Altered mental status
  - Change in behavior
  - Vomiting
  - Loss of consciousness
  - History of high-risk motor vehicle accident or other mechanism of injury
  - Scalp hematoma when younger than age 2 years
  - Evidence of basilar skull fracture
  - Non-accidental injury
- Non-acute trauma in EITHER of the following scenarios:
  - Focal neurological signs or symptoms that are new, progressive, or unexplained by CT performed for acute trauma
  - Progressive nonfocal neurologic signs or symptoms (including postconcussive syndrome) refractory to therapy

IMAGING STUDY

- CT brain
- MRI brain for non-acute trauma

Rationale

Carelon adult trauma guidelines follow well established clinical prediction rules for this indication. In particular, Carelon guidelines follow the Canadian Head CT rules (CCHR) developed and externally validated on thousands of North American level 1 trauma center patients, a population at highest risk for clinically significant head trauma.[47]

While both the New Orleans Criteriaand the Canadian Head CT rules have excellent sensitivity (100%; 95% CI, 96%-100%) for clinically important brain injury, the Canadian Head CT rules achieve this sensitivity with substantially greater specificity (range 37%-50.7% vs 3%-12.7%),[48-50] resulting in improved overall diagnostic accuracy.

Of note, patients with new focal neurological deficits and seizures are usually candidates for neuro imaging regardless of whether they are post-traumatic, and altered mental status (Glasgow coma scale < 15) is also addressed in separate Carelon guidelines and as such is included here as criteria even though it is not a part of the CCHR clinical prediction rule (which also applies to patients with a Glasgow coma scale of 13 to 15). Patients with a bleeding diasthesis or intracranial shunts were excluded from the development of the CCHR, so imaging can be performed whenever clinically significant trauma is suspected.

Guidelines for pediatric head trauma follow a similar approach, adopting the Pediatric Emergency Care Applied Research Network (PECARN) rules for the detection of clinically significant brain injury. The PECARN rules were developed (33,785) and validated (8627) in multiple North American emergency departments[51] with—for example—subsequent separate multicenter geography validations.[52] Sensitivity of PECARN in this population is 98.8% (95% CI, 89%-99.6%) and the rule did not miss neurosurgical head trauma in any pediatric patients.[51] While PECARN is less specific (53% vs 91%) compared to clinical gestalt, the rule is substantially more sensitive(~100% vs 60%),[53] although the greater specificity of clinical gestalt is questioned by other studies.[54] Compared to other clinical prediction rules for pediatric head trauma (including CATCH and CHALICE), PECARN has a higher sensitivity (100% vs 91% and 84%, although confidence intervals overlap) and has undergone more extensive external validation.[54]

High-risk mechanisms as defined in the Carelon adoption of PECARN include motor vehicle collision with patient ejection or rollover, death of another passenger, pedestrian or bicyclist without helmet struck by a motorized vehicle, high-impact
head trauma, falls from more than 3 feet.

CT is the preferred imaging modality for acute head trauma because it is more sensitive for intracranial hemorrhage and fracture, more readily available than MRI, and takes less time to perform.[55] MRI is an add-on advanced imaging test in select cases of acute head trauma, especially in situations where abnormalities on the neurological exam are unexplained by head CT or are worsening or progressive.[56] MRI is more sensitive for the evaluation of diffuse axonal injury (DAI) and microhemorrhage, which may explain this discrepancy. The presence of DAI has been associated with a modest (odds ratio=3) risk of unfavorable outcome,[57] although there is currently no effective treatment.[58]

Other experimental advanced imaging techniques such as DTI, fMRI, and MRS are promising, but have not been consistently shown to change management or improve patient level prognosis as add-on tests and are not in widespread clinical use at this time.[59]

Advanced imagingfollowing acute trauma is indicated in patients with new focal neurological abnormalities or abnormalities that remain unexplained by CT. Postconcussive syndrome (PCS) refers to a constellation of nonfocal neurological signs or symptoms (examples include headache, nausea, fatigue, blurred visision, memory, emotional and executive dysfunction) that persist following mild traumatic brain injury (mTBI). There is no consensus on the use of advanced imaging post concussion in either adult or pediatric patients,[60] although the diagnostic yield of clinically significant findings is very low[61] and imaging is not routinely recommended but is reserved for atypical cases when an intracranial lesion is suspected.[62-64]

Tumor or Neoplasm

Acoustic neuroma

Also see indication for hearing loss.

Also see Head and Neck Imaging guidelines.

Advanced imaging is considered medically necessary for management of known acoustic neuroma in patients with neurofibromatosis type 2 or in **ANY** of the following scenarios:

Management

- Signs, symptoms or imaging findings suggestive of recurrence or progression

Surveillance

- Following conservative treatment ("watch and wait") or incomplete resection (including proton beam therapy or stereotactic radiosurgery) annually for 5 years
- Single follow up study following gross total resection within the first year after surgery

IMAGING STUDY

- MRI brain

Meningioma

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

Management

- For a patient with known meningioma and new or worsening symptoms

Surveillance in **EITHER** of the following scenarios:

- Every 6 months if **ANY** of the following are present:
    - Vasogenic edema on prior MRI
    - Interval growth on prior imaging
    - Lesion is located in the sphenoid wing, venous sinus, or skull base regions
- Every 12 months if none of the above features are present

IMAGING STUDY

- MRI brain
- CT brain when MRI cannot be performed

Pituitary adenoma

For management and surveillance, this indication applies to pituitary lesions that have been previously characterized by a dedicated pituitary protocol MRI with one or more findings suggestive of an adenoma.

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Diagnosis of suspected pituitary adenoma when supported by signs or symptoms as well as laboratory findings
- Management (including perioperative evaluation) of known adenoma
- Surveillance of clinically stable adenoma in EITHER of the following:
    - Unresected
        - Macroadenoma (size greater than 10 mm)
        - Microadenoma (size 10 mm or less): Annual surveillance imaging
    - Resected
        - At least 3 months following resection

Note: Surveillance imaging applies to patients who are clinically stable and in whom there is no anticipated change in management. Management applies to patients with new or worsening signs or symptoms, or in whom resection or other change in treatment is planned.

IMAGING STUDY

- MRI brain
- CT brain for management or surveillance of microadenoma when MRI cannot be performed or as an alternative to MRI brain for macroadenoma

Rationale

Pituitary adenomas can be broadly classified into clinically functioning (hormone-secreting, typically presenting with abnormal lab values and systematic signs/symptoms with or without neurologic ones) and clinically nonfunctioning (typically presenting with neurological signs/symptoms related to regional extension and mass effect).

For suspected functional adenomas, the Endocrine Society recommends MRI in patients with biochemically proven acromegaly to evaluate for a functioningpituitary adenoma as well as to visualize tumor size and regional extension; CT is suggested if MRI is contraindicated or unavailable.[65] In addition, the American College of Radiology identifies MRI with and without contrast as "usually appropriate" for patients with hyperthyroidism, hypopituitarism, Cushing's syndrome, hyperprolactinemia, diabetes insipitus, and precocious puberty.[66] The Congress of Neurological Surgeons recommends MRI as the advanced imaging modality of choice in the preoperative diagnosis of nonfunctional pituitary adenomas with potential supplementation by CT, but notes insufficient evidence to support MR spectroscopy, perfusion, and PET/CT for this indication.[67]

Pituitary apoplexy is a special case of pituitary adenoma that results from acute hemorrhage or infarct of the pituitary and that presents with severe headache(up to 97%), visual deficits, and/or ophthalmoplegia, and requires emergent MRI.[66, 68] Apoplexy is commonly associated with pituitary adenomas (up to 90% of the time).[68]

The Congress of Neurological Surgeons also recommends follow-up MRI for patients with known nonfunctional pituitary adenomas after surgery or radiation therapy, but notes that the evidence is insufficient to make recommendations about the frequency of imaging with the exception of surveillance. Additionally, subtotal resections should be followed more closely than gross total ones, and surveillance should begin at least 3 months after surgical intervention.[69]

For patients with functional adenomas that are causing acromegaly, the Endocrine Society recommends MRI at least 12 weeks after surgery or serial MRI in patients receiving pegvisomant medical therapy,[65] while the American College of Radiology recommends MRI with and without contrast for further characterization of thepostoperative sella.[66]

A pituitary incidentaloma is a previously unsuspected pituitary lesion that is discovered on an imaging study performed for an unrelated reason.[70] The majority of pituitary incidentalomas are adenomas and the condition is prevalent occurring in 10% of autopsy specimens.[70] For incidentalomas identified on CT, the Endocrine Society recommends a dedicated MRI to further characterize. For adenomas that are not treated, the Endocrine Society recommends periodic surveillance at 6 months and 1 year with suggested tapering of subsequent follow up frequency for stable findings.[70]

Pituitary incidentaloma

Applies to pituitary lesions incidentally discovered on advanced imaging that have not been fully characterized with a dedicated pituitary protocol MRI.

Advanced imaging is considered medically necessary for the diagnosis of an incidentaloma greater than or equal to 5 mm that is not a simple cyst.

IMAGING STUDY

- MRI brain

Rationale

Incidental pituitary findings are common, occurring in nearly 25% of postmortem studies. Improvements in advanced imaging techniques including isotropic CT reconstruction and increased MRI Tesla strength have increased the number of pituitary lesions ("incidentalomas") discovered on brain imaging for other clinical indications. The vast majority of incidentalomas are benign and the likelihood of growth is related to size. Pituitary cysts are most likely congenital Rathke's cleft cysts and do not require treatment. Mixed solid/cystic lesions less than 10 mm are most likely microadenomas and are rarely functional. Lesions less than 10 mm, especially those less than 5 mm, have a very low probability of further growth.[71] The recent ACR consensus based white paper on incidental pituitary findings does not recommend follow up for simple cysts or mixed solid/cystic lesions less than 10 mm.[71] There is no prospective evidence on the value of surveillance imaging in patients with small pituitary incidentalomas.

Tumor – not otherwise specified

See Oncologic Imaging guidelines for management of an established malignancy

Advanced imaging is considered medically necessary for diagnosis, management, and surveillance of tumor when suggested by prior imaging.

IMAGING STUDY

- CT brain
- MRI brain

Exclusions: In the absence of suspicious features (hemorrhage, contrast enhancement, calcifications), routine surveillance of the following lesions is not indicated:

- *Arachnoid cyst*
- *Pineal cyst*
- *Lipoma*
- *Epidermoid*

Rationale

MRI brain has the highest diagnostic accuracy in the evaluation of suspected intracranial neoplasm due to superior soft tissue contrast. Magnetic resonance spectroscopy (MRS) has moderate diagnostic accuracy in determining the grade of a glioma and distinguishing recurrent tumor from radiation necrosis[72, 73] but adds little to brain MRI in the evaluation of suspected disease. Furthermore, lack of standardized protocols for MRS limit test reproducibility and reliability and the impact on patient management is unclear. For these reasons, the Centers for Medicare and Medicaid has issued a national noncoverage determination for MRS.[74]

Pineal cysts generally show a benign course with very rare need for intervention. Features that are associated with a greater risk of hydrocephalus or malignancy include hemorrhage or contrast enhancement on MRI, as well as calcification.[76] In the absence of suspicious features, cyst growth is uncommon, and long-term neurosurgical follow-up is not routinely indicated.[77]

Miscellaneous Conditions

Bell's palsy (peripheral facial nerve palsy)

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Additional neurologic findings suggestive of intracranial pathology (atypical presentation)
- Symptoms persisting beyond 6 weeks in the absence of additional neurologic findings

IMAGING STUDY

- CT brain
- MRI brain

Rationale

Bell's palsy is an idiopathic disruption of facial nerve function that typically manifests as facial nerve paralysis and ipsilateral facial muscle weakness. It is most commonly self-limiting, resolving in 60%-90% of patients.[78, 79] While Bell's palsy is a diagnosis of exclusion, it is rare for intracranial lesions to cause isolated facial nerve palsy.[78] Neuroimaging for Bell's palsy is generally reserved for patients with additional neurological signs and/or symptoms or in cases that fail to respond in a self-limited fashion. When imaging is appropriate, MRI is recommended over CT,[80] as MRI can visualize both the cisternal and intracanalicular course of the 7th cranial nerve.

Specialty society and practice based guidelines recommend against routine imaging for Bell's palsy. The American Academy of Otolaryngology Guideline recommends that clinicians not routinely perform diagnostic imaging for patients with new-onset Bell's palsy.[81] The American College of Radiology states "In general, Bell's palsy patients need not be imaged unless the symptoms are atypical or persist for > 2 months."[80]

Hematoma or hemorrhage – intracranial or extracranial

Also see Vascular Imaging

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain

Horner's syndrome

Also see Chest Imaging and Head and Neck Imaging guidelines.

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- MRI brain
- CT brain when MRI cannot be performed or is nondiagnostic

Rationale

Horner's syndrome is condition that results from a disruption of the sympathetic nervous supply to the eye and is characterized by the triad of miosis, ptosis, and anhidrosis.[82]

Evaluation of Horner's syndrome begins with a complete neurological and ophthalmological examination, which may reveal an etiology for the condition such as surgical trauma. Additional neurological features such as additional cranial nerve deficits may localize the pathology to the brain, in which case a sequential diagnostic testing strategy starting with brain MRI may be possible. In nonlocalized cases, the entire course of the oculo sympathetic pathway may need to be visualized, includingan MRI of the brain and an MRI, CT, or MRA/CTA of the neck if there is concern for carotid dissection as a cause. The yield of diagnostic imaging in isolated Horner's syndrome is approximately 15%-20%[83, 84] and the most common etiologies identified by neuroimaging are carotid artery dissections and cavernous sinus masses.

Children can also develop Horner's syndrome and neuroimaging—typically MRI of the head, neck, and sometimes chest—identifies a cause in up to 33% of patients.[85] Unlike with adults, neoplasms such as neuroblastoma and Ewing sarcoma are the most common etiologies for Horner's syndrome identified by neuroimaging.

Hydrocephalus/ventricular assessment

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Evaluation of signs or symptoms suggestive of increased intracranial pressure or hydrocephalus
    - Ultrasound required for initial evaluation in patients under 5 months of age
- Diagnosis and management of congenital or secondary hydrocephalus
- Diagnosis of idiopathic normal pressure hydrocephalus (NPH) presenting with gait disturbance, cognitive impairment, and/or urinary incontinence
- Management of established hydrocephalus and ventricular shunts

IMAGING STUDY

- CT brain
- MRI brain

Rationale

Hydrocephalus is dilation of the ventricular system resulting from obstruction of cerebrospinal fluid flow or excess production.[86] Hydrocephalus can be further classified based on physiology and time of onset. Physiologically, hydrocephalus can be communicating (no macroscopic obstruction to cerebrospinal fluid (CSF) flow but inadequate resorption in the subarachnoid space) or obstructive (where a mass lesion blocks CSF flow within the ventricular system). Temporally, hydrocephalus can be classified as congenital (present at birth) or acquired (occurring after birth).[87] Neuroimaging can be used to diagnose hydrocephalus based on clinical signs and symptoms of increased intracranial pressure and to follow changes in ventricular size after treatment or when recurrence is suspected.

Congenital hydrocephalus is most commonly caused by aqueductal stenosis, which can be visualized on MRI. Other etiologies such as neural tube defects, Chiari malformation, and Dandy-Walker Syndrome are disorders of brain parenchy maformation optimally visualized by MRI. While the evidence is insufficient to recommend a specific threshold for ventricular size change to evaluate treatment response,[88] changes in ventricular size measured by either CT or MRI can be helpful to assess for shunt malfunction.[89]

Idiopathic normal pressure hydrocephalus (NPH) is a type of acquired hydrocephalus that typically occurs in older adults and is characterized by the triad of gait disturbance, urinary incontinence, and memory impairment. NPH is also characterized by the presence of normal CSF pressure on lumbar puncture (LP), neuroimaging findings of enlarged cerebral ventricles, and improvement after ventricular shunting. While neuroimaging—either by MRI or CT—can suggest the diagnosis of NPH, there is inconsistent and insufficient evidence for the prognostic value of imaging findings such as periventricular fluid and aqueductal flow voids.[90] However, moderate quality evidence suggests that the

presence of one of the triad symptoms and suggestive MRI features are highly predictive of a positive tap test and shunt responsiveness In neonates with open fontanelles, cranial ultrasound allows reliable assessment of hydrocephalus and is the initial imaging modality of choice, since it does not require exposure of this high-risk population to ionizing radiation (unlike CT), or sedation and/or prolonged immobility (unlike MRI).[91]

Acquired hydrocephalus can also be secondary due to obstructing lesions such as intraventricular tumors, intraventricular hemorrhage, or colloid cysts. Therefore, neuroimaging plays a central role in identifying an etiology for obstruction, with MRI being more sensitive than CT in the majority of cases.[86]

Neurocutaneous disorders

Includes neurofibromatosis, Sturge-Weber syndrome, tuberous sclerosis, and von Hippel-Lindau disease

Advanced imaging is considered medically necessary for diagnosis and management (including perioperative evaluation) of central nervous system lesions associated with a known neurocutaneous disorder.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Pseudotumor cerebri

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Seizure disorder and epilepsy

ADULT

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

Diagnosis

- Initial evaluation of a new or changing pattern of seizures, to rule out a structural brain lesion as a cause of seizure

Management of patients without a confident diagnosis of idiopathic generalized epilepsy in **ANY** of the following scenarios:

- Evaluation of seizures increasing in frequency or severity despite optimal medical management
- Prior to discontinuation of anticonvulsant therapy in patients who have not been previously imaged
- Epilepsy refractory to optimal medical management in surgical candidates

PEDIATRIC

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- Neonatal/infantile seizure (age 2 years or younger) when **EITHER** of the following is present:
    - Initial evaluation of seizure not associated with fever
    - Periodic follow up at 6 month intervals up to 30 months, if initial imaging study is nondiagnostic
- Childhood/adolescent seizure (over age 2) when **ANY** of the following is present:
    - Focal neurologic findings at the time of the seizure
    - Persistent neurologic deficit in the postictal period

  - Idiopathic generalized epilepsy with atypical clinical course
  - Partial seizures
  - Electroencephalogram (EEG) findings inconsistent with idiopathic epilepsy
- Complex febrile seizure (age 6 months to 5 years) when **EITHER** of the following is present:
  - More than one seizure during a febrile period
  - Seizure lasting longer than 15 minutes

Management of patients without an established diagnosis of idiopathic generalized epilepsy in **ANY** of the following scenarios:

- Evaluation of seizures increasing in frequency or severity despite optimal medical management
- Prior to discontinuation of anticonvulsant therapy in patients who have not been previously imaged
- Epilepsy refractory to optimal medical management in surgical candidates

Note: Imaging is not generally indicated for simple febrile seizures.

IMAGING STUDY

- CT brain
- MRI brain
- Functional MRI (fMRI) in epilepsy refractory to optimal medical management in surgical candidates when done as a replacement for a Wada test or direct electrical stimulation mapping
- PET brain imaging in epilepsy refractory to optimal medical management in surgical candidates when done to identify a focus of seizure activity

Rationale

Epilepsy is a heterogeneous group of disorders, with variations in seizure types, age of onset, and underlying pathology. The lifetime risk of developing a seizure can be as high 8%-10% in the general population with 0.5% to 1% occurring while in childhood.[92] Functional and/or structural imaging is often crucial in the evaluation of underlying systemic etiologies or abnormal pathology as well as to direct further therapy.

Adult seizures

The use of advanced imaging is indicated for the initial evaluation of adults with seizure in order to identify a treatable structural cause such as a bleed or a tumor.[93] The preferred modality is MRI due to its superior sensitivity over CT imaging.[93] Other indications for neuroimaging in adults include evaluation for structural abnormalities with change in seizure severity and frequency, as well as prior to discontinuation of anti-epileptic therapy if prior neuroimaging was not completed.

Pediatric seizures

For pediatric febrile seizure, the American Academy of Pediatrics does not recommend advanced imaging.[94] The diagnostic yield of clinically significant abnormalities is very low; thus, imaging findings rarely impact management.[95] Complex febrile seizures are defined as those that are focal onset, recurrent during the febrile illness, or prolonged (lasting morethan 10 to 15 minutes).[96] While the diagnostic yield remains low[97] and the management impact is controversial,[95, 96] MRI may be appropriate for neonates/infants with complex febrile seizures given their substantially increased likelihood (odds ratio = 4.3 [95% CI, 1.2-15.0]) of structural abnormalities on MRI relative to simple seizures.[95] In pediatric patients with idiopathic generalized epilepsy diagnosed by EEG, the diagnostic yield is low (8%), and neuroimaging is not routinely warranted.[93] When other patterns are present, pediatric patients are more likely to have a structural cause for their seizures.[93] Imaging should be considered in individuals with any suggestion of a focal onset on history, examination, or EEG (unless there is clear evidence of benign focal epilepsy) as well as seizures refractory to first-line medication. The diagnostic yield in patients < 2 years old with focal neurological abnormalities or focal seizures can range from 22%-27%.[98,99] When imaging is indicated, MRI is the preferred imaging modality[93] for its high diagnostic accuracy and lack of ionizing radiation. CT is an option if MRI is not available, contraindicated, or requires sedation.[93] In an acute setting, CT may be preferred for expedient determination of acute neurological lesion or illness.[93]

Preoperative evaluation

In a meta-analysis evaluating the predictive value of MRI findings and benefit of epilepsy surgery, the odds of postoperational seizure-free rate were 2.03 times higher in MRI-positive patients (odds ratio=2.03 [95% CI, 1.67-2.47];

P<.00001).[100] The utility of MRI is further augmented with functional imaging in patients with refractory seizure and undergoing surgical treatment. Functional MRI can be used for presurgical evaluation of treatment-refractory seizure patients as a replacement for a Wada test or direct electrical stimulation mapping. In a 2015 single institution case series comparing electrocortical stimulation (ECS) and fMRI for localization of somatosensory and language cortex defects, ECS only identified somatosensory-related and language-related sites in 75% and 58% of the patients, respectively; fMRI revealed somatosensory-related sites in anatomically meaningful locations in 100% of the patients.[101] A second small single center case series study employing fMRI prior to surgery found that 7 out of the 9 surgery patients had imaging abnormalities concordant with surgical resection.[102]

FDG-PET imaging also plays a role in presurgical evaluation of patients with medication-refractory epilepsy. A 2013 systematic review that included 39 studies reported that PET hypometabolism showed a 56%-90% agreement with seizure onset localized by intracranial electroencephalogram (EEG) in adults and 21%-86% in children.[103] In another recent systematic review of 13 primary studies, the proportion of adult and pediatric patients in whom PET correctly localized a seizure focus and had a good surgical outcome ranged from 36% to 89%. When PET results were combined with MRI or EEG, the sensitivity of detecting adult patients with good outcome increased by 8% to 23%. In terms of impact on patient management, PET findings influenced the clinical decision in 53% to 71% of adult patients and 51% to 95% of pediatric patients.[103]

Spontaneous intracranial hypotension (SIH)

Also see Spine Imaging guidelines

Imaging is considered medically necessary for diagnosis in the setting of an orthostatic headache.

IMAGING STUDY

- MRI brain (preferred)
- CT brain

Rationale

Spontaneous intracranial hypotension (SIH) refers to a state of decreased cerebrospinal fluid (CSF) due to a spontaneous or idiopathic source of leakage, typically of spinal origin.[104] The condition is relatively rare with an estimated incidence of 2-5 per 100,000[105] and typically presents with an orthostatic headache in the setting of a low (< 6 cm H_2O) CSF pressure and only very rarely without headache.[104] MRI brain is nonspecific but findings such as pachymeningeal enhancement, subdural effusions, sagging of the brain parenchyma with sulcal and cisternal effacement support the diagnosis are a part of the International Classification of Headache Disorders (ICHD) criteria.[105] CT myelography may also be indicated to evaluate for an intracranial or spinal CSF leak and is covered in the Spine Imaging guidelines.

Stroke or transient ischemic attack (TIA)

Also see Vascular Imaging guidelines.

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain is preferred for evaluation of acute hemorrhagic stroke
- MRI brain is preferred for subacute or chronic hemorrhage and ischemia
- CT perfusion

Rationale

Stroke is the fifth leading cause of mortality and one of the leading causes of morbidity in the U.S. The American Stroke Association predicts that nearly 800,000 people will suffer a stroke in 2018, of which more than 120,000 will die.[106] A stroke is a condition caused by insufficient blood flow to the brain. The 2 main types of stroke are ischemic and hemorrhagic. Ischemic strokes are caused by an occlusion of an arterial blood vessel and comprise almost 90% of all strokes.[107] These can develop locally (thrombotic stroke) or originate from other parts of the body (embolic stroke). Hemorrhagic strokes, on the other hand, are caused by bleeding, either intraparenchymal or subarachnoid. In both forms, patients may acutely present with partial o r full paralysis of muscles, vision and speech disturbances, or change in level of consciousness.[106]

Transient ischemic attack (TIA) has been traditionally defined as the sudden loss of neurologic function that recovers completely within 24 hours. TIA confers an increased risk of stroke—11.3% (95% CI, 7.5% to 16.6%) within the subsequent 90 days[108]—and may be related to mimics such as migraine, epilepsy, functional disorders, and neoplasm in up to 50% of cases. Although the diagnostic yield of neuroimaging for an alternative etiology is low (< 5%),[108] imaging with CT or MRI is important to exclude a rare but treatable structural cause like a tumor or subdural hemotoma. As

clinical prediction rules—such as the ABCD2 score—miss up to 20% of post-TIA strokes[109] and as MRI (with diffusion-weighted imaging) may identify strokes in up to 34% of patients,[108] neuroimaging may be helpful in selecting patients for subsequent treatment, which may include more aggressive medical management such as dual antiplatelet therapy and high-dose statin therapy.[110] Vascular imaging may be indicated to identify critical extracranial stenosis, as these patients benefit from carotid endarterectomy or stenting[111] and echocardiography may be used to diagnose atrial fibrillation.[112]

Patients presenting with acute stroke who are candidates for tissue plasminogen activator (tPA) or mechanical thrombectomy benefit from immediate advanced brain and head and neck vascular imaging (CT/CTA or MR/MRA), as advanced imaging was a major selection criterion for the 5 recent randomized control trials—MR CLEAN, ESCAPE, REVASCAT, SWIFT PRIME, and EXTEND IA)—that established the net benefit of thrombectomy in selected patients.[113] With the recent publication of the DAWN and DEFUSE-3 trials, patients with acute stroke and wake-up stroke presenting with 6-24 hours may be candidates for thrombectomy when MR or CT perfusion shows a mismatch between at risk tissue and infarct core.[114,115]

In patients presenting with stroke who are not candidates for tPA or mechanical thrombectomy, stroke evaluation may involve neuroimaging to establish the diagnosis and vascular imaging to identify critical extracranial stenosis or as otherwise needed to inform management.[106, 116]

Regarding modality selection for vascular imaging, ultrasound has comparable sensitivity (> 95%) to advanced noninvasive vascular imaging (CTA/MRA) for anterior circulation TIA or stroke. Ultrasound also has good negative predictive value for critical stenosis, and is often used as an initial exam with advanced vascular imaging as a problem solving tool or for preoperative planning.[117,118,119] For posterior circulation infarcts, advanced vascular imaging is more sensitive than ultrasound and is usually the primary modality of choice when indicated to direct management.[120]

Trigeminal neuralgia and persistent idiopathic facial pain (Adult only)

Also see Vascular Imaging guidelines

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- MRI brain (to evaluate for a structural lesion or demyelinating disease as a cause of symptoms)

Perioperative/Periprocedural Imaging

Lumbar puncture risk assessment

Advanced imaging is considered medically necessary when at least **ONE** of the following is present:

- Papilledema
- Absent venous pulsations on funduscopic exam
- Altered mental status
- Abnormal neurological exam
- Evidence of meningeal irritation

IMAGING STUDY

- CT brain

Rationale

According to the American College of Emergency Physician Clinical Policy Statement on Acute Headache,[121] adult patients with headache and exhibiting signs of increased intracranial pressure (e.g., papilledema, absent venous pulsations on funduscopic examination, altered mental status, focal neurologic deficits, signs of meningeal irritation) should undergo a neuroimaging study before having a lumbar puncture. In the absence of clinical findings suggestive of increased intracranial pressure, a lumbar puncture can be performed without obtaining a neuroimaging study.

Signs and Symptoms

Advanced imaging based on nonspecific signs or symptoms is subject to a high level of clinical review. Appropriateness of imaging depends upon the context in which it is requested. At a minimum, this includes a differential diagnosis and temporal component, along with documented findings on physical

exam. Additional considerations that may be relevant include comorbidities, risk factors, and likelihood of disease based on age and gender. In general, the utility of structural brain imaging is limited to the following categories, each with a unique set of clinical presentations:

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

Abnormality on neurologic exam

Advanced imaging is considered medically necessary for diagnosis and management when **ALL** of the following apply:

- A focal abnormality is present on neurologic evaluation
- The abnormality has not been evaluated by advanced imaging, or has progressed since prior advanced imaging
- The abnormality is concerning for intracranial pathology

Note: This guideline does not apply to diffuse abnormalities such as generalized weakness.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Ataxia

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Dizziness or vertigo

Also see Head and Neck Imaging guidelines

Advanced imaging is considered medically necessary in **ANY** of the following scenarios:

- When associated with additional signs or symptoms suggestive of a central nervous system lesion
- Tullio's phenomenon (noise-induced dizziness)
- Symptoms associated with abnormal audiogram or vestibular function testing suggestive of an intracranial or vestibulocochlear mass lesion

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

IMAGING STUDY

- CT brain
- MRI brain

Rationale

Dizziness is a nonspecific term used to describe the sensation of disturbed or impaired spatial orientation without a false or distorted sense of motion. Up to 40% of all Americans will seek medical attention for dizziness at some point in their lives.[122] Vertigo is a type of dizziness causing the sensation of self-motion (of head/body) when no self-motion is occurring or the sensation of distorted self-motion during an otherwise normal head movement. The differential

diagnosis for vertigo may encompass benign to acutely life-threatening etiologies such as benign positional vertigo, migraines, stroke/TIA, acute vestibular syndrome, or Meniere's disease. The initial history and physical examination are key to confirming a suspected diagnosis and guiding additional diagnostic evaluation.

In patients with isolated vertigo without additional neurological signs or symptoms, the diagnostic yield of identifying a structural cause is low. In a large single institutional retrospective study (n = 1028), CT found structural causes for dizziness or vertigo in only 6.1% of patients (only 0.74% clinically significant).[122] In a retrospective study comparing different imaging modalities for the workup of dizziness, the likelihood of CTA and MRI affecting management has been reported in the range of 1.1%-1.3%.[123] The diagnostic yield for imaging of patients with benign positional vertigo on clinical exam is also low, such that advanced imaging is not warranted. The American Academy of Otolaryngology–Head and Neck Surgery recommends that "clinicians should not perform imaging for a patients who meets diagnostic criteria for benign paroxysmal positional vertigo in the absence of signs of symptoms inconsistent with BPPV" and to "reassess patients within 1 month after an initial period of observation or treatment to document resolution or persistence of symptoms."[124]

When central vertigo is suspected, prompt use of advanced imaging is generally appropriate to rule out acute potentially life-threatening causes. The odds ratios for identifying stroke in patients presenting with gait instability, neurologic findings, and focal neurologic deficits were 9.3, 8.7, and > 20, respectively.[125] In a 2 single-center retrospective studies, MRI changed management in 16%-21.6% of patients with central vertigo.[126,127] CT imaging may also be performed, although MRI is more sensitive than CT for detection of posterior fossa strokes.[125, 127]

Headache

Advanced imaging is considered medically necessary to evaluate for an intracranial lesion as a secondary cause of headaches in **ANY** of the following scenarios:

- Characteristics not typical for migraine or tension type headache (**ANY** of the following):
    - Thunderclap or sentinel headache, sudden onset and severe (worst headache of life), reaching maximal intensity within minutes
    - Headache triggered by or occurring primarily in association with exertion or Valsalva including cough, exercise, or sexual activity
    - Positional or orthostatic headache
    - New onset of headache over age 50
    - Change in headache pattern
    - Abnormal neurological exam
    - Unexplained and unexpected increase in frequency and/or severity of headaches
- Comorbid conditions that increase the likelihood of an intracranial lesion, including malignancy, immunosuppression, sarcoidosis, neurocutaneous disorders (phakomatoses), or pregnancy
- Initial evaluation of trigeminal autonomic cephalgia (TAC), including cluster, paroxysmal hemicrania/hemicrania continua, and short-lasting unilateral neuralgiform headache

Note: For headache known or suspected to be related to trauma, spontaneous intracranial hypotension, infection, or other specific diagnoses, please refer to those indications in the Brain Imaging guidelines.

For headache known or suspected to be secondary to aneurysm, dissection, venous sinus thrombosis, or other specific vascular diagnosis, please refer to those indications in the Vascular Imaging guidelines.

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Rationale

Headache is the most common neurological complaint seen by general practitioners and neurologists. It accounts for 1%-4% of primary care consultations, 1%-4% of emergency department visits,[128, 129] and up to 30% of neurology appointments.[130,131] Additional advanced imaging evaluation should be avoided, as the likelihood of changing management or identification of relevant abnormality is low.[132] In a systematic review and meta-analysis of incidental brain MRI findings based on 16 studies and 19,559 patients, the prevalence of incidental findings excluding markers of cerebrovascular disease was 2.7%, including 0.7% intracranial neoplasms, 0.35% intracranial aneurysms, and 0.5%

arachnoid cysts.[133] In addition to uncertainty around management for some of these incidental findings, particularly tiny aneurysms, there is the risk of over-testing and over-diagnosis. These incidental findings are particularly difficult in patients with headache who are at low risk for a structural cause and may lead the incidental finding to be misattributed as a cause of the headache.[134] [135] [136] [137] [138] Secondary headaches, especially with focal neurologic symptoms, can be a harbinger of life-threatening and high-morbidity neurological conditions including subarachnoid or subdural hemorrhage, arteriovenous malformation, intracranial neoplasm, and hydrocephalus. Neuroimaging with CT and/or MRI plays a central role in early and accurate diagnosis of these clinically significant conditions.

Headache with a pattern change or increasing in frequency and/or severity without a pattern change

The majority of patients presenting with characteristic primary headaches will have spontaneous resolution of their symptoms. When headaches fail to respond to conservative therapy or change in pattern, frequency, or severity, additional imaging may be required. Consensus exists among a number of high quality guidelines that further investigation, including neuroimaging, is appropriate in the following scenarios:

- Change in headache frequency, characteristics, or associated symptoms[130]
- Any recent change in the presentation of a primary headache that is suggestive of a secondary headache[131]
- Patients with headaches that do not fit the typical pattern of migraine or tension-type headache, and patients with a major change in headache pattern should be considered for specialist consultation and/or neuroimaging, depending on the clinical judgment of the practitioner[139]
- Chronic headache with new feature or neurologic d eficit[140]
- Subacute and/or progressive, worsening headaches over weeks to months; rapidly increasing headache frequency[141]
- Patients with progressive headache lasting weeks[142]

When neuroimaging is warranted, MRI is preferred over CT imaging due to its superior sensitivity.[143] CTA and MRA can be used as an adjunct to CT/MRI imaging when initial advanced imaging fails to reveal a cause and evaluation of the cerebral and cervical vessels is required.

Chronic headache (including typical migraine or tension headaches) without neurological signs or symptoms

Neuroimaging for patients with primary headache or chronic daily headache without additional neurological signs or symptoms has a low diagnostic yield. Based on high-quality evidence based guidelines, further investigation including neuroimaging is usually not appropriate. Clinicians should use a detailed headache history—that includes duration of attacks and the exclusion of secondary causes—as the principal means to diagnose primary headache. Additional testing in patients without atypical symptoms or an abnormal neurologic examination is unlikely to be helpful.[141] In all cases, chronic daily headache existing for less than 6 months should be explored.[131] In slowly progressive headaches developing over weeks to months, there may be an indication for CT or MRI scan, and—if the neuroimaging examination is negative—for cerebrospinal fluid analysis.[142] When neuroimaging is warranted, MRI is preferred over CT imaging for its superior sensitivity.[143] SPECT and PET provide minimal diagnostic value even in patients who experience unusual and/or severe attacks when attacks can be fully accounted for by the standard headache classification (IHS).[144]

Headache with neurologic signs, symptoms or seizures

Neuroimaging is usually appropriate for patients with headaches accompanied by neurologic signs, symptoms or seizures based on consensus among multiple high-quality evidence based guidelines. Emergency care is recommended for headache associated with neurological signs.[131] The presence of subtle neurological signs suggests a secondary cause for headache. For example, meningismus, confusion, altered level of consciousness, memory impairment, papilledema, visual field defect, cranial nerve abnormalities, pronator drift, extremity weakness, significant sensory deficits, reflex asymmetry, extensor plantar response, or gait disturbance when accompanying a headache should elicit caution.[141] In addition, patients with unexplained focal neurological signs and recurrent headache require specialist referral and/or neuroimaging to exclude a space-occupying central nervous system lesion. MRI is preferred in the non-urgent setting.[139] Patients presenting to the emergency department with headache and new abnormal findings on neurologic examination (focal deficit, altered mental status, altered cognitive function) should undergo emergent non contrast head CT.[145] In patients with atypical headache patterns, a history of seizures, or neurological signs or symptoms, or symptomatic illness such as tumors, AIDS, or neurofibromatosis, MRI may be indicated (to be carefully evaluated in each case).[144] Further investigation and/or referral for people who present with or without migraine headache and with atypical aura symptoms, motor weakness, double vision, visual symptoms affecting only one eye, poor balance, or decreased level of consciousness is also warranted.[130]

Sudden onset severe headache (including worst ever and thunderclap)

Neuroimaging in headache patients with sudden onset or thunderclap headache (peak intensity within one minute) is recommended by multiple high-quality evidence-based guidelines and moderate-quality evidence. Until there is evidence to the contrary, all patients complaining of headache who fulfill one criterion of the Ottawa clinical decision rule should be suspected of having subarachnoid hemorrhage.[146] A patient who presents with sudden-onset headache or headache associated with a neurological deficit should have an emergency CT scan.[121] CTA should be used to identify an an eurysmor other vascular malformation if there is a subarachnoid hemorrhage.[147] MRI with MR angiography can be the first-line exploration if therapeutic management is not delayed. If subarachnoid hemorrhage is suspected and the

imaging results do not provide evidence for the diagnosis, a lumbar puncture should always be performed, even if the headache has subsided.[131]

Headache associated with cough, exertion or sexual activity (Valsalva headaches)

Valsalva or exertional headaches can signal an intracranial abnormality, usually of the posterior fossa.[141]

Multiple evidence-based guidelines recommend neuroimaging for Valsalva headache, although the evidence quality supporting this risk factor is low-quality. Findings concerning for more insidious underlying pathology include exertional headaches that are new onset, occur after age 40, last beyond a few hours, or are accompanied by vomiting or focal neurologic symptoms.[140] Patients with headache clearly precipitated by exertion, cough, or Valsalva should be considered for specialist referral and/or a brain MRI scan to exclude a Chiari 1 malformation or a posterior fossa lesion.[139]

Headache in the pediatric population

Headaches in children are extremely common. The estimated prevalence of headache in children and adolescents is close to 60%. The vast majority of childhood headaches are primary. In the primary care setting, approximately 1.1% (in a cohort of 48,575 children) had a secondary cause for their headache.[148] Advanced imaging in childhood headaches in the absence of other neurological abnormalities has a very low yield in terms of intracranial pathology (0.9%-1.2%).[149] Secondary headaches, however, are more common in very young patients and in those with high-risk features.[150,151] Neuroimaging is recommended for patients with an abnormal neurological exam.[152] Other high-risk clinical features, based primarily on clinical consensus on extrapolations from the adult headache literature include change in the pattern or intensity of a headache, headache that awakes from sleep, and headaches that are not responsive to medical management[151] although evidence supporting the increased relative risk of these headache features is very limited and the pretest probability remains low.[153, 154] Similar to adults, sudden onset "worst headache of life" should be urgently evaluated to exclude subarachnoid hemorrhage.[150] When neuroimaging is indicated, MRI is generally preferred due to its higher diagnostic accuracy for secondary causes and lack of ionizing radiation.

Hearing loss

Also see Head and Neck Imaging guidelines

ADULT

Advanced imaging is considered medically necessary for detecting a structural cause of hearing loss in **EITHER** of the following scenarios:

- Conductive hearing loss
- Sensorineural hearing loss characterized by **ANY** of the following features:
    - Idiopathic sudden onset hearing loss
    - Gradual onset of unilateral or asymmetric hearing loss demonstrated by audiometric testing (15 dB or greater at 2 consecutive frequencies between 0.5 and 8 kHz)
    - Hearing loss associated with at least one neurologic sign or symptom known to increase the pretest probability of a retro cochlear lesion

PEDIATRIC

Advanced imaging is considered medically necessary to evaluate for a structural cause of sensorineural, conductive, or mixed hearing loss.

IMAGING STUDY

- MRI brain for evaluation of sensorineural hearing loss
- CT orbit, sella, posterior fossa and outer, middle, or inner ear for evaluation of sensorineural hearing loss in pediatric patients; or in adult patients when MRI cannot be performed or is nondiagnostic
- CT orbit, sella, or posterior fossa and outer, middle, or inner ear for evaluation of conductive hearing loss
- MRI brain or CT orbit, sella, or posterior fossa and outer, middle, or inner ear for evaluation of
- mixed hearing loss, based on clinical scenario

Rationale

The primary purpose of imaging sensorineural hearing loss is to detect retro cochlear pathology, typically a tumor of the vestibular nerve (cranial nerve 8) or cerebellopontine angle (CPA). More than 85% of these tumors are acoustic neuromas (also called vestibular schwannomas). However, vestibular schwannomas are rare, with an overall prevalence of 1 per 100,000, and they are found in only 2% to 8% of patients with autoimmune sensorineural hearing loss.

A 15 dB or greater difference at 2 consecutive frequencies has a sensitivity of 97% and a specificity of 49% for the diagnosis of vestibular schwannoma. For optimum specificity (~67%) with high sensitivity (~90%) the American Academy of Otolaryngology–Head and Neck Surgery protocol is recommended, which proposes ≥ 15 dB between ears, averaging 0.5 to 3 kHz.[155]

MRI of the head and the internal auditory canal, commonly known as an IAC protocol, is most effective in screening for CPA tumors. Clinicians should not order CT of the head/brain in the initial evaluation of a patient with presumptive sudden sensorineural hearing loss.[156]

Mental status change and encephalopathy

Advanced imaging is considered medically necessary for initial evaluation when documented by neurologic exam and when unexplained by initial clinical and laboratory evaluation.

IMAGING STUDY

- CT brain
- MRI brain

Papilledema

Advanced imaging is considered medically necessary for diagnosis and management.

IMAGING STUDY

- CT brain
- MRI brain

Syncope

Also see Vascular Imaging guidelines.

Advanced imaging is considered medically for evaluation when **ANY** of the following features are present:

- Documented abnormality on neurological examination
- Presence of at least one persistent neurological symptom
- Seizure activity at the time of the episode

IMAGING STUDY

- CT brain
- MRI brain

Rationale

Syncope is a common medical complaint that is rarely due to intracranial disease. Multiple North American specialty societies recommend against routine neuroimaging in the evaluation of syncope:

- American College of Emergency Physicians: “Avoid CT of the head in asymptomatic adult patients in the emergency department with syncope, insignificant trauma and a normal neurological evaluation.”[157]
- Canadian Society of Internal Medicine: “Don’t routinely obtain neuro-imaging studies (CT, MRI, or carotid dopplers) in the evaluation of simple syncope in patients with a normal neurological examination.”[158]
- Canadian Association of Emergency Physicians: “Don’t order CT head scans in adult patients with simple syncope in the absence of high-risk predictors.”[159]

A recent systematic review of 15 studies evaluating syncope patients (N = 6944) found a high prevalence of neuroimaging (57% CT, 10% MRI), but very low diagnostic yield (1.18% CT, 3.74%) MRI.[160] In unselected patients, the diagnostic yield approaches 0%.[161] However, patients with a focal neurological deficit have a significantly higher risk of

intracranial pathology, with an odds ratio of 5.2 (95% CI, 2.3-8.1) with non hemorrhagic infarct, intracranial hemorrhage and neoplasm being the most common etiologies.[162]

Tinnitus

Also see Vascular Imaging guidelines for evaluation of pulsatile tinnitus

Advanced imaging is considered medically necessary in **EITHER** of the following scenarios:

- Evaluation for vascular pathology when tinnitus is pulsatile in quality
- Evaluation for retro cochlear pathology when at least **ONE** of the following features is present:
    - Associated neurologic findings
    - Unilateral or asymmetric symptoms

IMAGING STUDY

- MRI brain
- CT orbit, sella, or posterior fossa and outer, middle, or inner ear when MRI cannot be performed or is nondiagnostic

Visual disturbance

Also see Head and Neck Imaging guidelines.

Advanced imaging is considered medically necessary in the following scenario:

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

IMAGING STUDY

- CT brain
- MRI brain (preferred)

Codes

The following code list is not meant to be all-inclusive. Authorization requirements will vary by health plan. Please consult the applicable health plan for guidance on specific procedure codes.

CPT/HCPCS

Specific CPT codes for services should be used when available. Non-specific or not otherwise classified codes may be subject to additional documentation requirements and review.

0042T	Cerebral perfusion analysis using CT with contrast administration, including post-processing of parametric maps with determination of cerebral blood flow, cerebral blood volume, and mean transit time
70450	CT head/brain, without contrast
70460	CT head/brain, with contrast
70470	CT head/brain, without contrast, followed by re-imaging with contrast
70480	CT orbit, sella, or posterior fossa or outer, middle or inner ear, without contrast
70481	CT orbit, sella, or posterior fossa or outer, middle or inner ear, with contrast
70482	CT orbit, sella, or posterior fossa or outer, middle or inner ear, without contrast, followed by re-imaging with contrast
70551	MRI brain (including brain stem), without contrast
70552	MRI brain (including brain stem), with contrast
70553	MRI brain (including brain stem), without contrast, followed by re-imaging with contrast
70554	MRI brain functional, not requiring physician or psychologist administration
70555	MRI brain functional, requiring physician or psychologist administration of entire neurofunctional testing

76390	MRI spectroscopy
78608	Brain imaging PET, metabolic evaluation
78609	Brain imaging PET, perfusion evaluation
A9552	Fluorodeoxyglucose f-18 fdg, diagnostic, per study dose, up to 45 millicuries
A9586	Florbetapir f18, diagnostic, per study dose, up to 10 millicuries
A9601	Flortaucipir f 18 injection, diagnostic, 1 millicurie
G0235	PET imaging, any site, not otherwise specified
Q9982	Flutemetamol f18, diagnostic, per study dose, up to 5 millicuries
Q9983	Florbetaben f18, diagnostic, per study dose, up to 8.1 millicuries
S8085	Fluorine-18 fluorodeoxyglucose (f-18 fdg) imaging using dual-head coincidence detection system (non-dedicated PET scan)

ICD-10 Diagnosis

Refer to the ICD-10 CM manual

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History

Status	Review Date	Effective Date	Action
Updated	-	09/01/2022	Added codes A9552 and A9601.
Revised	05/26/2021	03/13/2022	Independent Multispecialty Physician Panel (IMPP) review. Revised indications: Acoustic neuroma, Pituitary adenoma, Tumor, Headache. Added indications: Sickle cell disease, Meningioma, Pituitary incidentaloma. Added codes A9586, Q9982, and Q9983.
Revised	02/03/2020	03/14/2021	IMPP review. Revised indications: Ataxia, Acoustic neuroma, Pituitary adenoma, Tumor, Seizure disorder, Dizziness or vertigo, Headache, Hearing loss, Mental status change, Tinnitus. Added CPT code 0042T and HCPCS codes G0235 and S8085.
Revised	01/28/2019	09/28/2019	IMPP review. Revised indications: Infectious conditions – not otherwise specified (was Infection), Multiple sclerosis, Movement disorders, Neurocognitive disorders, Trauma, Pituitary adenoma, Tumor – not otherwise specified, Hematoma or hemorrhage, Hydrocephalus, Pseudotumor cerebri, Seizure refractory, Spontaneous intracranial hypotension, Trigeminal neuralgia, Abnormality on neurologic exam, Ataxia, Dizziness or vertigo, Headache, Hearing loss, Tinnitus.
Restructured	09/12/2018	01/01/2019	IMPP review. Advanced Imaging guidelines redesigned and reorganized to a condition-based structure. Incorporated Carelon guidelines for pediatric imaging.
Revised	07/11/2018	03/09/2019	IMPP review. Renamed the Administrative Guidelines to "General Clinical Guideline." Retitled Pretest Requirements to "Clinical Appropriateness Framework" to summarize the components of a decision to pursue diagnostic testing. Revised to expand applicability beyond diagnostic imaging, retitled Ordering of Multiple Studies to "Ordering of Multiple Diagnostic or Therapeutic Interventions" and replaced imaging-specific terms with "diagnostic or therapeutic intervention." Repeated Imaging split into two subsections, "repeat diagnostic testing" and "repeat therapeutic intervention."
Reaffirmed	08/15/2017	03/12/2018	Annual review.
Revised	11/01/2016	02/20/2017	IMPP review. Revised indications: Movement disorders, Frontotemporal lobe dementia and Alzheimer's disease. Added CPT code 78609 (PET brain). Restructured content and added clarification language.
Created	-	03/30/2005	Original effective date.