CDI QUALITY INSTITUTE

Provider Led Entity

CDI Quality Institute PLE Headache AUC 2021 Update

11/09/2021

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

*including MRI, CT, MRA, MRV, CTA, CTV, 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
EFNS	European Federation of Neurological Societies
EHF	European Headache Federation
FLAIR	Fluid-attenuated inversion recovery
ICHD-3	International Classification of Headache Disorders 3rd edition
ICSI	Institute for Clinical Systems Improvement
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
SIGN	Scottish Intercollegiate Guidelines Network
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:

The majority of 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 are generally diagnosed by taking a detailed headache history and by exclusion of secondary causes. Advanced imaging is unlikely to yield significant positive findings in patient 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. MRI is preferred 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 in order to exclude intracranial hemorrhage. These include a thunderclap headache, headache after injury, headache after sexual activity, and headache precipitated by exercise. CT is also indicated in patients with chronic or subacute post-traumatic headache in order to exclude a subdural hematoma. CT scanning is also 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.

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:

- **Green** –
- **Yellow** –
- **Red** – **MRI**; **CT**; **MR angiography**; **CT angiography**; **MR venography**; **CT venography**; **PET**; **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:
"Primary headaches" are headache disorders that are not due to another underlying medical condition (*SIGN* 2008). These headache disorders (mainly migraine and tension-type headache) are exceedingly common (Beithon et al [*ICSI*] 2013). 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 (Whitehead et al [*ACR*] 2019; Sandrini et al [*EFNS*] 2011; *SIGN* 2008: grade D recommendation; *TOP Clinical Practice Guideline* 2016). The diagnostic yield of neuroimaging in patients with typical recurrent migraine attacks is very low (*TOP Clinical Practice Guideline* 2016; Whitehead et al [*ACR*] 2019), and patients diagnosed with tension-type headache, migraine, or medication overuse headache should not be referred for neuroimaging solely for reassurance (*NICE* 2015). Sinus and cervical spine imaging is not recommended for the routine evaluation of patients with migraine headaches (*TOP Clinical Practice Guideline* 2016).

Clinical notes:

- Chronic headache is typically characterized by long-duration history of headache, occurring 15 or more days per month (Whitehead et al [*ACR*] 2019).
- 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 (Beithon et al [*ICSI*] 2013).
- Most cases of primary headache can be managed in primary care and investigations are rarely needed (*SIGN* 2008).
- Red flag features for the identification of secondary headaches include (*NICE* 2015; *TOP Clinical Practice Guideline* 2016; *SIGN* 2008):
    - 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.
- Medication overuse headaches are associated with analgesic (prescription and over-the-counter) and migraine-specific medication use (Beithon et al [*ICSI*] 2013; *TOP Clinical Practice Guideline* 2016).
- In patients with new daily persistent headache, specialist referral should be considered for investigation and treatment (*TOP Clinical Practice Guideline* 2016; *SIGN* 2008).

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.

Tung et al (2014), in a retrospective study, evaluated the efficiency of Rothrock criteria (age > 60, new onset focal neurologic deficit, headache with vomiting, or altered mental status) in predicting clinically significant findings on CT. The prevalence of significant findings was 10.1%. The Rothrock criteria had a sensitivity of 97.1% (34/35 significant findings) among the 346 patients. The one false negative case was a patient with known metastatic melanoma without focal neurological signs or symptoms. Although 100% sensitivity was not achieved, these results may contribute to the evidence that in the absence of focal neurologic deficit, headache with vomiting, or altered mental status in patients aged < 60 years, CT can be refrained from.

Headache with atypical features, an abrupt increase in frequency or severity, and/or an abrupt pattern change:

- 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** or **CT head without and with 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 – **MR angiography brain and/or neck**, **MR venography brain**, **CT angiography head and/or neck**, or **CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **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, vascular abnormalities or infection (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

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 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 (*TOP Clinical Practice Guideline* 2016; *NICE* 2015; *SIGN* 2008). A progressive headache is an indication for head imaging (Beithon et al [*ICSI*] 2013), which can be used to search for an expansive intracranial process or a vascular cause (Moisset et al [*SFEMC* & *SFN*] 2016, professional agreement). Neuroimaging may be indicated to evaluate for secondary headache if causes of concern (including a new, progressive, or "different" headache) have been identified in the patient history or physical examination (Beithon et al [*ICSI*] 2013).

MRI
In patients with headache with new/atypical features or increasing frequency, MRI of the brain is usually appropriate (Whitehead et al [*ACR*] 2019; Sandrini et al [*EFNS*] 2011). For most processes, MRI of the brain will be more sensitive than a CT head scan (Beithon et al [*ISCI*] 2013), specifically in identifying white matter lesions and developmental venous anomalies (Beithon et al [*ICSI*] 2013; Sandrini et al [*EFNS*] 2011; SIGN 2008). Unless there is an emergency, intracranial hemorrhage is suspected, or MRI is not easily accessible, CT is not needed (Moisset et al [*SFEMC & SFN*] 2016, professional agreement).

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 (PLE expert panel consensus opinion). CT is also indicated to evaluate for suspected hemorrhage (Moisset et al [*SFEMC & SFN*] 2016, professional agreement; Whitehead et al [*ACR*] 2019). 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). CT of the head without and with IV contrast may be appropriate to evaluate for potential leptomeningeal or dural enhancing lesion(s) (Whitehead et al [*ACR*] 2019).

Clinical notes:

- 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).
- Headaches that worsen with time may be due to a progressive intracranial lesion such as a tumor, subdural hematoma, or hydrocephalus (Beithon et al [*ICSI*] 2013).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischaemic 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): No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

Headache with neurologic signs/symptoms or seizures:

- 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** or **CT head without and with 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 – **MR angiography brain and/or neck, MR venography brain, CT angiography head and/or neck, or CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

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; *SIGN* 2008: grade D recommendation). While neurological signs may be unrelated to a headache, previously undocumented neurological findings need to be considered. Seizures can occasionally be a manifestation of a primary headache disorder, but this is to be the exception and not the rule; it is a diagnosis of exclusion (Beithon et al [*ICSI*] 2013). Other etiologies for seizures including space-occupying lesions, infection, stroke, or metabolic derangement need to be considered (Beithon et al [*ICSI*] 2013). Usually, cranial imaging will be the initial study (Beithon et al [*ICSI*] 2013).

MRI
In patients with new, progressive, or unexplained neurological signs, neurological symptoms, or a history of seizures, brain MRI is the neuroimaging of choice in the non-urgent setting (*TOP Clinical Practice Guideline* 2016; Sandrini et al [*EFNS*] 2011; Beithon et al [*ICSI*] 2013). MRI, rather than CT, is the more

sensitive method for neuroimaging (Sandrini et al [*EFNS*] 2011). MRI without and with IV contrast or MRI without IV contrast are both considered to be appropriate (Whitehead et al [*ACR*] 2019).

CT

In patients with headache associated with new or unexplained neurologic signs, neurologic symptoms, or seizures, CT without IV contrast should be considered if hemorrhage is suspected or if the patient is unable to undergo MRI (PLE expert panel consensus opinion). CT with IV contrast should be considered if tumor or infection is suspected and the patient is unable to undergo MRI (PLE expert panel/multidisciplinary committee consensus opinion). CT scans can be useful to exclude a space-occupying lesion as a cause of headache (*TOP Clinical Practice Guideline* 2016), 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).

Clinical notes:

- Neuroimaging in patients with headache and an abnormal neurological examination is significantly more likely to reveal an underlying cause (*SIGN* 2008).
- For patients with unusual aura symptoms, consider referral to a neurologist for diagnosis and possible investigation (*TOP Clinical Practice Guideline* 2016).
- 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).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischaemic 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):

No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

Sudden onset of severe headache (thunderclap headache):

- Green – **CT head without IV contrast** or **CT head without and with IV contrast**
- Green – **CT angiography head and/or neck** or **MR angiography brain and/or 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 – **MR venography brain** or **CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**

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. MRI brain with IV contrast can be used to characterize abnormalities seen on a previous MRI brain without IV contrast. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

Guideline and PLE expert panel consensus opinion summary:
Headache that presents suddenly, "like a thunderclap," can be characteristic of several serious intracranial processes (Beithon et al [*ICSI*] 2013). Patients presenting with severe headache of sudden onset should be sent to an emergency department for immediate investigation to exclude subarachnoid hemorrhage (*TOP Clinical Practice Guideline* 2016; *SIGN* 2008: grade D recommendation). If subarachnoid hemorrhage is not present, specialist involvement and further neuroimaging may be necessary, as the differential diagnosis includes arterial dissection, dural sinus thrombosis, bacterial meningitis, spontaneous cerebral spinal fluid leak, pituitary apoplexy, and reversible cerebral vasoconstriction syndrome (*TOP Clinical Practice Guideline* 2016; Beithon et al [*ICSI*] 2013).

CT
The first investigation for a patient who presents with sudden, severe headache or “worst headache of life” is a CT head scan without contrast (Whitehead et al [*ACR*] 2019; Moisset et al [*SFEMC & SFN*] 2016: grade B recommendation; Beithon et al [*ICSI*] 2013). Sensitivity of CT for subarachnoid hemorrhage is 98% at 12 hours, dropping to 93% by 24 hours (*SIGN* 2008). A normal noncontrast head CT performed within 6 hours of symptom onset in an ED headache patient with a normal neurologic examination rules out nontraumatic SAH (Godwin et al [*ACEP*] 2019: level B recommendation; PLE expert panel consensus opinion). 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).

CT angiography or MR angiography
While CTA is not indicated as the initial imaging technique in isolation for a thunderclap headache (Whitehead et al [*ACR*] 2019), 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 (Godwin et al [*ACEP*] 2019; Level C recommendation). CTA or MRA is also useful in patients diagnosed with acute subarachnoid hemorrhage to evaluate for an aneurysm or arteriovenous malformations (AVM) (Godwin et al [*ACEP*] 2019; PLE expert panel consensus opinion).

In patients with a thunderclap headache and no vascular malformation, the etiological search should focus on a reversible cerebral vasoconstriction syndrome (RCVS). The diagnosis requires demonstration of typical arterial anomalies on CTA or MRA. The first imaging exploration may be normal if performed early during the first 4-5 days after symptom onset as abnormalities peak 2-3 weeks after the first symptoms (Moisset et al [*SFEMC & SFN*] 2016; PLE expert panel consensus opinion). If initial 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 3 months to see if the findings have resolved in order to confirm the diagnosis

MRI
MRI with FLAIR, gradient-recalled T2*, and susceptibility-weighted (SWI) sequences are each sensitive to subarachnoid hemorrhage and could be used in the initial evaluation of patients with thunderclap headache, although in most circumstances CT is more readily available and more efficient (PLE multidisciplinary committee consensus opinion; Mitchell et al 2001; Lummel et al 2011). If both CT without contrast and lumbar puncture are normal, and suspicion of subarachnoid hemorrhage is still high, an MRI (without and with contrast) can be obtained (Beithon et al [*ICSI*] 2013).

CT venography or MR venography
If the differential diagnosis includes suspicion for cerebral venous sinus thrombosis (CVST), CT venography or MR venography can be useful (PLE expert panel consensus opinion).

<u>Clinical notes:</u>

- Thunderclap headache is defined as severe head pain of abrupt onset, reaching maximum intensity in less than 1 minute and lasting for ≥ 5 minutes (*ICHD-3* 2018).
    - New headache upon waking does not meet the classification of a thunderclap headache (PLE expert panel consensus opinion).
- Differential diagnosis of thunderclap headache includes subarachnoid hemorrhage (SAH) or other intracranial bleeding, brain infarction, RCVS, cerebral venous thrombus, cervical arterial dissection, meningitis and/or encephalitis, hypertensive encephalopathy and eclampsia, pituitary necrosis, and temporal arteritis. Other causes, such as CSF hypotension, angina pectoris, or intra-ventricular tumor can also produce the same clinical presentation (Moisset et al [*SFEMC & SFN*] 2016).
- 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):
    - Ischaemic 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

Technical notes:

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

Evidence update (2013-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:

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.

Cheng et al (2014) presented imaging findings in 31 prospective consecutive patients with SAH. 24 (72.7%) of these patients fulfilled the criteria for thunderclap headache (TCH). RCVS was confirmed in 14 (45.2%) patients with SAH and in 11 (45.8%) patients with TCH. The authors concluded that RCVS is a common cause of SAH and TCH.

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 a 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 and the diagnostic yield is low, 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 ≤ 1 hour in 44% and it was the "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.

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.

Graff-Radford et al (2016) in a retrospective study, presented the imaging findings in 88 patients with non-traumatic cSAH. The most common causes were RCVS (26, 29.5%), cerebral amyloid angiopathy (CAA) (23, 26.1%), indeterminate (14, 15.9%), and endocarditis (9, 10.2%).

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.

Han et al (2013) in a retrospective study, reported on the utility of CTA in 512 patients with sudden-onset of acute severe headache, no severe neurological deficits, and no abnormalities on noncontrast CT. Thirty-four (6.6%) of the 512 patients had intracranial vascular lesions on CTA, including 33 aneurysms (2 patients had 2 aneurysms each), 2 with Moyamoya disease and 1 with arterial dissection.

New headache with suspicion for encephalitis or meningitis:

- Green – **CT head without IV contrast**
- Green – **MRI brain without and with IV contrast** or **MRI brain without IV contrast**
- Yellow – **CT head without and with IV contrast** or **CT head with IV contrast**
  [patient unable to undergo MRI]
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **MR angiography brain and/or neck, MR venography brain, CT angiography head and/or neck, or CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**

Level of Evidence: CT, MRI: low; MR angiography, MR venography, CT angiography, 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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

Guideline and PLE expert panel consensus opinion summary:
Symptoms suggestive of a systemic disorder, while not incompatible with a coexistent primary headache disorder, should signal caution, and patients should be carefully evaluated (Beithon et al [*ICSI*] 2013). If a severe headache is more subacute in onset, chronic meningitis may need to be considered along with a space-occupying intracranial lesion or hydrocephalus, and neuroimaging should be performed (Beithon et al [*ICSI*] 2013). Patients with suspected bacterial meningitis should be sent immediately to an emergency department with urgent CT and lumbar puncture capability for investigation and treatment (*TOP Clinical Practice Guideline* 2016). In general, CT should be performed prior to lumbar puncture to determine if there is elevated intracranial pressure (PLE expert panel consensus opinion). If encephalitis is suspected, MRI is the recommended imaging procedure of choice; CT should be performed if the patient is unable to undergo MRI (PLE expert panel consensus opinion).

Clinical notes:

- The differential diagnosis for headache with symptoms suggestive of a systemic disorder will be long, and the index of suspicion for any given process will largely depend on the clinical setting (Beithon et al [*ICSI*] 2013).

- Headache of variable duration caused by bacterial meningitis or meningoencephalitis is typically associated with neck stiffness, nausea, fever, and changes in mental state and/or other neurological symptoms and/or signs (*ICHD-3* 2018).
- Patients who present with headache and features suggestive of CNS infection should be referred for urgent specialist evaluation (*SIGN* 2008).

Evidence update (2014-present):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

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** or **CT head without and with 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** – **MR angiography brain and/or neck, MR venography brain, CT angiography head and/or neck, or CT venography 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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

Guideline and PLE expert panel consensus opinion summary:
Symptoms suggestive of a systemic disorder (cancer, HIV, etc.), while not incompatible with a coexistent primary headache disorder, should signal caution and patients should be carefully evaluated (Beithon et al [*ICSI*] 2013). 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). Patients who are immunosuppressed, immunocompromised, or with known cancer should undergo imaging when a headache develops or if there is a change in headache characteristics (Whitehead et al [*ACR*] 2019).

MRI head without and with IV contrast or MRI head without IV contrast is usually appropriate in this scenario (Whitehead et al [*ACR*] 2019; Sandrini et al [*EFNS*] 2011); CT without IV contrast can be used to exclude new hemorrhage, significant mass effect, or hydrocephalus (Whitehead et al [*ACR*] 2019; PLE expert panel consensus opinion). CT without IV contrast should also be considered if the patient is unable to undergo MRI (PLE expert panel consensus opinion). CT with IV contrast should be considered if there is a suspicion of intracranial neoplasm, encephalitis, or complications of meningitis, and the patient is unable to undergo MRI (PLE expert panel/multidisciplinary committee consensus opinion).

Clinical notes:

- In the setting of known malignancy, immunosuppressed, or immunocompromised, the addition of MRI [or CT] postcontrast imaging further aids in the evaluation of any parenchymal or meningeal process (Whitehead et al [*ACR*] 2019).
- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischaemic 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):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

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** or **CT head without and with 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 – **MR angiography brain and/or neck** or **CT angiography head and/or neck**
  [suspected cranial or cervical vascular disorder]
- Red – **MR venography**; **CT venography**; **SPECT**; **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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA or CTA.

Guideline and PLE expert panel consensus opinion summary:
Brain MRI should be considered in patients with cluster headache/trigeminal autonomic cephalgia (TAC), paroxysmal hemicrania or SUNCT, in order to exclude the wide variety of secondary causes (*SIGN* 2008: Grade D recommendation; Sandrini et al [*EFNS*] 2011 Whitehead et al [*ACR*] 2019; Misikostas et al [*EHF*] 2015*). In patients with new primary headache of suspected trigeminal autonomic origin, MRI brain without and with IV contrast is usually appropriate for initial imaging, while MRI brain without IV contrast may be appropriate if the patient cannot receive IV contrast (Whitehead et al [*ACR*] 2019; PLE expert panel consensus opinion). MRI is considered to be the most sensitive imaging method and is therefore recommended over CT (Sandrini et al [*EFNS*] 2011). When treatments for TAC fail, additional MRA or CTA brain and carotid/vertebral arteries may be required (Mitsikostas et al [*EHF*] 2015*). 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). CT should be considered if the patient is unable to undergo MRI (PLE expert panel consensus opinion).

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 relative common member of this family (Whitehead et al [*ACR*] 2019).

- 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; Beithon et al [*ICSI*] 2013; *SIGN* 2008).
- Cluster headaches are associated with pituitary macroadenomas in 4% of patients (Whitehead et al [*ACR*] 2019).
- In patients with new onset cluster headache or another trigeminal autonomic cephalgia, specialist referral should be considered for diagnosis, neuroimaging and treatment (*TOP Clinical Practice Guideline* 2016; *SIGN* 2008).

Evidence update (2014-present):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

New onset of headache after age 50:

- 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** or **CT head without and with 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 – **MR angiography brain and/or neck, MR venography brain, CT angiography head and/or neck, or CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**

Level of Evidence: CT, MRI: 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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

Guideline and PLE expert panel consensus opinion summary:
Warning signs or red flags for potential secondary headache include new onset of headache after age 50, and many of these patients will merit brain imaging (Beithon et al [*ICSI*] 2013; SIGN 2008), even with 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 and will require urgent specialist referral and/or neuroimaging (*TOP Clinical Practice Guideline* 2016). In addition, a new headache disorder in patient more than 50 years of age should evoke suspicion of possible giant cell arteritis (Beithon et al [*ICSI*] 2013). In these patients, MRI brain without and with IV contrast or MRI brain without IV contrast is considered usually appropriate (Whitehead et al [*ACR*] 2019). CT of the head without IV contrast should be considered if (acute or subacute) hemorrhage is suspected, or if the patient is unable to undergo MRI (PLE expert panel consensus opinion).

Clinical notes:

- The large majority of individuals who are destined to develop a primary headache disorder do so prior to age 50 years (Beithon et al [*ICSI*] 2013).
- Patients who present with headache and red flag features for potential secondary headache should be referred to a specialist appropriate to their symptoms for further assessment (*SIGN* 2008).
- Symptoms of polymyalgia rheumatica, jaw claudication, scalp tenderness, or fever will increase the likelihood of giant cell arteritis diagnosis (Beithon et al [*ICSI*] 2013).

- The differential diagnosis of headache attributed to cranial or cervical vascular disorder includes (*ICHD-3* 2018):
    - Ischaemic 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):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

Headache with signs/symptoms of increased intracranial pressure, including papilledema:

- 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** or **CT head without and with 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 – **MR angiography brain and/or neck, MR venography brain, CT angiography head and/or neck, or CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**

Level of Evidence: MRI, CT: 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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MR contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV.

Guideline and PLE expert panel consensus opinion summary:
Patients who present with headache and features suggestive of raised intracranial pressure should be referred urgently to a specialist for assessment (*SIGN* 2008: grade D recommendation). Patients with papilledema, a normal level of consciousness, and no focal neurological signs may have benign intracranial hypertension; they should have urgent specialist referral and will need urgent neuroimaging (*TOP Clinical Practice Guideline* 2016). Patients with papilledema and altered level of consciousness and/or focal neurological signs may have a space occupying lesion and could be at risk for incipient transtentorial herniation; they should be sent immediately to an emergency department with neuroimaging capability and specialist resources for investigation and treatment (*TOP Clinical Practice Guideline* 2016). For headache that worsens when lying down, a brain CT or MRI scan can be used to exclude a space-occupying lesion (*TOP Clinical Practice Guideline* 2016).

MRI
In patients with new headache with optic disc edema, MRI head without and with IV contrast or MRI head without IV contrast is usually appropriate (Whitehead et al [*ACR*] 2019). MRI provides more

accurate differentiation than CT of parenchymal or meningeal processes, which may be contributing to symptoms (Whitehead et al [*ACR*] 2019).

CT

CT with IV contrast should be considered if tumor is suspected and the patient is unable to undergo MRI (PLE expert panel consensus opinion). CT without IV contrast should be considered if the patient is unable to undergo MRI and has a moderate or severe allergy to CT contrast (PLE expert panel consensus opinion). Noncontrast head CT is also useful to assess for space-occupying processes, such as intracranial hemorrhage, mass effect, macroadenoma causing optic chiasm compression, and hydrocephalus. IV contrast is useful for venographic assessment (Whitehead et al [*ACR*] 2019).

MR venography or CT venography

Dedicated MRV is complementary to the brain MRI evaluation and may be performed without or with IV contrast depending on institutional preference (Whitehead et al [*ACR*] 2019). Although venous sinus thrombosis and stenosis can be detected on precontrast and postcontrast brain MRI sequences, the addition of MRV has improved accuracy for the detection of venous pathology when compared with anatomic imaging alone (Whitehead et al [*ACR*] 2019). In the setting of optic disc edema, CTV is a comprehensive evaluation for cerebral venous thrombosis (Whitehead et al [*ACR*] 2019).

<u>Clinical notes:</u>

- Headache caused by increased cerebrospinal fluid (CSF) pressure is usually accompanied by other symptoms and/or clinical signs of intracranial hypertension. It remits after normalization of CSF pressure (*ICHD-3* 2018).
- The presence of bilateral papilledema indicates increased intracranial pressure that is transmitted to the optic nerve sheath (Whitehead et al [*ACR*] 2019).
- The differential diagnosis for headache in this setting includes secondary causes, such as intracranial abscess, primary or metastatic tumor, hematoma, cerebral edema, hydrocephalus, medications or medical conditions, and pseudotumor cerebri syndrome associated with primary idiopathic intracranial hypertension (IIH) or secondary to cerebral venous thrombosis (Whitehead et al [*ACR*] 2019).
- Headache secondary to intracranial neoplasm has at least one of the three features: progressive, worse in the morning or after daytime napping, or aggravated by Valsalva-like maneuvers (*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):
    - Ischaemic 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):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

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** or **CT head without and with IV contrast**
  [patient unable to undergo MRI]
- **Yellow** – **CT head with IV contrast**
  [characterize abnormalities seen on previous CT head without IV contrast]
- **Yellow** – **MR myelography** of the spine or **CT myelography** of the spine
- **Red** – **MR angiography**; **CT angiography**; **MR venography**; **CT venography**; **SPECT**; **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 IV contrast can be useful in patients with suspected low CSF pressure/orthostatic headache as it can detect secondary signs of a chronic CSF leak such as dural enhancement of arachnoditis. It can also be useful in patients following lumbar spine surgery to identify dural leaks associated with extradural fluid collections (PLE expert panel consensus opinion).

Guideline and PLE expert panel consensus opinion summary:
In patients with suspected low pressure/orthostatic headache, consider additional investigation and/or referral to a specialist (*NICE* 2015; *SIGN* 2008). 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; Whitehead et al [*ACR*] 2019). In patients with low pressure headache, CT of the head with IV contrast is recommended if the patient is unable to undergo MRI or MRI is unavailable. If the patient has an allergy to CT contrast, this can be performed without contrast (PLE expert panel consensus opinion).

Clinical notes:

- In patients with spontaneous or iatrogenic intracranial hypotension, the headache develops or worsens soon after assuming an upright posture and lessens or resolves shortly after lying down. Intracranial hypotension should be considered in all patients with headache developing or worsening after assuming an upright posture (*SIGN* 2008).
- Manifestations of spontaneous intracranial hypotension are variable. Comprehensive diagnostic criteria have been proposed based on symptoms, lumbar puncture, imaging (e.g., MRI, MR myelography, CT myelography) and response to epidural blood patch (Whitehead et al [*ACR*] 2019).
- 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):
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

Headache precipitated by cough, Valsalva maneuver, or sneeze:

- 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** or **CT head without and with 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 – **MR angiography brain and/or neck** or **CT angiography head and/or neck**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**; **MR venography**; **CT venography**

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 (Whitehead et al [*ACR*] 2019). An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast. If the patient is unable to receive MRI contrast, CT head without and with IV contrast can be used. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA or CTA.

Guideline and PLE expert panel consensus opinion summary:
Consider further investigations and/or referral in patients who present with headache triggered by cough, Valsalva maneuver, or sneeze (*NICE* 2015; Beithon et al [*ICSI*] 2013). These patients should be considered for a brain MRI scan to exclude a Chiari 1 malformation or a posterior fossa lesion; however, it must also be considered that patients with typical migraine may have exertion as one of their headache triggers (*TOP Clinical Practice Guideline* 2016; Beithon et al [*ICSI*] 2013). Brain MRI, including the craniocervical junction is used to exclude structural abnormalities in patients presenting with headache which is precipitated, rather than aggravated, by cough (*SIGN* 2008: grade D recommendation; Mitsikostas et al [*EHF*] 2016*). MRA is not generally recommended, however, dynamic MRI CSF studies may be useful (Mitsikostas, et al [*EHF*] 2016*).

CT with IV contrast 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 be considered if hemorrhage is suspected, or if the patient is unable to undergo MRI and has a moderate or severe allergy to CT contrast (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 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).
- Symptomatic cough headache may represent a primary headache or may be a sign of an underlying structural abnormality (Evers et al [*EFNS*] 2011; *SIGN* 2008). Underlying etiologies are present in about 40% of cases, with most related to Chiari type I malformation (*ICHD-3* 2018; Cordenier et al 2013). Other reported causes include spontaneous intracranial hypotension, carotid or vertebrobasilar diseases, middle cranial fossa or posterior fossa tumors, midbrain cyst, basilar impression, platybasia, subdural hematoma, cerebral aneurysms and reversible cerebral vasoconstriction syndrome (*ICHD-3* 2018).
- Patients who present with headache and red flag features for potential secondary headache should be referred to a specialist appropriate to their symptoms for further assessment (*SIGN* 2008).

Evidence update:

Moderate Level of Evidence:

Chen et al (2009) reported on the clinical characteristics and outcome in 83 consecutive patients with cough headaches. 9/83 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 (moderate level of evidence).

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 (moderate level of evidence).

Headache precipitated by exertion or sexual activity:

- Green – **CT head without IV contrast** or **CT head without and with IV contrast**
- Green – **CT angiography head and/or neck** or **MR angiography head and/or 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 head without and with IV contrast**
- Yellow – **MRI brain with IV contrast**
  [characterize abnormalities seen on previous MRI brain without IV contrast]
- Yellow – **MR venography brain** or **CT venography head**
  [suspected cranial or cervical vascular disorder]
- Red – **SPECT**; **PET**

Level of Evidence: CT, MRI, MR angiography, CT angiography: very low; MR venography, CT venography, SPECT, PET: insufficient.

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. MRI brain with IV contrast can be used to characterize abnormalities seen on a previous MRI brain without IV contrast. IV contrast is useful to identify vascular abnormalities in patients undergoing MRA, MRV, CTA or CTV. CTA may identify incidental cerebral aneurysms in patients still considered at risk for SAH following a negative noncontrast CT (Godwin et al [*ACEP*] 2019).

Guideline and PLE expert panel consensus opinion summary:
Exertional headache, such as with exercise or during sexual activity, may represent a benign process such as migraine; however, if the headache is severe (thunderclap) in onset, investigation will be necessary (Beithon et al [*ICSI*] 2013). Imaging in these cases should be used to exclude structural causes or vascular abnormalities (*ICHD-3* 2018; *SIGN* 2008). Posterior fossa processes or SAH have been shown in some cases, while symptoms attributed to venous stenosis and reversible cerebral vasoconstriction syndrome (RCVS) have been seen in others (Whitehead et al [*ACR*] 2019). In patients with suspected RCVS, repeat imaging may be indicated. If the initial study is negative, then a second study is indicated at the time of a first recurrence. If the initial study is positive for RCVS, then a repeat study is recommended for follow-up to ensure resolution of the patient's vascular abnormalities (PLE expert panel consensus opinion).

CT
In patients with new or progressively worsening headache upon sexual activity or exertion, CT head without IV contrast is initially recommended to rule out subarachnoid hemorrhage (Whitehead et al [*ACR*] 2019; PLE expert panel consensus opinion). In most circumstances for this clinical scenario, CT is more readily available and efficient than MRI (PLE multidisciplinary committee consensus opinion).

MRI
MRI for thunderclap headache [headaches precipitated by exertion or headaches precipitated by sexual activity] should only be performed when radiology expertise is available and MR imaging equipment supports the use of fluid-attenuated inversion recovery (FLAIR), gradient-recalled T2* and/or susceptibility-weighted (SWI) sequences (PLE multidisciplinary committee consensus opinion).

MR angiography or CT angiography
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 or recurrent occurrence of a headache precipitated by exercise [or sexual activity] (Mitsikostas et al [*EHF*] 2016*).

CT venography or MR venography
If the differential diagnosis includes suspicion for cerebral venous sinus thrombosis (CVST), CT venography or MR venography can be useful (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:

- Primary exercise headache is precipitated by any form of exercise in the absence of any intracranial disorder, particularly in hot weather or at high altitude (*ICHD-3* 2018).
- Headaches associated with sexual activity may incrementally intensify with increasing sexual excitement or may intensify just before or with orgasm (*ICHD-3* 2018).
- 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. RCVS can be triggered by sexual activity or Valsalva maneuvers (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):
    - Ischaemic 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

Technical notes:

- If an MRI is obtained to evaluate a 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) and select articles from guideline bibliographies:

Low Level of Evidence:

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.

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%).

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** or **CT head without and with 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** – **PET**; **SPECT**; **MR angiography**; **CT angiography**; **MR venography**; **CT venography**

Level of Evidence: Low

Notes concerning applicability and/or patient preferences: None.

Notes concerning use of contrast: 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. An MRI brain with IV contrast can be used to characterize abnormalities seen on previous MRI brain without IV contrast.

Guideline and PLE expert panel consensus opinion summary:
Neuroimaging plays an important role in the management of head injury, which can be separated into acute (0-7 days), subacute (< 3 months), and chronic (> 3 months) phases (Shih et al [*ACR*] 2021). Brain imaging (CT or MRI) should be considered in patients with subacute or chronic head injuries with new or unexplained neurologic signs or symptoms or for progressive/worsening symptoms (*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. If, on a case-by-case basis, it is felt that there may be a need for neuroimaging, specialist referral is recommended (*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 when subacute or chronic post-traumatic headaches are increasing in severity and/or are accompanied by new, persistent, or increasing neurologic deficits or symptoms (Whitehead et al [*ACR*] 2019; *TOP Clinical Practice Guideline* 2016; Sandrini et al [*EFNS*] 2011; Beithon et al [*ICSI*] 2013; PLE expert panel consensus opinion; *also see new or increasing neurologic deficits scenario of this document*). MRI can best detect late, sub-acute, and chronic structural changes in the brain which underlie abnormal functioning, is more sensitive than CT for subtle findings adjacent to the calvarium or skull base, and is more sensitive for 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).

While there is no relevant literature to support the added value or routine use of contrast-enhanced 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

(Whitehead et al [*ACR*] 2019). 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).

CT
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). At this time, 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). At this time, 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>
- Headaches are one of the most common symptoms seen in general medical practices. 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" and treat headaches and other symptoms 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).

<u>Evidence update (2014-present)</u>:
No articles identified in the 2021 update that have impact on the guideline summary and recommendations listed above.

Guideline exclusions:

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

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
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11/09/2021	N/A	CDI 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.mycdi.com/ple**

Provider Led Entity

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11/09/2021

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