PROVIDER LED ENTITY

Headache AUC
2023 Update

06/06/2023

Appropriateness of advanced imaging procedures* in patients with the following headache presentations:

*including MRI, CT, angiography, venography, SPECT, and PET

Abbreviation list:

ACEP	American College of Emergency Physicians
ACR	American College of Radiology
AUC	Appropriate Use Criteria
AVM	Arteriovenous malformations
CSF	Cerebrospinal fluid
CT	Computed tomography
CTA	Computed tomography angiography
CTV	Computed tomography venography
CVT	Cerebral venous thrombosis
EFNS	European Federation of Neurological Societies
EHF	European Headache Federation
FLAIR	Fluid-attenuated inversion recovery
ICHD-3	International Classification of Headache Disorders 3rd edition
IIH	Idiopathic intracranial hypertension
LP	Lumbar puncture
MRA	Magnetic resonance angiography
MRI	Magnetic resonance imaging
MRV	Magnetic resonance venography
NICE	National Institute for Health and Care Excellence
PET	Positron emission tomography
PLE	Provider Led Entity
RCVS	Reversible cerebral vasoconstriction syndrome
SAH	Subarachnoid hemorrhage
SFEMC	French Society for the Study of Migraine and Headache Disorders
SFN	French Society of Neurology
SPECT	Single-photon emission computed tomography
SUNA	Short-lasting unilateral neuralgiform headache attacks with cranial autonomic features
SUNCT	Short-lasting unilateral neuralgiform headache attacks with conjunctival injection and tearing
SWI	Susceptibility-weighted imaging
TBI	Traumatic brain injury
TCH	Thunderclap headache
TOP	Toward Optimized Practice
WMHs	White matter hyperintensities

Appropriate Use Criteria: How to Use this Document

The CDI Quality Institute follows the recommendation framework defined by the Appraisal of Guidelines for Research & Evaluation (AGREE II), AMSTAR 2 (A Measurement Tool to Assess Systematic Reviews) and a modified version of the QUADAS-2 (Quality Assessment of Diagnostic Accuracy Studies) to evaluate the strength of recommendations concerning advanced imaging. Considerations used to determine a recommendation are listed below.

Primary recommendation (green): A strong recommendation for initial imaging for this presentation; there is confidence that the desirable effects of imaging outweigh its undesirable effects.

Alternative recommendation (yellow): A conditional recommendation for imaging; the desirable effects of imaging likely outweigh its undesirable effects, although some uncertainty may exist. The individual patient's circumstances, preferences, and values should be considered on a case-by-case basis. This may include: contraindication to the primary recommendation, specific clinical circumstances that require use of the alternative recommendation, or the primary recommendation has results that are inconclusive or incongruent with the patient's clinical diagnosis. Case-by-case indications to consider have been noted in brackets when appropriate.

Recommendation against imaging (red): The undesirable effects of imaging outweigh any desirable effects. Additionally, the recommendation may be impractical or not feasible in the targeted population and/or practice setting(s).

Headache AUC Summary:

Many headache patients who present for imaging have chronic headaches without a change in pattern, or primary headaches which do not have an underlying anatomic abnormality or medical condition. These headaches are generally diagnosed by taking a detailed history and then excluding secondary causes. Advanced imaging is unlikely to yield significant positive findings in those without increasing or atypical symptoms and without new neurologic symptoms or findings.

Advanced imaging for headache is indicated in patients that have atypical features, a change in frequency and severity, or associated neurologic signs or symptoms. If advanced imaging is indicated:

- **MRI** is generally the most appropriate modality, especially outside of the acute setting. MRI is preferred over CT in these cases as it offers greater visualization of brain anatomy and does not use ionizing radiation.
- **CT scanning** is the primary diagnostic methodology in specific clinical scenarios to exclude intracranial hemorrhage. These include a thunderclap headache, headache after injury, and exertional headache. In patients with chronic or subacute post-traumatic headache, CT can be useful to exclude a subdural hematoma. CT scanning is also usually appropriate whenever the patient cannot undergo MRI or if MRI is not available on a timely basis.
- **MR or CT angiography or venography** are typically indicated in patients who have clinical symptoms that suggest a vascular etiology.

PICO 1 - Primary or chronic headache (e.g., migraine, tension-type headache, medication overuse/rebound headache) *without* a change in pattern, neurological signs/symptoms, or other red flag features:

- **Red** – **MRI**
- **Red** – **CT**
- **Red** – **MRA** or **CTA**
- **Red** – **MRV** or **CTV**
- **Red** – **PET**
- **Red** – **SPECT**

Level of Evidence: CT, MRI: moderate; MR angiography, CT angiography, MR venography, CT venography: low; SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None.

Guideline and PLE expert panel consensus opinion summary:
A single/first-time headache should prompt appropriate evaluation for secondary causes (*VA/DoD 2020*). Primary headache disorders refer to headaches that are idiopathic, recurrent, and stereotyped, without underlying secondary causes (*VA/DoD 2020*). For adult patients with chronic headache that has no recent change in pattern, no history of seizures, and no focal neurological signs or symptoms or other red flag features, the routine use of neuroimaging is not warranted (Utukuri et al [*ACR*] 2022; *NICE* 2015; Sandrini et al [*EFNS*] 2011; *TOP Clinical Practice Guideline* 2016). Despite the clinical and social impact of migraine and tension-type headache, numerous studies have demonstrated very few significant structural abnormalities on neuroimaging (Utukuri et al [*ACR*] 2022; *TOP Clinical Practice Guideline* 2016).

Clinical notes:

- Primary headaches are disorders in and of themselves. They are caused by independent pathomechanisms and not by other disorders (*ICHD-3* 2018).
- In contrast to primary headache, secondary headaches can be attributed to an identifiable underlying cause that may be structural, pharmacologic, vascular, or related to a systemic illness or disorder of homeostasis (*VA/DoD* 2020).
- Chronic headache is typically characterized by long-duration history of headache, occurring 15 or more days per month for > 3 months, while episodic refers to those occurring less frequently (*VA/DoD* 2020).
- Medication overuse headaches are associated with analgesic or migraine-specific medication use (*VA/DoD* 2020; *TOP Clinical Practice Guideline* 2016).
- Red flag features for the identification of secondary headaches include (*NICE* 2015; *TOP Clinical Practice Guideline* 2016):
    - new onset or change in headache in patients who are older than 50 years of age
    - change in headache frequency, characteristics and/or associated symptoms
    - new onset cognitive dysfunction or change in personality
    - new onset neurological symptoms and/or abnormal neurological examination
    - papilledema and/or impaired level of consciousness
    - thunderclap headache

- headache changing with posture or that wakens
- headache precipitated by physical exertion, sexual activity, or Valsalva maneuver
- patients with risk factors for cerebral venous sinus thrombosis
- symptoms suggestive of giant cell arteritis
- symptoms suggestive of acute narrow angle glaucoma
- patients with jaw claudication or visual disturbance
- neck stiffness and/or fever or
- new onset in patients with history of HIV or cancer

- White matter hyperintensities are the most common minor intracranial abnormality in patients with migraine (Utukuri et al [*ACR*] 2022).
- Sinus and cervical spine imaging are not recommended for the routine evaluation of patients with migraine headaches (*TOP Clinical Practice Guideline* 2016).

Evidence update (2014-present):

Moderate Level of Evidence:

Kamtchum-Tatuene et al (2020), in a systematic review and meta-analysis, examined overall and disease-specific prevalence of unexpected findings among patients presenting with headache and normal neurological examination. A total of 41 studies (n = 15,760) were included. The overall prevalence of normal variants (those without potential to cause symptoms and not requiring therapeutic intervention) and unexpected findings (any neuroimaging finding distinct from known and well-characterized normal variants) was 17.5% (95% CI: 13.1-22.3), rising to 26.6% (95% CI, 15.5-39.4) in studies using MRI only. Prevalence of vascular, neoplastic, and non-neoplastic findings was 6.6%, 1.4%, and 9.6%. The pooled disease-specific prevalence was 2.0% for stroke, 1.8% for aneurysm, 0.8% for subdural hematoma, 0.7% for hydrocephalus, 0.2% for glioma, and 0.1% for meningioma. The authors conclude that in patients with headache and normal neurologic examination, important vascular and neoplastic unexpected findings are rare and better detected with MRI.

Evans et al (2019), in a systematic review, provided updated evidence-based recommendations from the *American Headache Society* about when to obtain neuroimaging in patients with migraine. A total of 23 articles met inclusion criteria: ten studies evaluated the utility of CT only, nine MRI only, and four evaluated both. Common abnormalities included chronic ischemia or atrophy with CT and MRI scanning, and non-specific white matter lesions with MRI. Clinically meaningful abnormalities requiring intervention were relatively rare. Clinically significant neuroimaging abnormalities in patients with headaches consistent with migraine without atypical features or red flags appeared no more common than for general population. Neuroimaging may be considered for the following reasons: unusual, prolonged, or persistent aura; increasing frequency, severity or change in clinical features; first or worst migraine; migraine with brainstem aura; migraine with confusion; migraine with motor manifestations; late-life migraine; aura without headache; and posttraumatic headache. However, most recommendations were deemed consensus-based, with little or no literature support.

Low Level of Evidence:

Carey et al (2019), in a retrospective study, examined the role of early neuroimaging in identifying malignant brain tumors among individuals presenting with headache. Using administrative claims data, a total of 180,623 individuals were included; 22.2% had early neuroimaging. Imaging was divided between MRI (53.7%) and CT (51.5%), with some receiving both. A referent group not receiving early imaging was created. Malignant brain tumors were identified in 0.22% of individuals (n = 178) receiving early imaging, vs. 0.04% of the referent group. Median time to diagnosis was 8 (range 3-19) days vs. 72 (range 39-189) days for referent group. Likely incidental findings were discovered in 3.17% of the early imaging

group and in 0.66% of referent group. The authors conclude that malignant brain tumors in those presenting with incident headache are rare and early neuroimaging leads to a small reduction in time to diagnosis.

Wang et al (2019), in a prospective study, compared neuroimaging findings of primary headache patients (n = 1,070) and healthy controls (n = 1,070). All participants were assessed with either CT or MRI scans, with findings classified as significant abnormalities, non-significant abnormalities, or normal. Results found that all significant abnormalities were identified using MRI scans. Significant abnormalities were identified in 4 primary headache patients (0.58%) and 5 healthy controls (0.73%); the rate was not significantly different between both groups (P > .05). The authors conclude that neuroimaging was found to be unnecessary for primary headache patients.

Xie et al (2018), in a prospective study, examined the correlation of white matter hyperintensities (WMHs) with migraine features and explored the relationship between WMHs and migraine prognosis. A total of 69 consecutive migraine patients underwent MRI scans; migraine features were compared between those with (n = 24) and without (n = 45) WMHs. Patients with WMHs were significantly older (39.0 vs. 30.6 years, P < 0.0001) and had longer disease duration (median 180 vs. 84 months, P = 0.013). After an average period of 3 years, 33 patients completed follow-up: “improved” (n = 15) or “non-improved” (n = 18). Patients in the “non-improved” group had a higher frequency of WMHs (55.6% vs. 13.3%, P = 0.027). The authors conclude that WMHs can predict short-term unfavorable migraine prognosis.

PICO 2 - Headache with any of the following:

- **Atypical features,**
- **Abrupt increase in frequency or severity,**
- **Abrupt pattern change,**
- **New onset after age 50**

- Green – **MRI brain without IV contrast** or **MRI brain without and with IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [suspicion of hemorrhage; or patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRA brain (with or without MRA neck)**, **MRV brain**, **CTA head (with or without CTA neck)**, or **CTV head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**
- Red – **PET**

Level of Evidence: MRI, CT: low; SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast:
MRI contrast administration will aid in detection and assessment of intracranial pathology, and brain MRI without and with IV contrast should be obtained in the setting of suspected intracranial mass or infection (Utukuri et al [*ACR*] 2022). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Patients with headaches that do not fit the typical pattern of migraine or tension-type headache, and/or patients with a major change in headache pattern should be considered for specialist consultation and/or neuroimaging, depending on the clinical judgment of the provider (*TOP Clinical Practice Guideline* 2016; *NICE* 2015). When an unusual headache comes on or worsens, brain imaging may be needed to search for an expansive intracranial process or a vascular cause (Moisset et al [*SFEMC* & *SFN*] 2016, professional agreement). Warning signs or red flags for potential secondary headache include a new onset of headache after age 50; these patients may require brain imaging, even following a normal neurologic examination (*TOP Clinical Practice Guideline* 2016). Elderly patients with a new headache and a recent subacute (days to weeks) decline in cognition may have a subacute or chronic hematoma, even when history of head injury is not always present (*TOP Clinical Practice Guideline* 2016).

MRI
MRI brain can be useful in the initial imaging evaluation of headache with increasing severity or frequency, which are associated with a higher likelihood of intracranial pathology (Utukuri et al [*ACR*]

2022). Given the higher soft tissue resolution of MRI when compared with CT, MRI may be the preferred initial imaging modality, especially outside of the acute setting (Utukuri et al [*ACR*] 2022). For most processes, MRI without and with contrast will be more sensitive than a CT head scan in identifying white matter lesions and developmental venous anomalies (Sandrini et al [*EFNS*] 2011). Ideally, brain MRI with T1, T2, FLAIR, and T1 injected sequences will be performed to search for contrast uptake and signs of venous thrombosis (Moisset et al [*SFEMC* & *SFN*] 2016: professional agreement). Following initial evaluation with a brain MRI, brain MRV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022).

CT

In patients with headaches associated with atypical features, an abrupt increase in severity or frequency, or an abrupt pattern change, CT of the head (without IV contrast) can be performed if MRI is contraindicated or unavailable (Moisset et al [*SFEMC & SFN*] 2016, professional agreement; PLE expert panel consensus opinion). CT head without IV contrast can be useful in the initial imaging evaluation of headache with increasing severity or frequency, as these are associated with a higher likelihood of intracranial neuropathology (Utukuri et al [*ACR*] 2022). It can also be useful to evaluate for suspected hemorrhage (Moisset et al [*SFEMC & SFN*] 2016, professional agreement). CT of the head with IV contrast can be considered if tumor is suspected and the patient is unable to undergo MRI (PLE expert panel/multidisciplinary committee consensus opinion). Following initial evaluation with a noncontrast head CT, head CTV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022).

<u>Clinical notes:</u>

- A gradual increase in the frequency of migraine headaches over time is typical and does not require additional imaging (Mitsikostas, et al [*EHF*] 2016; PLE expert panel consensus opinion).
- Atypical features of migraine headaches may include hemimotor symptoms, hemisensory symptoms outlasting the headache episode (ictus), diplopia, and onset of new aura after the age of 40 (PLE expert panel consensus opinion).
- Further investigation is recommended for migraine patients with poor balance, visual symptoms affecting only one eye, or decreased level of consciousness (*NICE* 2015).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischemic stroke or TIA
    - Non-traumatic intracranial hemorrhage
    - Unruptured vascular malformation
    - Arteritis
    - Cervical carotid or vertebral artery disorder
    - Cerebral venous thrombosis
    - Other acute intracranial arterial disorder (including RCVS)
    - Genetic vasculopathy
    - Pituitary apoplexy

<u>Evidence update (2014-present):</u>

There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

PICO 3 - Headache with any of the following:

- **Neurologic signs/symptoms**
- **Seizures**
- **Increased intracranial pressure, including papilledema**

- Green – **MRI brain without and with IV contrast** or **MRI brain without IV contrast**
- Yellow **- MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [suspicion of hemorrhage; or patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRA brain (with or without MRA neck), MRV brain, CTA head (with or without CTA neck), or CTV head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**
- Red – **PET**

Level of Evidence: CT, MRI: moderate; MR angiography, CT angiography, MR venography, CT venography, SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: Consulting and reporting requirements are not required for orders for applicable imaging services made by ordering professionals under the following circumstances (*42 C.F.R. § 414.94. 2015*):

- Emergency services when provided to individuals with emergency medical conditions.
- For an inpatient and for which payment is made under Medicare Part A.

Notes concerning use of contrast:
MRI contrast administration will aid in detection and assessment of intracranial pathology, and brain MRI without and with IV contrast should be obtained in the setting of suspected intracranial mass or infection (Utukuri et al [*ACR*] 2022). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Patients with headaches and new onset of neurological symptoms or abnormal neurological examination should be considered for specialist consultation and/or neuroimaging, depending on the clinical judgment of the practitioner (*TOP Clinical Practice Guideline* 2016; *NICE* 2008). While neurological signs may be unrelated to a headache, previously undocumented neurological findings need to be evaluated (PLE expert panel consensus opinion). Patients with headache and signs or symptoms of increased intracranial pressure including papilledema require neuroimaging. Increased intracranial pressure may be idiopathic (primary idiopathic intracranial hypertension/IIH) or may be secondary to mass, hydrocephalus, or venous sinus thrombosis (Utukuri et al [*ACR*] 2022). Venous imaging can be useful to exclude venous sinus thrombosis in headache patients with features of intracranial hypertension (Utukuri et al [*ACR*] 2022).

MRI

In headache patients with unexplained focal neurological signs, atypical patterns, or a history of seizures, brain MRI is the neuroimaging modality of choice in the non-urgent setting (*TOP Clinical Practice Guideline* 2016; Sandrini et al [*EFNS*] 2011; Utukuri et al [*ACR*] 2022). These headaches are associated with a higher likelihood of intracranial pathology, and MRI provides higher soft tissue resolution when compared with CT (Utukuri et al [*ACR*] 2022). Brain MRI is also useful to detect imaging signs associated with primary IIH (e.g., partially empty sella, optic nerve head protrusion, flattening of the posterior globe) and help exclude secondary causes of elevated intracranial pressure such as mass, edema, or hydrocephalus (Utukuru et al [*ACR*] 2022). Following initial evaluation with a brain MRI, brain MRV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022).

CT

CT scans can be useful in patients who cannot undergo MRI to exclude intracranial pathology, such as a space-occupying lesion, as a cause of headache (Utukuri et al [*ACR*] 2022; *TOP Clinical Practice Guideline* 2016; PLE expert panel consensus opinion) and can also be used to evaluate abnormal mental status, focal neurologic deficits, or acute seizure (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019). In patients with headache associated with neurologic signs, neurologic symptoms, or seizures, CT without IV contrast should be considered if hemorrhage is suspected (PLE expert panel consensus opinion). In patients with increased intracranial pressure who are unable to undergo MRI, CT without IV contrast can be helpful to evaluate for mass, edema, or hydrocephalus (Utukuri et al [*ACR*] 2022; PLE expert panel consensus opinion). CT with IV contrast can be useful to characterize abnormalities seen on previous CT head without IV contrast (PLE expert panel consensus opinion). Following initial evaluation with a noncontrast head CT, head CTV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022).

<u>Clinical notes:</u>

- Atypical features of migraine headaches may include hemimotor symptoms, hemisensory symptoms outlasting the headache episode (ictus), diplopia, and onset of new aura after the age of 40 (PLE expert panel consensus opinion).
- For patients with unusual aura symptoms, consider referral to a neurologist for diagnosis and possible investigation (*TOP Clinical Practice Guideline* 2016).
- Headache caused by increased cerebrospinal fluid (CSF) pressure is usually accompanied by other symptoms and/or clinical signs of intracranial hypertension including nausea/vomiting, pulsatile tinnitus and/or papilledema. It remits after normalization of CSF pressure (*ICHD-3* 2018).
- Although the majority of patients with IIH have papilledema, IIH without papilledema has been observed. Other symptoms of IIH include pulse-synchronous tinnitus, transient visual obscurations, neck or back pain, and diplopia (*ICHD-3* 2018).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischemic stroke or TIA
    - Non-traumatic intracranial hemorrhage
    - Unruptured vascular malformation
    - Arteritis
    - Cervical carotid or vertebral artery disorder
    - Cerebral venous thrombosis
    - Other acute intracranial arterial disorder (including RCVS)

- Genetic vasculopathy
- Pituitary apoplexy

Evidence update (2014-present):
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

PICO 4 - Sudden onset of severe headache* (thunderclap headache):

- Green – **CT head without IV contrast**
- Green – **CTA head (with or without CTA neck)** or **MRA brain (with or without MRA neck)**
- Yellow – **CT head with IV contrast**
  [characterize abnormalities detected on previous CT head without IV contrast]
- Yellow – **MRI brain without IV contrast** or **MRI brain without and with IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **MRV brain** or **CTV head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**
- Red – **PET**

*This scenario covers headache associated with exertion or sexual activity

Level of Evidence: MRI, CT: moderate; MR angiography, CT angiography, MR venography, CT venography: low; SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: Consulting and reporting requirements are not required for orders for applicable imaging services made by ordering professionals under the following circumstances (*42 C.F.R. § 414.94. 2015*):

- Emergency services when provided to individuals with emergency medical conditions.
- For an inpatient and for which payment is made under Medicare Part A.

Notes concerning use of contrast:
CT head with IV contrast can be used to characterize abnormalities detected on a previous CT head without IV contrast (PLE expert panel consensus opinion). MRI brain with IV contrast can be used to characterize abnormalities seen on a previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
The most important feature of thunderclap headache (TCH) is the abrupt onset of a severe headache that reaches maximum intensity in < 1 hour, and often < 1 minute (Utukuri et al [*ACR*] 2022; *ICHD-3* 2018). Patients presenting with severe headache of sudden onset should undergo immediate investigation to exclude the primary concern of subarachnoid hemorrhage (Utukuri et al [*ACR*] 2022; *TOP Clinical Practice Guideline* 2016). If subarachnoid hemorrhage is not present, further neuroimaging may still be necessary, as other causes of TCH include arterial dissection, cerebral venous sinus thrombosis, bacterial meningitis, spontaneous cerebral spinal fluid leak, pituitary apoplexy, and reversible cerebral vasoconstriction syndrome (RCVS), among others (Utukuri et al [*ACR*] 2022; *TOP Clinical Practice Guideline* 2016; Moisset et al [*SFEMC & SFN*] 2016). On the first occurrence of an exercise-induced or sexual-activity headache, imaging may be indicated to exclude subarachnoid hemorrhage, arterial dissection, and reversible vasoconstriction syndrome (*ICHD-3* 2018).

CT
The first investigation for a patient who presents with sudden, severe headache or "worst headache of

life" is a CT head scan without IV contrast (Utukuri et al [*ACR*] 2022; Moisset et al [*SFEMC & SFN*] 2016: grade B recommendation). A normal noncontrast head CT performed within 6 hours of symptom onset in those with a normal neurologic examination rules out nontraumatic SAH, with a negative predictive value of 99.9% (Utukuri et al [*ACR*] 2022; Godwin et al [*ACEP*] 2019: level B recommendation; PLE expert panel consensus opinion).

CT angiography or MR angiography

While CTA is not indicated as the initial imaging technique in isolation for a thunderclap headache, a CTA (or lumbar puncture) should be performed to safely rule out SAH in a patient still considered to be at risk after a negative noncontrast head CT result, or when the onset of severe headache is > 6 hours (Godwin et al [*ACEP*] 2019; Level C recommendation; Utukuri et al [*ACR*] 2022). When possible, it is recommended that the CTA be performed in conjunction with the noncontrast head CT, and not as an independent initial imaging technique in isolation (Utukuri et al [*ACR*] 2022). In patients diagnosed with acute subarachnoid hemorrhage, CTA or MRA is also useful to evaluate for an aneurysm or arteriovenous malformations (Godwin et al [*ACEP*] 2019; PLE expert panel consensus opinion).

In patients with a thunderclap headache and no vascular malformation, the etiological search should next focus on RCVS, and CTA or MRA can be useful for this purpose (Utukuri et al [*ACR*] 2022). The first imaging exploration may be normal if performed early (first 4-5 days after symptom onset); anomalies are seen at maximum two-three weeks after the first symptoms (Moisset et al [*SFEMC & SFN*] 2016; PLE expert panel consensus opinion). If the CTA or MRA findings are negative or equivocal for RCVS, then CT and CTA or MRA should be repeated at the time of the first recurrent headache (PLE expert panel consensus opinion). If initial CTA or MRA findings are consistent with RCVS, then repeat CTA or MRA should be obtained in three months to see if the findings have resolved to confirm the diagnosis (PLE expert panel consensus opinion).

Multiple severe headaches precipitated by sexual activity should be considered RCVS until proven otherwise by angiographic studies or transcranial Doppler ultrasonography (*ICHD-3* 2018). CTA or MRA of the head and carotid/vertebral arteries can be used to evaluate for aneurysm, arteriovenous malformations, arterial dissection, or vasoconstriction with RCVS on the first occurrence of exercise headache (Mitsikostas et al [*EHF*] 2016**).

MRI

MRI with FLAIR, gradient-recalled T2*, and susceptibility-weighted (SWI) sequences are equally sensitive to subarachnoid hemorrhage and could be used in the initial evaluation of patients with thunderclap headache, although in most circumstances CT would be more readily available and efficient (Utukuri et al [*ACR*] 2022; PLE multidisciplinary committee consensus opinion; Lummel et al 2011). Brain MRI has higher contrast resolution than head CT and, when used as a follow-up examination, can help to delineate parenchymal changes from various other non-SAH etiologies of TCH (Utukuri et al [*ACR*] 2022). A contrast-enhanced brain MRI can be useful for diagnosis of spontaneous intracranial hypotension, pituitary apoplexy, and intraventricular colloid cyst, which are rare causes of TCH (Utukuri et al [*ACR*] 2022).

CT venography or MR venography

While there is no support for CTV in the initial imaging evaluation of TCH, when the differential diagnosis includes suspicion for cerebral venous sinus thrombosis (CVST), CT venography or MR venography can be useful (Utukuri et al [*ACR*] 2022; PLE expert panel consensus opinion).

**This guideline did not pass the Agree II review. It is used here, however because of its direct relevance to these uncommon headache disorders.

Clinical notes:

- The Ottawa Subarachnoid Hemorrhage Rule is a clinical decision tool that has been validated as 100% sensitive to capture all patients with SAH; however, it is not specific and is unable to determine the etiology of the TCH (Utukuri et al [*ACR*] 2022).
    - Patients require investigation if one or more of the following findings are present: ≥40 years of age, neck pain or stiffness, witnessed loss of consciousness, onset during exertion, TCH, or limited neck flexion on examination (Utukuri et al [*ACR*] 2022).
    - Although the presence of neck pain and stiffness on physical examination in ED patients with an acute headache is strongly associated with SAH, a single physical sign and/or symptom should not be used to rule out SAH (Godwin et al [*ACEP*] 2019).
- New headache upon waking does not meet the classification of a thunderclap headache (PLE expert panel consensus opinion).
- RCVS has been diagnosed in 45% of patients presenting with thunderclap headaches. RCVS is attributed to transient reversible abnormal regulation of cerebral arterial tone, which triggers multifocal diffuse vasoconstriction and vasodilatation. It can be triggered by vasoactive substances such as cannabis, cocaine, ecstasy, amphetamines, LSD, antidepressants, nasal decongestants, triptans and ergotamine (Moisset et al [*SFEMC & SFN*] 2016; *ICHD-3* 2018).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischemic stroke or TIA
    - Non-traumatic intracranial hemorrhage
    - Unruptured vascular malformation
    - Arteritis
    - Cervical carotid or vertebral artery disorder
    - Cerebral venous thrombosis
    - Other acute intracranial arterial disorder (including RCVS)
    - Genetic vasculopathy
    - Pituitary apoplexy
- A lumbar puncture (LP) may no longer be indicated to exclude a subarachnoid hemorrhage following a timely negative CT, as the accuracy of CT for subarachnoid hemorrhage has increased significantly (e.g., Dubosh et al 2016).
- The diagnostic criteria for a primary exercise headache consists of at least two headaches that are brought on by and occurring only during or after strenuous physical exercise, lasting < 48 hours and not accounted for by another ICHD-3 diagnosis (*ICHD-3* 2018).
- The diagnostic criteria for a headache associated with sexual activity are at least two headaches brought on by and occurring only during sexual activity with increasing intensity with increasing sexual excitement or abrupt intensity just before or with orgasm, lasting less than 24 hours and not accounted for by another ICHD-3 diagnosis (*ICHD-3* 2018).

Technical notes:

- If an MRI is obtained to evaluate a thunderclap headache or headache precipitated by exertion or sexual activity, it should include fluid-attenuated inversion recovery (FLAIR), gradient recalled T2* and/or SWI sequences (PLE expert panel consensus opinion).

Evidence update (2014-present):

High Level of Evidence:
Dubosh et al (2016), in a systematic review of 5 articles concerning the accuracy of CT for SAH, reported an overall sensitivity of 0.987 (95% CI, 0.971-0.994) and specificity of 0.999 (95% CI, 0.993-1.0). The pooled likelihood ratio of a negative CT was 0.010 (95% CI, 0.003-0.034). The authors concluded that for patients presenting with thunderclap headache and normal neurological examination, a normal brain CT within 6 hours of headache is extremely sensitive in ruling out aneurysmal SAH.

Moderate Level of Evidence:
Walton et al (2022), in a systematic review, evaluated strategies (decision rule or diagnostic test) in neurologically intact patients presenting to the ED with non-traumatic sudden onset severe headache with a clinical suspicion of subarachnoid hemorrhage (SAH). A total of 37 studies were included, with quality assessed using QUADAS-2. Eight studies assessing the Ottawa SAH clinical decision rule were pooled, with sensitivity of 99.5% (95% CI: 90.8-100) and specificity of 24% (95% CI: 15.5-34.4). Four studies assessing CT within 6 hours of headache onset were pooled, with sensitivity of 98.7% (95% CI: 96.5-100) and specificity of 100% (95% CI: 99.7-100). The sensitivity of CT beyond 6 hours was considerably lower ($\leq$ 90% in two studies). Three studies assessing lumbar puncture following negative CT were pooled, with sensitivity of 100% (95% CI 100-100) and specificity of 95% (95% CI: 86-98.5). The authors conclude that the Ottawa SAH Rule rules out further investigation in only a small proportion of patients, while CT undertaken within 6 hours (with expertise of a radiologist who routinely interprets brain images) is highly accurate and likely to be sufficient to rule out SAH.

Perry et al (2020) conducted a multicenter prospective study to evaluate the implementation of both the Ottawa SAH rule and the 6-hour-CT rule on further testing rates (CT, LP, CTA) and length of stay at six academic emergency departments. A total of 3,672 consecutive patients with headache were included (1,743 control and 1,929 post-implementation). A total of 188 patients with subarachnoid hemorrhage were identified. Proportions undergoing CT went unchanged (88% vs. 87.5%; P=0.643), while lumbar puncture use decreased (38.9% vs. 25.9%; P<0.0001). Additional testing following CT also decreased (51.3% vs. 42.2%; P<0.0001). Mean emergency department stay was largely unchanged (6.3 +/- 4.0 vs. 6.4 +/- 4.2 hours; P=0.685), but admissions declined (9.8% vs. 7.4%; P=0.011). The Ottawa SAH rule was 100% (95% CI, 98.1-100) sensitive and the 6-hour-CT rule was 95.5% (95% CI, 89.8-98.5) sensitive for SAH. The authors conclude that implementing both rules led to a meaningful decrease in testing and hospital admission.

Low Level of Evidence:
Wu et al (2020), in a retrospective cohort study, assessed the performance of the Ottawa Subarachnoid Hemorrhage (OSAH) rule among 913 ED headache patients. All patients had acute headache onset within 14 days of ED visit. According to the OSAH rule, patients with any predictors (thunderclap or maximum intensity within 1 hour, neck pain or stiffness, limited neck flexion, presence of neurologic deficits, loss of consciousness, or onset during exertion) required further investigation. A total of 15 patients were diagnosed with SAH. The OSAH had 100% (95% CI: 78.2-100%) sensitivity and 37% (95% CI: 33.8-40.2) specificity for identifying SAH. Its sensitivity decreased to 75% (95% CI: 53.3-90.2%) for non-hemorrhagic intracranial pathology. The authors conclude that the OSAH rule may be an effective tool to exclude acute ICH and SAH. Further, a low threshold for CT scanning by application of the OSAH rule may help to avoid possible delays in diagnosing SAH.

Sahraian et al (2019), in a retrospective study, assessed the value of noncontrast head CT (NCCT) in 224 patients with known migraine history and chief symptom “worst headache of life” (WHOL) or “thunderclap headache” (TCH). Patients without known intracranial pathology, cancer, recent head

trauma, or immunocompromising disease (n = 132) were the main study group. Patients with any of these factors (n = 92) were included as a comparison group. All scans were graded as (1) normal, (2) minor unimportant findings, (3) findings requiring intervention or follow-up, or (4) critical. In the main study group, no patients had grade 4 imaging findings, one had a false-positive grade 3 finding (0.8%), and there were no cases of subarachnoid hemorrhage. In the comparison group, six patients had grade 4 imaging findings (6.5%) and three had grade 3 findings (3.3%). The authors conclude that the value of repetitive scanning of migraineurs with WHOL or TCH is limited unless they have known intracranial pathology, cancer, or recent head trauma.

Tulla et al (2019), in a retrospective study, investigated the role of lumbar puncture (LP) after negative head CT to rule out subarachnoid hemorrhage (SAH) within 24 hours of symptom onset. A total of 539 patients were included; all underwent CT. When CT was performed within 24 hours of symptom onset, it had sensitivity of 100% (95% CI: 95-100%), specificity of 98% (95% CI: 96-100%), and NPV of 100% (95% CI: 98-100%) in detecting SAH. The authors conclude that LP has no added benefit after negative head CT in ruling out SAH when CT was performed within 24 hours of symptom onset.

Alons et al (2018) in a retrospective study, aimed to develop a diagnostic prediction model to identify headache patients with high probability of abnormality on CTA. A total of 384 patients underwent non-contrast CT (NCCT) and CTA due to acute headache (peaking $\leq$ 5 minutes). NCCT was abnormal in 194 patients (50.5%); of these, CTA abnormalities were found in 116 (59.8%), of which 99 were aneurysms. In the remaining 190 patients (49.5%) with normal NCCT, CTA abnormalities were found in 12 cases (6.3%), including four cases of unruptured aneurysm and two cases of RCVS. Abnormal NCCT, impaired consciousness, and presentation within 6 hours of headache onset were all independently associated with abnormal CTA. The authors conclude that in acute headache patients, abnormal NCCT is the strongest predictor of vascular abnormality on CTA. If NCCT is normal, the diagnostic yield is low, and no other predictors were found to increase the probability of finding an abnormality on CTA.

Chen et al (2018) in a prospective study, aimed to determine whether absence of arterial wall pathology on imaging is a universal finding in patients with RCVS. A total of 62 patients presenting with acute severe headache underwent 3-T brain MRI to exclude intracranial lesions; sequential MRAs were next performed until vasoconstrictions normalized or until 3 months after disease onset. Vascular wall enhancement was rated as marked, mild, or absent. Of 48 patients with RCVS, 22 (45.8%) had vascular wall enhancement (5 marked and 17 mild). Patients with vascular wall enhancement had fewer headache attacks than those without ($p = 0.04$). Follow-up imaging (mean 7 months) in 14 patients showed reduced enhancement in 9 patients, but persistent enhancement in 5. The authors conclude that almost half of RCVS patients exhibited imaging enhancement of diseased vessels, and it was persistent for over a third with follow-up imaging available. Both acute and persistent vascular wall enhancement may be unhelpful for differentiating RCVS from central nervous system vasculitis or subclinical atherosclerosis.

Chu et al (2017) in a cross-sectional study, described characteristics of 847 headache presentations (median age 39; range 18-92 years) to the ED. Headache peaked $\leq$ 1 hour in 44% and it was “worst ever” in 37%. Persisting neurologic deficit was found in 6.5%. CT head scan was performed in 38% and lumbar puncture in 4.7%. Overall, there were 18 SAH, six intraparenchymal hemorrhages, one subdural hematoma, one newly diagnosed brain metastasis, and two bacterial meningitis cases. Migraine was diagnosed in 23% and “primary headache not further specified” in 45%. The authors conclude that a majority of patients had a benign diagnosis, with intracranial hemorrhage and bacterial meningitis accounting for only 3%. As over one-third of presentations underwent CT scans, the authors note there

is scope to rationalize diagnostic testing to rule out life-threatening conditions.

Chen et al (2017), in a systematic review concerning headaches associated with sexual activity (HSA), reported intracranial abnormalities in 3/31 patients: one with an aneurysmal subarachnoid hemorrhage, one with right middle cerebral artery spasm and one with a posterior fossa subarachnoid cyst.

Cooper et al (2016) conducted a retrospective study of 517 consecutive neurological patients presenting to the ED with sudden onset acute severe headache. 510/517 underwent CT for the diagnosis of SAH. 27/510 patients had an abnormal CT: 13 positive for SAH and 14 positive for other diagnoses. 309/491 patients underwent LP: 11 positive for SAH (only one of which had a positive angiogram), 16 for viral meningitis, and one for nonocclusive sagittal sinus thrombosis. 6/13 patients with SAH had abnormal angiogram findings. The authors concluded that the decision to follow a negative CT with an LP in all cases needs careful consideration, as CSF results may only rarely confer therapeutic benefit to patients suspected of SAH.

Alons et al (2015) conducted a retrospective study on the utility of CT angiography in 70 consecutive patients reporting to the ED with acute severe headache. Patients with neurologic deficits, subdural or subarachnoid hemorrhage on CT, and increased CSF bilirubin concentration were excluded. 13 (19%) patients had vascular abnormalities on CT: 4 with prior aneurysm or CVT, 8 with unruptured intracranial aneurysm (UIA), 2 with CVT (3%), 2 with RCVS (3%) and 1 with cerebral ischemia (1%). The authors concluded that patients with history of UIA or CVT should undergo CTA despite normal CT and LP.

Vlak et al (2011) evaluated the trigger factors in 250 patients with aneurysmal subarachnoid hemorrhage. The authors found 8 triggers. Sexual intercourse had a RR of 11.2 and vigorous physical exercise 2.4. The highest population-attributable risks were found for coffee consumption (10.6%) and vigorous exercise (7.9%).

PICO 5 - New headache or change in headaches in a cancer patient or immunocompromised patient:

- Green – **MRI brain without and with IV contrast** or **MRI brain without IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [suspicion of hemorrhage; or patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRA brain (with or without MRA neck), MRV brain, CTA head (with or without CTA neck), or CTV head**
  [suspected cranial or cervical vascular disorder]
- Yellow – **FDG-PET** or **Thallium 201 SPECT**
  [differentiate tumor from infection]

Level of Evidence: MRI, CT: low; MR angiography, CT angiography, MR venography, CT venography, PET, SPECT: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast:
MRI contrast administration will aid in detection and assessment of intracranial pathology, and brain MRI without and with IV contrast should be obtained in the setting of suspected intracranial mass or infection (Utukuri et al [*ACR*] 2022). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Patients with new-onset headache (or a major change in headache pattern) and a systemic illness that may indicate a serious cause for the headache may require urgent specialist consultation and/or investigation (*TOP Clinical Practice Guideline* 2016; *NICE* 2015). In particular, patients with a history of cancer of immunocompromise should undergo imaging when a headache develops or if there is a change in headache characteristics (Utukuri et al [*ACR*] 2022).

MRI brain can be useful for the initial imaging evaluation of headache with history of cancer or immunocompromise, which are associated with a higher likelihood of intracranial pathology (Utukuri et al [*ACR*] 2022; Sandrini et al [*EFNS*] 2011). Given the higher soft tissue resolution of MRI when compared with CT, MRI may be the preferred initial imaging modality for this scenario, especially outside of the acute setting (Utukuri et al [*ACR*] 2022). Following initial evaluation with a brain MRI, brain MRV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022). When MRI is not available, CT without IV contrast can be useful, and it is also helpful to exclude new hemorrhage, significant mass effect, or hydrocephalus (Utukuri et al [*ACR*] 2022; PLE expert panel consensus opinion). CT with IV contrast can characterize abnormalities seen on previous CT head without IV contrast (PLE expert panel/multidisciplinary committee consensus opinion). Following initial evaluation with a noncontrast head CT, head CTV can be useful when there are clinical or imaging findings suspicious for CVT (Utukuri et al [*ACR*] 2022).

Clinical notes:

- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischemic stroke or TIA
    - Non-traumatic intracranial hemorrhage
    - Unruptured vascular malformation
    - Arteritis
    - Cervical carotid or vertebral artery disorder
    - Cerebral venous thrombosis
    - Other acute intracranial arterial disorder (including RCVS)
    - Genetic vasculopathy
    - Pituitary apoplexy

Evidence update (2014-present):
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

PICO 6 - Trigeminal autonomic cephalgia (cluster headache, SUNCT/SUNA, paroxysmal hemicrania):

- Green – **MRI brain without and with IV contrast**
- Yellow – **MRI brain without IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [suspicion of hemorrhage; or patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRA brain (with or without MRA neck), MRV brain, CTA head (with or without CTA neck), or CTV head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**
- Red – **PET**

Level of Evidence: MRI, CT: very low; MR angiography, CT angiography, MR venography, CT venography, SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast:
MRI contrast administration will aid in detection and assessment of intracranial pathology, and brain MRI without and with IV contrast should be obtained in the setting of suspected intracranial mass or infection (Utukuri et al [ACR] 2022). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
While trigeminal autonomic cephalgia (TAC) is considered a primary headache disorder, the differential diagnosis includes structural lesions affecting the trigeminal autonomic reflex and pain pathways (Utukuri et al [*ACR*] 2022). Therefore, neuroimaging, preferably brain MRI, is usually recommended to rule out a secondary cause of cluster headache/TAC, paroxysmal hemicrania, or "Short-lasting, Unilateral, Neuralgiform headache attacks with Conjunctival injection and Tearing (SUNCT) (Utukuri et al [*ACR*] 2022; Sandrini et al [*EFNS*] 2011). MRI is the most sensitive imaging method and therefore recommended over CT (Sandrini et al [*EFNS*] 2011). MRI without and with IV contrast is often the most appropriate advanced imaging modality, with MRI without IV contrast reserved for instances when the patient cannot receive IV contrast (Utukuri et al [*ACR*] 2022; PLE expert panel consensus opinion). CT should be considered if the patient is unable to undergo MRI (PLE expert panel consensus opinion). MRA or CTA of the head and neck may also be considered for patients presenting with a first cluster headache (Moisset et al [*SFEMC* & *SFN*) 2016). The use of brain MRV or CTV head can be used as a follow-up imaging study in cases of suspected CVT, which is in the differential diagnosis for TACs (Utukuri et al [*ACR*] 2022).

Clinical notes:

- Trigeminal autonomic cephalgia is a group of primary headache disorders characterized by pain in unilateral trigeminal distribution in association with ipsilateral cranial autonomic signs and

symptoms. Cluster headache is the only relatively common member of this family (*VA/DoD* 2020).

- Cluster headache is characterized by repeated short-lasting but excruciating intense attacks of strictly unilateral peri-orbital pain associated with local autonomic symptoms or signs. The most striking feature of cluster headache is the unmistakable circadian and circannual periodicity (*ICHD-3* 2018; *VA/DoD* 2020).
- In patients with new onset cluster headache or another trigeminal autonomic cephalgia, hemicranias continua, or new daily persistent headache, specialist referral should be considered for investigation and treatment (*TOP Clinical Practice Guideline* 2016; *NICE* 2015).

Evidence update (2014-present):
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

PICO 7 - Suspected low CSF pressure/orthostatic headache:

- Green – **MRI brain without and with IV contrast** or **MRI without IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRI spine with and/or without IV contrast**
- Yellow – **MR myelography spine** or **CT myelography spine**
- Red – **MRA** or **CTA**
- Red – **MRV** or **CTV**
- Red – **SPECT**
- Red – **PET**

Level of Evidence: MRI, CT: very low; MR angiography, CT angiography, MR venography, CT venography, SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast:
Although some findings of spontaneous intracranial hypotension can be detected on noncontrast brain MRI, contrast-enhanced brain MRI is typically needed to evaluate for pachymeningeal enhancement, which is reported in up to 83% of patients (Utukuri et al [*ACR*] 2022).

Guideline and PLE expert panel consensus opinion summary:
In patients with suspected low pressure/orthostatic headache, imaging should be considered (*NICE* 2015). For headache that worsens on standing, brain MRI scanning with gadolinium enhancement may be needed to look for indirect evidence of a CSF leak (dural enhancement) (*TOP Clinical Practice Guideline* 2016; Moisset et al [*SFEMC & SFN*] 2016: professional agreement; Utukuri et al [*ACR*] 2022). CT of the head can be used if the patient is unable to undergo MRI (Utukuri et al [*ACR*] 2022; PLE expert panel consensus opinion). Spine imaging is useful in cases of spontaneous intracranial hypotension to look for an extradural fluid collection, usually at the level of the thoracic spine, that would be consistent with a dural tear (Utukuri et al [*ACR*] 2022). Spine imaging can also be useful to evaluate for chronic dural leaks in patients following spine surgery (PLE expert panel consensus opinion).

Clinical notes:
- Headache attributed to low CSF pressure is worse when upright and can be accompanied by neck pain, tinnitus, changes in hearing, photophobia, or nausea (*ICHD-3* 2018).
- Orthostatic headache can also be seen with a dural leak following lumbar spine surgery or lumbar spine injection therapy (PLE expert committee consensus opinion).

Evidence update (2014-present):
There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

PICO 8 - Headache precipitated by cough:

- Green – **MRI brain without and with IV contrast** or **MRI brain without IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **CT head without IV contrast**
  [suspicion of hemorrhage; or patient unable to undergo MRI]
- Yellow – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- Yellow – **MRA brain (with or without MRA neck)** or **CTA head (with or without CTA neck)**
  [suspected cranial or cervical vascular disorder]
- Red – **MRV** or **CTV**
- Red – **SPECT**
- Red – **PET**

Level of Evidence: CT, MRI: very low; MR angiography, CT angiography, MR venography, CT venography, SPECT, PET: PLE expert panel consensus opinion.

Notes concerning applicability and/or patient preferences: None

Notes concerning use of contrast:
MRI contrast administration will aid in detection and assessment of intracranial pathology, and brain MRI without and with IV contrast should be obtained in the setting of suspected intracranial mass or infection (Utukuri et al [*ACR*] 2022). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Symptomatic cough headache may represent a primary headache or could also be a sign of an underlying structural abnormality (Evers et al [*EFNS*] 2011). The syndrome of cough headache is symptomatic in about 40% of cases, and many of these patients have Arnold–Chiari malformation type I (*ICHD-3* 2018). Other reported causes include spontaneous intracranial hypotension, carotid or vertebrobasilar diseases, middle cranial fossa or posterior fossa tumors, midbrain cyst, basilar impression, platybasia, subdural haematoma, cerebral aneurysms, and reversible cerebral vasoconstriction syndrome (*ICHD-3* 2018). Patients with headache precipitated by cough, Valsalva maneuver, or sneeze should be considered for a brain MRI scan to exclude structural abnormalities; however, it should also be considered that patients with typical migraine may have cough as one of their headache triggers (*TOP Clinical Practice Guideline* 2016). CT should be considered if tumor is suspected in patients with headache precipitated by cough and the patient is unable to undergo MRI (PLE multidisciplinary committee consensus opinion). CT without IV contrast should also be considered if hemorrhage is suspected (PLE expert panel consensus opinion).

Clinical notes:

- The diagnostic criteria for a cough headache are at least two headaches brought on by or occurring only with coughing, straining and/or other Valsalva maneuvers, sudden onset, and lasting up to 2 hours (*ICHD-3* 2018).

Evidence update (2008-Present):

Low Level of Evidence
Chen et al (2009) reported on the clinical characteristics and outcome in 83 consecutive patients with cough headaches. Nine (11%) of the patients had abnormalities on brain imaging. Abnormalities localized to the posterior fossa in 6/9 patients, with Chiari malformation in 2 patients and a cerebellar mass in 4 patients

Pascual et al (2008) reported the incidence of secondary headache in patients seen in their clinic from 1997 through 2006. 40/68 patients with cough headaches had secondary headaches: 32/40 with Chiari 1 malformation. The remaining 8 had other posterior fossa lesions including 3 subarachnoid cysts, 2 dermoid cysts, 2 meningiomas and one os odontoideum. 2/11 patients with exertional headaches had SAH. 2/18 patients with sexual headaches had secondary headaches: one with hydrocephalus and one with a cervical AVM

PICO 9 - Persistent (subacute or chronic) headache attributed to traumatic injury to the head:

- **Green** – **MRI brain without IV contrast** or **MRI brain without and with IV contrast**
- **Green** – **CT head without IV contrast**
- **Yellow** – **CT head with IV contrast**
  [characterize abnormalities detected on previous CT head without IV contrast]
- **Yellow** – **MRI brain with IV contrast**
  [characterize abnormalities detected on previous MRI brain without IV contrast]
- **Red** – **MRA** or **CTA**
- **Red** – **MRV** or **CTV**
- **Red** – **SPECT**
- **Red** – **PET**

Level of Evidence: Low

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast:
An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion). A CT head with IV contrast can be used for patients who have had a previous CT head without IV contrast and are unable to undergo MRI (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
Neuroimaging plays an important role in the management of head/brain injury, which can be separated into acute (0-7 days), subacute (< 3 months), and chronic (> 3 months) phases (Shih et al [*ACR*] 2021). The goals of imaging for subacute or chronic head trauma are to better characterize any intracranial injuries and understand persistent symptoms (Shih et al [*ACR*] 2021). Delayed brain imaging should be considered when neurologic signs or symptoms are suggestive of possible intracranial pathology, or when progressive/worsening symptoms occur without any indications of other cause (*Ontario Neurotrauma Foundation* 2018: grade C recommendation). There is insufficient evidence to recommend for or against neuroimaging in patients with persistent headache attributed to head trauma who do not have new focal signs or other red flags to indicate the need for neuroimaging (*TOP Clinical Practice Guideline* 2016).

MRI
Brain MRI is a useful imaging modality for evaluating subacute or chronic head trauma once the initial acute stage has passed and when rapid detection of acute ICH and neurosurgical lesions is no longer the primary focus (Shih et al [*ACR*] 2021; *CO Division of Workers' Compensation Medical Treatment Guidelines* 2019). In particular, MRI should be considered in patients whose subacute or chronic post-traumatic headaches are increasing in severity and/or are accompanied by new, persistent, or increasing neurologic deficits or symptoms (*TOP Clinical Practice Guideline* 2016; Sandrini et al [*EFNS*] 2011; PLE expert panel consensus opinion; *also see new or increasing neurologic deficits scenario of this document*). While there is no relevant literature to support the added value or routine use of contrast-enhanced brain MRI over noncontrast brain MRI in the initial imaging evaluation of subacute or chronic head trauma (Shih et al [*ACR*] 2021), MRI without and with IV contrast is useful when neurologic deficits

or symptoms are present (Utukuri et al [*ACR*] 2022). The addition of IV contrast can also be useful to characterize abnormalities seen on previous MRI brain without IV contrast (PLE expert panel consensus opinion). MRI can best detect late, sub-acute, and chronic structural changes in the brain which underlie abnormal functioning, and it is more sensitive than CT for subtle findings adjacent to the calvarium or skull base and small white matter lesions (microbleeds) as chronic sequelae of previous traumatic axonal injury (Shih et al [*ACR*] 2021; *CO Division of Workers' Compensation Medical Treatment Guidelines* 2019). Advanced MRI techniques are not recommended for diagnostic purposes (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019).

CT

Patients presenting in the setting of recent trauma would benefit from head CT as an initial study to exclude intracranial hemorrhage as a cause of secondary headache (Utukuri et al [*ACR*] 2022). CT is a valid option for those presenting in a delayed fashion after head trauma (Shih et al [*ACR*] 2021) and should be considered at least once in patients with mild TBI and persistent headache or subsequent decline in cognition to exclude chronic subdural hematoma (PLE expert panel consensus opinion; *TOP Clinical Practice Guideline* 2016). CT can also be useful when there is a specific question not requiring the high soft-tissue contrast resolution of MRI (Shih et al [*ACR*] 2021). CT scans provide somewhat limited information compared to MRI regarding intrinsic cerebral damage of deep brain structures, although many types of intrinsic damages can be seen on CT scans (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019).

SPECT

SPECT is not generally accepted as a diagnostic test for TBI of any severity and is considered investigational for diagnostic purposes (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019). There is insufficient evidence to support the routine clinical use of SPECT at the individual patient level (Shih et al [*ACR*] 2021).

PET

PET is not generally accepted as a diagnostic study and should not be used solely to diagnose the presence of TBI (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019). There is insufficient evidence to support the routine clinical use of PET at the individual patient level (Shih et al [*ACR*] 2021).

<u>Clinical notes:</u>

- Following TBI, more than 50% of injured individuals experience headache throughout the first year post-injury. The majority of these are self-limited, but headache persistence may occur. Every effort should be made to identify the "cause" as early as possible (*CO Division of Workers' Compensation Medical Treatment Guidelines* 2019).
- Periodic re-evaluation of the patient for worsening of symptoms or presence of new symptoms/problems following mTBI is important for those with a more chronic course of recovery (*Ontario Neurotrauma Foundation* 2018).
- There is no relevant literature to support the use of radiographs in the initial imaging evaluation of subacute or chronic head trauma with unexplained cognitive or neurologic deficit(s) (Shih et al [*ACR*] 2021).

<u>Evidence update (2014-present)</u>:

There were no recent articles that significantly affected the recommendations or conclusions found in the guidelines referenced above.

Guideline exclusions:

- Cases meeting the definition of a suspected or confirmed emergency medical condition
- Inpatients for which payment is made under Medicare Part A
- Acute head/brain injury
- Patients in whom headache is not the chief complaint or with other clinical features present that suggest a more specific diagnosis
- Patients with prior neurosurgery
- MR perfusion or CT perfusion
- Dynamic MRI CSF studies
- Investigational MRI techniques, including voxel-based morphometry, magnetic resonance spectroscopy, functional MRI, diffusion tensor imaging, and 7 Tesla MRI
- Headache associated with pregnancy
- Pediatric patients
- Use of AI for the interpretation of MRI or CT exams in headache patients.

AUC Revision History:

Revision Date	New Clinical Scenario	Approval Body
09/26/2017	Initial Document Development	CDI Quality Institute's Multidisciplinary Committee
09/04/2018	N/A	CDI Quality Institute's Multidisciplinary Committee
09/10/2019	N/A	CDI Quality Institute's Multidisciplinary Committee
10/20/2020	N/A	CDI Quality Institute's Multidisciplinary Committee
11/09/2021	N/A	CDI Quality Institute's Multidisciplinary Committee
06/06/2023	N/A	RAYUS Quality Institute's Multidisciplinary Committee

Information on our evidence development process, including our conflicts of interest policy is available on our website at **https://www.rayusradiology.com/ple**

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Appropriateness of Advanced Imaging in Patients with Headache: Bibliography

06/06/2023

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