CLINICAL APPROPRIATENESS GUIDELINES

ADVANCED IMAGING

Appropriate Use Criteria: Imaging of the Brain

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Description and Application of the Guidelines

The AIM Clinical Appropriateness Guidelines (hereinafter “the AIM 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 AIM, 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 AIM 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. AIM reviews all of its Guidelines at least annually.

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

AIM 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 AIM 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. If requested by a health plan, AIM will review requests based on health plan medical policy/guidelines in lieu of the AIM Guidelines.

The Guidelines may also be used by the health plan or by AIM 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.

Administrative Guidelines

Ordering of Multiple Studies

Requests for multiple imaging studies to evaluate a suspected or identified condition and requests for repeated imaging of the same anatomic area are subject to additional review to avoid unnecessary or inappropriate imaging.

Simultaneous Ordering of Multiple Studies

In many situations, ordering multiple imaging studies at the same time is not clinically appropriate because:

- Current literature and/or standards of medical practice support that one of the requested imaging studies is more appropriate in the clinical situation presented; or
- One of the imaging studies requested is more likely to improve patient outcomes based on current literature and/or standards of medical practice; or
- Appropriateness of additional imaging is dependent on the results of the lead study.

When multiple imaging studies are ordered, the request will often require a peer-to-peer conversation to understand the individual circumstances that support the medically necessity of performing all imaging studies simultaneously.

Examples of multiple imaging studies that may require a peer-to-peer conversation include:

- CT brain and CT sinus for headache
- MRI brain and MRA brain for headache
- MRI cervical spine and MRI shoulder for pain indications
- MRI lumbar spine and MRI hip for pain indications
- MRI or CT of multiple spine levels for pain or radicular indications
- MRI foot and MRI ankle for pain indications
- Bilateral exams, particularly comparison studies

There are certain clinical scenarios where simultaneous ordering of multiple imaging studies is consistent with current literature and/or standards of medical practice. These include:

- Oncologic imaging – Considerations include the type of malignancy and the point along the care continuum at which imaging is requested
- Conditions which span multiple anatomic regions – Examples include certain gastrointestinal indications or congenital spinal anomalies

Repeated Imaging

In general, repeated imaging of the same anatomic area should be limited to evaluation following an intervention, or when there is a change in clinical status such that imaging is required to determine next steps in management. At times, repeated imaging done with different techniques or contrast regimens may be necessary to clarify a finding seen on the original study.

Repeated imaging of the same anatomic area (with same or similar technology) may be subject to additional review in the following scenarios:

- Repeated imaging at the same facility due to motion artifact or other technical issues
- Repeated imaging requested at a different facility due to provider preference or quality concerns

- Repeated imaging of the same anatomic area (MRI or CT) based on persistent symptoms with no clinical change, treatment, or intervention since the previous study
- Repeated imaging of the same anatomical area by different providers for the same member over a short period of time

Pre-Test Requirements

Critical to any finding of clinical appropriateness under the guidelines for specific imaging exams is a determination that the following are true with respect to the imaging request:

- A clinical evaluation has been performed prior to the imaging request (which should include a complete history and physical exam and review of results from relevant laboratory studies, prior imaging and supplementary testing) to identify suspected or established diseases or conditions.
- **For suspected diseases or conditions:**
  - Based on the clinical evaluation, there is a reasonable likelihood of disease prior to imaging; and
  - Current literature and standards of medical practice support that the requested imaging study is the most appropriate method of narrowing the differential diagnosis generated through the clinical evaluation and can be reasonably expected to lead to a change in management of the patient; and
  - The imaging requested is reasonably expected to improve patient outcomes based on current literature and standards of medical practice.
- **For established diseases or conditions:**
  - Advanced imaging is needed to determine whether the extent or nature of the disease or condition has changed; and
  - Current literature and standards of medical practice support that the requested imaging study is the most appropriate method of determining this and can be reasonably expected to lead to a change in management of the patient; and
  - The imaging requested is reasonably expected to improve patient outcomes based on current literature and standards of medical practice.
- 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 pre-test 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.

History

Status	Date	Action
Reviewed and revised	07/26/2016	Independent Multispecialty Physician Panel review and revision
Created	03/30/2005	Original effective date

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

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) 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 frequently 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 first. 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

Ataxia, congenital or hereditary

Includes ataxia-telangiectasia, fragile X syndrome, and congenital anomalies of the posterior fossa

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or MRI brain

Developmental delay (Pediatric only)

Advanced imaging is considered medically necessary for evaluation 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 or MRI brain

Congenital cerebral anomalies

Includes Chiari malformation, craniosynostosis, macrocephaly, and microcephaly

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or MRI brain
- Ultrasound required as the initial study to evaluate macrocephaly in patients under 5 months of age

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]

Infection

Infection

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or MRI brain

Inflammatory Conditions

Multiple sclerosis and other white matter diseases

Advanced imaging is considered medically necessary for diagnosis and management when results of imaging will impact treatment decisions.

IMAGING STUDY

- MRI brain
- CT brain (when MRI contraindicated)

Inflammatory conditions, unspecified

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or MRI brain

Trauma

Trauma

Does not apply to patients with bleeding diatheses or intracranial shunts in whom advanced imaging may be performed when the results will impact management decisions.

ADULT

Advanced imaging is considered medically necessary in the initial evaluation of head trauma when a mechanism of injury has been identified and **ANY** of the following features is 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

IMAGING STUDY

- CT brain for initial evaluation
- MRI brain (following CT, when required to direct management or inform prognosis)

PEDIATRIC

Advanced imaging is considered medically necessary in the initial evaluation of head trauma when **EITHER** of the following is present:

- Non-accidental injury
- Trauma associated with **ANY** of the following features:
  - 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

IMAGING STUDY

- CT or MRI brain

Rationale

AIM adult trauma guidelines follow well established clinical prediction rules for this indication. In particular, AIM 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.[12]

While both the New Orleans Criteria and the Canadian Head CT rules have excellent sensitivity (100% 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%),[13-15] resulting in improved overall diagnostic accuracy.

Of note, patients with new focal neurological deficits and seizures are usually candidates for neuroimaging regardless of whether they are post-traumatic, and altered mental status (Glasgow coma scale < 15) is also addressed in separate AIM 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[16] with—for example—subsequent separate multicenter geography validations.[17] Sensitivity of PECARN in this population is 98.8% (CI 89%-99.6%) and the rule did not miss neurosurgical head trauma in any pediatric patients.[16] While PECARN is less specific (53% vs 91%) compared to clinical gestalt, the rule is substantially more sensitive (~100% vs 60%),[18] although the greater specificity of clinical gestalt is questioned by other studies.[19] 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.[19]

High-risk mechanisms as defined in the AIM 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.[20] 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.[21] 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,[22] although there is currently no effective treatment.[23]

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.[24]

Tumor or Neoplasm

Acoustic neuroma (Adult only)

Also see indication for hearing loss.

Advanced imaging is considered medically necessary for management of known acoustic neuroma in **ANY** of the following scenarios:

- Symptoms suggestive of recurrence or progression
- Following conservative treatment or incomplete resection at 6, 18, 30, and 42 months

- Post resection baseline imaging and follow up at 12 months after surgery

IMAGING STUDY

- CT or MRI brain

Pituitary adenoma (Adult only)

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

- Diagnosis of suspected pituitary adenoma when supported by symptoms and laboratory findings
- Management (including perioperative evaluation) of known adenoma

IMAGING STUDY

- CT or MRI brain

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 functioning pituitary adenoma as well as to visualize tumor size and regional extension; CT is suggested if MRI is contraindicated or unavailable.[25] 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.[26] 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.[27]

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.[26,28] Apoplexy is commonly associated with pituitary adenomas (up to 90% of the time).[28]

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.[29]

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,[25] while the American College of Radiology recommends MRI with and without contrast for further characterization of the postoperative sella.[26]

A pituitary incidentaloma is a previously unsuspected pituitary lesion that is discovered on an imaging study performed for an unrelated reason.[30] The majority of pituitary incidentalomas are adenomas and the condition is prevalent occurring in 10% of autopsy specimens.[30] 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.[30]

Tumor – not otherwise specified

See Oncologic Imaging guidelines for management of an established tumor.

Advanced imaging is considered medically necessary for evaluation of suspected tumor when supported by the clinical evaluation.

IMAGING STUDY

- CT or MRI brain
- MRS to differentiate tumor from other diagnoses—such as abscess or another infectious/inflammatory lesion—when a structural brain lesion has been identified

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 or 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.[31,32] While Bell's palsy is a diagnosis of exclusion, it is rare for intracranial lesions to cause isolated facial nerve palsy.[31] 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,[33] 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.[34] 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."[33]

Cerebrovascular accident or transient ischemic attack

See Vascular Imaging guidelines.

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

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

Rationale

Cerebrovascular accident (CVA), also known as stroke, is the fifth leading cause of mortality and one of the leading causes of morbidity in the United States. The American Stroke Association predicts that nearly 800,000 people will suffer a stroke in 2018, of which more than 120,000 will die.[35] 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.[36] 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 or full paralysis of muscles, vision and speech disturbances, or change in level of consciousness.[35]

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[37]—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%),[37] 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[38] and as MRI (with diffusion-weighted imaging) may identify strokes in up to 34% of patients,[37] 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.[39] Vascular imaging may be indicated to identify critical extracranial stenosis, as these patients benefit from carotid endarterectomy or stenting[40] and echocardiography may be used to diagnose atrial fibrillation.[41]

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.[42] 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.[43,44]

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.[35, 45]

Regarding modality selection for vascular imaging, ultrasound has comparable sensitivity (> 95%) to advanced noninvasive vascular imaging (CTA/MRA) for anterior circulation TIA or CVA. 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.[46,47,48] 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.[49]

Dementia (Adult only)

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

- Initial evaluation to exclude a secondary cause of symptoms
- Evaluation of rapidly progressive symptoms

IMAGING STUDY

- MRI brain
- CT brain (when MRI contraindicated)

A one-time FDG-PET scan for differentiating between frontotemporal dementia and Alzheimer's disease is considered medically necessary provided that **ALL** of the following conditions are met:

- A recent diagnosis of frontotemporal dementia or Alzheimer's disease made by a physician experienced in the evaluation of dementia
- Documentation of cognitive decline of at least 6 months duration
- A comprehensive clinical evaluation, including **ALL** of the following:
  - History and physical examination, including an assessment of activities of daily living from a well-acquainted informant other than the patient
  - Cognitive scales or neuropsychological testing
  - Laboratory testing to evaluate for metabolic causes of cognitive impairment
  - Structural imaging of the brain (CT or MRI) to identify a structural cause for cognitive impairment
  - The evaluation has not clearly identified a specific neurodegenerative disease or other cause for the clinical symptoms
  - Results of the PET scan will help clarify the diagnosis in order to guide future treatment
  - A brain SPECT has not been obtained for the same indication

  Note: Documentation of this evaluation, including results of all testing, and a current list of medications are required.

Rationale

Dementia is an umbrella term for a group of symptoms associated with a decline in memory and other cognitive functions. Neurodegenerative disorders, of which Alzheimer's disease is the most common, are often responsible for dementia.[50,51] 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 and SPECT, and evaluates for metabolic changes in the brain parenchyma.

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.[52,53,54,55,56,57,58] The rationale for this recommendation is that no clinical prediction rule has sufficient accuracy to exclude treatable causes of dementia,[57] 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.[56]

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).[59,52,53]

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.[60,61] 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.[60]

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.[59] 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.[52] Gauthier et al.[62] 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%.[52]

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,[52] and are intended only for specialized clinical and research settings.[60] 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 and on predicting is.[62]

Horner's syndrome

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact management.

IMAGING STUDY

- MRI brain
- CT brain (when MRI contraindicated)

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.[63]

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 oculosympathetic pathway may need to be visualized, including an 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%[64, 65] 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.[66] 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 **EITHER** of the following scenarios:

- Evaluation of signs or symptoms suggestive of increased intracranial pressure or hydrocephalus
- Management of established hydrocephalus and ventricular shunts

IMAGING STUDY

- CT or MRI brain
- Ultrasound required for initial evaluation in patients under 5 months of age

Rationale

Hydrocephalus is dilation of the ventricular system resulting from obstruction of cerebrospinal fluid flow or excess production.[67] 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).[68] 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 parenchyma formation optimally visualized by MRI. While the evidence is insufficient to recommend a specific threshold for ventricular size change to evaluate treatment response,[69] changes in ventricular size measured by either CT or MRI can be helpful to assess for shunt malfunction.[70]

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.[71] 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).[72]

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.[67]

Mental status change and encephalopathy

Advanced imaging is considered medically necessary for initial evaluation when documented by neurologic exam and the results of imaging will impact management.

IMAGING STUDY

- CT or MRI brain

Movement disorders (Adult only)

Advanced imaging is considered medically necessary 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 or MRI brain

Rationale

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.[73]

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.[59]

Atypical features of Parkinson's disease[74] 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 system atrophy have characteristic imaging features that may be used to corroborate the diagnosis when clinically uncertain.[59,74,75]

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) starts in the limbs and may generalize; late onset (≥ 21) 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.[76]

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 or MRI brain

Pseudotumor cerebri (Pediatric only)

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or MRI brain

Seizure disorder

ADULT

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

- Initial evaluation, to rule out a structural brain lesion as a cause of seizure
- Evaluation of seizures increasing in frequency or severity
- Prior to discontinuation of anticonvulsant therapy in patients who have not been previously imaged

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 epilepsy with atypical clinical course
  - Partial seizures
  - Seizures increasing in frequency and severity despite optimal medical management
  - 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

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

IMAGING STUDY

- CT or MRI brain

Seizure, refractory

Functional MRI is considered medically necessary in the following scenario:

- Seizures refractory to medical treatment, for preoperative neurosurgical planning when done as a replacement for a Wada test or direct electrical stimulation mapping

PET brain imaging is considered medically necessary in the following scenario:

- Refractory seizures/epilepsy, for presurgical evaluation to identify a focus of seizure activity in patients who have failed conventional medical therapy

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.[77] 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.[78] The preferred modality is MRI due to its superior sensitivity over CT imaging.[78] 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.[79] The diagnostic yield of clinically significant abnormalities is very low; thus, imaging findings rarely impact management.[80] Complex febrile seizures are defined as those that are focal onset, recurrent during the febrile illness, or prolonged (lasting more than 10 to 15 minutes).[81] While the diagnostic yield remains low[82] and the management impact is controversial,[80,81] 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.[80] In pediatric patients with idiopathic generalized epilepsy diagnosed by EEG, the diagnostic yield is low (8%), and neuroimaging is not routinely warranted.[78] When other patterns are present, pediatric patients are more likely to have a structural cause for their seizures.[78] 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%.[83,84] When imaging is indicated, MRI is the preferred imaging modality[78] for its high diagnostic accuracy and lack of ionizing radiation. CT is an option if MRI is not available, contraindicated, or requires sedation.[78] In an acute setting, CT may be preferred for expedient determination of acute neurological lesion or illness.[78]

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).[85] 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.[86] 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.[87]

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.[88] 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.[88]

Trigeminal neuralgia and persistent idiopathic facial pain (Adult only)

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

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

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,[89] 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, cerebrovascular accident)
- Detection of parenchymal abnormalities (atrophy, demyelinating disease, infection, ischemic change)
- Identification of ventricular abnormalities (hydrocephalus)

Dizziness or vertigo

Also see Head and Neck Imaging guidelines.

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

- Evaluation of signs or symptoms suggestive of a central nervous system lesion
- Symptoms associated with abnormal audiogram or auditory brainstem response

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

IMAGING STUDY

- CT or 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.[116] 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, CVA/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).[116] 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%.[117] 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".[118]

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.[119] In a 2 single-center retrospective studies, MRI changed management in 16%-21.6% of patients with central vertigo.[120,121] CT imaging may also be performed, although MRI is more sensitive than CT for detection of posterior fossa strokes.[119, 121]

Headache

ADULT

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

- New headache
  - When associated with one or more red flag features (see Table 1)
  - Headache has not improved or has worsened during a course of physician-directed treatment, and the patient has been reevaluated by a clinician following completion of therapy
- Recurrent headache

- When associated with at least one red flag feature (see Table 1) and advanced imaging (CT or MRI) has not been performed to evaluate the headache
- When CT or MRI has been performed to evaluate the headache, and a red flag feature has developed since the prior imaging study
- Headaches are increasing in frequency and/or severity despite at least 4 weeks of physician-directed treatment and reevaluation by a clinician following completion of therapy

IMAGING STUDY

- CT or MRI
- CTA or MRA may be utilized when **ALL** of the following requirements are met:
  - Criteria for imaging of headache have been met
  - Neither MRI nor CT has determined the etiology for the headache
  - Headache is persistent and undifferentiated

Note: Undifferentiated headache refers to those not meeting criteria for a primary headache disorder (tension-type, migraine, or cluster).

Table 1. Red flag features for headache in adults

Headache characteristics	Associated clinical features and conditions
• Brought on by exertion or Valsalva • Cluster headache not previously evaluated with MRI • Postural/positional • Thunderclap or sentinel headache, sudden onset and severe (worst headache of life), reaching maximal intensity within minutes	• Abnormal neurological exam during the headache episode or in between episodes Note: photophobia and nausea are not considered abnormalities on neurologic exam • Neck or facial pain – concern for dissection (see Vascular Imaging guidelines) • Neck stiffness and fever (see infection and/or inflammatory conditions) • Risk factors for venous thrombosis (see Vascular Imaging guidelines)
Patient populations	**High-risk vascular patient**
• Over age 50 with new onset of headache • Known malignancy • Increased genetic risk for intracranial neoplasms including basal cell nevus syndrome, Gorlin syndrome, Li-Fraumeni syndrome, neurofibromatosis type 1 and type 2, Turcot syndrome, and von Hippel-Lindau syndrome • Immunodeficiency including HIV	• Personal or family history (at least one first-degree relative) of aneurysm, subarachnoid hemorrhage, or arteriovenous malformation • Heritable condition associated with intracranial aneurysm formation, including autosomal dominant polycystic kidney disease, Ehlers-Danlos syndrome, Marfan syndrome, neurofibromatosis type 1 and type 2, and other rare conditions including hereditary hemorrhagic telangiectasia, multiple endocrine neoplasia, pseudoxanthoma elasticum

PEDIATRIC

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

- Onset within the past 30 days with no prior history of headache and **ANY** of the following features:
  - Personal or family history of disorders that may predispose one to central nervous system (CNS) lesions and clinical findings suggesting CNS involvement (including, but not limited to, vascular malformations, aneurysms, brain neoplasms, infectious/inflammatory conditions such as sarcoidosis or personal history of meningitis and tuberculosis)
  - Associated neurologic findings on physical exam
  - Developmental delay

- Headache that awakens the patient repeatedly from sleep or develops upon awakening
- Sudden onset and severe headache (includes thunderclap headache or worst headache of life)

- Persistent or recurrent headache and **ANY** of the following features:
  - Change in quality (pattern or intensity) of a previously stable headache
  - Headache persisting for a period of up to 6 months duration and not responsive to medical treatment, and no prior imaging has been done to evaluate the headache
  - Headache associated with **ANY** of the following:
    - Abnormal reflexes
    - Altered mental status
    - Cranial nerve deficit
    - Gait/motor dysfunction
    - Nystagmus
    - Seizure
    - Sensory deficit
    - Sign of increased intracranial pressure (increased head circumference, vomiting, papilledema, symptoms that worsen with Valsalva)

Note: Imaging is not generally indicated for typical presentations of migraine.

IMAGING STUDY

- CT or MRI may be utilized based on clinical findings
- CTA or MRA may be utilized when **ANY** of the following features are present:
  - Exertional headache
  - Positional headache
  - Sudden onset of worst headache of life

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,[90, 91] and up to 30% of neurology appointments.[92,93] Additional advanced imaging evaluation should be avoided, as the likelihood of changing management or identification of relevant abnormality is low.[94] 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.[95] 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.[96,97,98,99,100] 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.

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

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[92]
- Any recent change in the presentation of a primary headache that is suggestive of a secondary headache[93]
- 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[101]

- Chronic headache with new feature or neurologic deficit[102]
- Subacute and/or progressive, worsening headaches over weeks to months; rapidly increasing headache frequency[103]
- Patients with progressive headache lasting weeks[104]

When neuroimaging is warranted, MRI is preferred over CT imaging due to its superior sensitivity.[105] 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.[103] In all cases, chronic daily headache existing for less than 6 months should be explored.[93] 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.[104] When neuroimaging is warranted, MRI is preferred over CT imaging for its superior sensitivity.[105] 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).[107]

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.[93] 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.[103] 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.[101] 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 noncontrast head CT.[106] 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).[107] 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.[108]

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.[109] A patient who presents with sudden-onset headache or headache associated with a neurological deficit should have an emergency CT scan.[89] CTA should be used to identify an aneurysm or other vascular malformation if there is a subarachnoid hemorrhage.[110] 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.[93]

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

Valsalva or exertional headaches can signal an intracranial abnormality, usually of the posterior fossa.[103]

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.[102] 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.[101]

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.[111] 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%).[112] Secondary headaches, however, are more common in very young patients and in those with high-risk features.[113,114]

Neuroimaging is not routinely recommended for patients with recurrent headaches and normal neurological exam although headache less than 1 month duration, family history, seizure or gait abnormalities increase the relative risk of a space occupying lesion.[115] 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.[114] Similar to adults, sudden onset "worst headache of life" should be urgently evaluated to exclude subarachnoid hemorrhage.[113] When neuroimaging is indicated, MRI is generally preferred due to its higher diagnostic accuracy for secondary causes and lack of ionizing radiation.[113]

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 the following scenarios:

- Conductive hearing loss
- Sensorineural hearing loss characterized by **ANY** of the following features:
- Gradual onset of unilateral or asymmetric hearing loss demonstrated by audiometric testing (15 dB or greater at 2 consecutive frequencies between 0.5 and 3 kHz)
- Hearing loss associated with at least one neurologic sign or symptom known to increase the pretest probability of a retrocochlear lesion

IMAGING STUDY

- MRI brain for evaluation of sensorineural hearing loss
- CT brain for evaluation of sensorineural hearing loss when MRI contraindicated
- CT orbit/sella/posterior fossa for evaluation of conductive hearing loss

PEDIATRIC

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

IMAGING STUDY

- MRI brain preferred for evaluation of sensorineural hearing loss
- CT orbit/sella/posterior fossa preferred for evaluation of conductive or mixed hearing loss

Rationale

The primary purpose of imaging sensorineural hearing loss is to detect retrocochlear 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.[122]

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.[123]

Papilledema

Advanced imaging is considered medically necessary for diagnosis and management when the results of imaging will impact treatment decisions.

IMAGING STUDY

- CT or 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 or 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."[124]
- 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."[125]
- Canadian Association of Emergency Physicians: "Don't order CT head scans in adult patients with simple syncope in the absence of high-risk predictors."[126]

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.[127] In unselected patients, the diagnostic yield approaches 0%.[128] 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 nonhemorrhagic infarct, intracranial hemorrhage and neoplasm being the most common etiologies.[129]

Tinnitus (Adult only)

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

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

**Note: abnormality on audiogram or auditory brainstem response is required if present longer than 6 months.*

IMAGING STUDY

- MRI brain
- CT orbit/sella/posterior fossa is appropriate when MRI is contraindicated
- MRA or CTA brain for pulsatile tinnitus only

Visual disturbance

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 or MRI brain

Codes

The following codes may be applicable to brain imaging and may not be all-inclusive.

CPT

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

HCPCS

None

ICD-10 Diagnosis

Refer to the ICD-10 CM manual

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History

Status	Date	Action
Restructured	01/01/2019	Advanced Imaging guidelines redesigned and reorganized to a condition-based structure
Reviewed and revised	03/01/2018	Last Independent Multispecialty Physician Panel review and revision
Created	03/30/2005	Original effective date