American College of Radiology
ACR Appropriateness Criteria®
Headache

Variant 1: **Sudden, severe headache or "worst headache of life." Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT head without IV contrast	Usually Appropriate	☢☢☢
CTA head with IV contrast	May Be Appropriate (Disagreement)	☢☢☢
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢

Variant 2: **New headache with optic disc edema. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
CT head without IV contrast	Usually Appropriate	☢☢☢
MRI head without IV contrast	Usually Appropriate	O
CTV head with IV contrast	May Be Appropriate	☢☢☢
MRV head without and with IV contrast	May Be Appropriate	O
MRV head without IV contrast	May Be Appropriate	O
CT head with IV contrast	May Be Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢

Variant 3: **New or progressively worsening headache with one or more of the following 'red flags': subacute head trauma, related activity or event (sexual activity, exertion, position), neurological deficit, known or suspected cancer, immunosuppressed or immunocompromised state, currently pregnant, or 50 years of age or older. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT head without IV contrast	Usually Appropriate	☢☢☢
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	Usually Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
MRA head without IV contrast	Usually Not Appropriate	O
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
MRA head without and with IV contrast	Usually Not Appropriate	O

Variant 4: **New headache. Classic migraine or tension-type primary headache. Normal neurologic examination. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
CTV head with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O

Variant 5: **New primary headache of suspected trigeminal autonomic origin. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	May Be Appropriate	O
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without IV contrast	Usually Not Appropriate	☢☢☢
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢

Variant 6: **Chronic headache. No new features. No neurologic deficit. Initial imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
CT head without IV contrast	Usually Not Appropriate	☢☢☢
MRI head without and with IV contrast	Usually Not Appropriate	O
MRI head without IV contrast	Usually Not Appropriate	O
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
CT head without and with IV contrast	Usually Not Appropriate	☢☢☢
CTV head with IV contrast	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
MRV head without and with IV contrast	Usually Not Appropriate	O
MRV head without IV contrast	Usually Not Appropriate	O
MRA head without and with IV contrast	Usually Not Appropriate	O
MRA head without IV contrast	Usually Not Appropriate	O

Variant 7: **Chronic headache. New features or increasing frequency. Initial Imaging.**

Procedure	Appropriateness Category	Relative Radiation Level
MRI head without and with IV contrast	Usually Appropriate	O
MRI head without IV contrast	Usually Appropriate	O
CT head without IV contrast	May Be Appropriate	☢☢☢
CT head without and with IV contrast	May Be Appropriate	☢☢☢
CT head with IV contrast	Usually Not Appropriate	☢☢☢
MRA head without IV contrast	Usually Not Appropriate	O
Arteriography cervicocerebral	Usually Not Appropriate	☢☢☢
CTA head with IV contrast	Usually Not Appropriate	☢☢☢
CTV head with IV contrast	Usually Not Appropriate	☢☢☢
MRA head without and with IV contrast	Usually Not Appropriate	O

HEADACHE

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Summary of Literature Review

Introduction/Background

Headache is one of the most common reasons for consulting physicians [1]. Studies have estimated overall lifetime prevalence of 0.2% to 60% for headache of any kind [2,3], and the burden of headache has shown to be very large. Headaches occur most commonly between the ages of 25 to 55 years.

The purpose of this document is to identify the most common clinical scenarios and the most appropriate imaging for their assessment based on the current literature. This document does not address follow-up recommendations for patients with a known underlying etiology for headache. Given the frequent coexistence of headache and other neurologic, traumatic, infectious, and vascular processes, it is important to acknowledge the overlap of symptoms with other conditions referenced in independent ACR Appropriateness Criteria documents, and others beyond the scope of this document. To avoid delay of appropriate care, any patient with a new neurologic deficit suggesting transient ischemic attack or stroke should have imaging guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4]. Headache accompanying clinical signs of meningitis should be managed by appropriate clinical guidelines. Please also reference the ACR Appropriateness Criteria® topic on "Head Trauma" [5], ACR Appropriateness Criteria® topic on "Cranial Neuropathy" [6], the ACR Appropriateness Criteria® topic on "Orbits, Vision and Vision Loss" [7], the ACR Appropriateness Criteria® topic on "Sinonasal Disease" [8], and the ACR Appropriateness Criteria® topic on "Neuroendocrine Imaging" [9], in the appropriate clinical context.

Headaches can be broadly classified into primary and secondary forms [1]. Most common primary headaches include migraine, tension-type, and trigeminal autonomic cephalalgias. The primary headache classification also includes those related to cough, exercise, sexual activity, cold-stimulus, thunderclap (mimicking but not caused by subarachnoid hemorrhage [SAH]), external pressure, stabbing, nummular, hypnic, and new daily persistent headaches. Secondary headaches are related to trauma, cranial or cervical vascular disorders, intracranial processes (tumor, cerebrospinal fluid pressure, seizure, etc), infection, substance use or withdrawal, referred pain, and psychiatric disorders [10]. In most cases, the cause and type of headache can be determined by procuring a detailed history and performing a physical examination. In the absence of worrisome features in the history or examination, the task is then to diagnose the primary headache syndrome based on the clinical features.

In the emergency setting, the majority of patients with primary headache usually respond well medically with nonsteroidal anti-inflammatory drugs and a minority with opioids [11]. If atypical features are present, the neurological examination is abnormal, or the patient does not respond to conventional therapy, the possibility of a secondary headache disorder should be investigated [12-15], and imaging might be indicated [15-17].

Neuroimaging techniques have shown to represent a valuable diagnostic bridge between neurophysiological studies and clinical findings [18]. At the same time, it is important to consider the low yield of imaging

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procedures for individuals presenting with headache unaccompanied by other neurological findings [19-24].

Discussion of Procedures by Variant

Variant 1: Sudden, severe headache or "worst headache of life." Initial imaging.

Given the morbidity and mortality of SAH from ruptured aneurysm and other causes of acute intracranial hemorrhage, imaging is often performed in patients presenting with a sudden, severe headache or "worst headache of life." The "Ottawa SAH rule" [25] and subsequent validations [26,27] are clinical inclusion and exclusion criteria that are 100% sensitive but only 15% specific. These tools were designed to not miss SAH in this patient population; however, they were not intended to independently diagnose SAH as the headache source.

Acute presentation may overlap with thunderclap-type primary headache [27-29] and reversible cerebral vasoconstriction syndrome, characterized by recurrent episodes of thunderclap headache with or without neurologic symptoms [30].

If intracranial hemorrhage is identified, or if there is also a new neurologic deficit, imaging should be guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4].

CT Head

The most appropriate initial imaging test in this clinical setting is a noncontrast head CT [31-33]. Negative predictive value of CT, when performed with modern scanners within the first 6 hours of symptoms and interpreted by a staff radiologist, might be as high as 99.9% [33,34]. A recent meta-analysis including 8,907 patients recorded an incidence of missed SAH of 1.46 per 1,000 in patients with classic thunderclap headache and absence of trauma [35]. Failure to obtain the head CT accounts for 73% of misdiagnosis [36]. There is no evidence to support the use of CT with intravenous (IV) contrast or CT without and with IV contrast in this setting.

CTA Head

CT angiography (CTA) is not indicated as the initial imaging technique in isolation; however, it may be useful in conjunction with a noncontrast head CT if there are 2 or more first-degree family members with aneurysmal SAHs. The CPT code for CTA is inclusive of both a noncontrast head CT and the arterial phase scan. This document acknowledges that some patients may be assessed at the time of noncontrast CT as to the need to proceed with the angiographic portion of the examination, and there may be institutional practices that have implications for clinical decision support. However, this document is for the initial imaging test, and appropriateness of imaging once SAH is identified is guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4].

MRI Head

Although SAH can be detected on MRI, particularly fluid-attenuated inversion recovery sequences [37,38], there are other etiologies for hyperintense fluid-attenuated inversion recovery signal in the cerebrospinal fluid spaces. There is no evidence to support the use of MRI as the initial imaging in this setting given the accuracy of CT.

MRA Head

There is no relevant literature to support the use of MR angiography (MRA) in the initial imaging evaluation of a patient in this setting. Imaging once SAH is identified is guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4].

Arteriography Cervicocerebral

Conventional angiogram is the gold standard of diagnostic tests used for evaluation of an aneurysm and for reversible cerebral vasoconstriction syndrome; however, it is not a first-line test for this presentation. Imaging of suspected infarct, and once SAH is identified, is guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4].

Variant 2: New headache with optic disc edema. Initial imaging.

The presence of bilateral disc edema indicates increased intracranial pressure transmitted to the optic nerve sheath. The differential diagnosis for headache in the setting of bilateral disc edema includes secondary causes, such as intracranial abscess, primary or metastatic tumors, hematoma, cerebral edema, communicating or obstructive hydrocephalus [39,40], medications or medical conditions, and pseudotumor cerebri syndrome associated with primary idiopathic intracranial hypertension or secondary to cerebral venous thrombosis. Patients with idiopathic intracranial hypertension are usually obese females of childbearing age. However, imaging,

preferably with MRI/MR venography (MRV) [41,42], is included in the diagnostic criteria of this condition, given its association with venous thrombosis or venous sinus stenosis. Cerebral venous thrombosis is a potentially lethal disorder also associated with prothrombotic states, pregnancy, oral contraceptives, and infection [43-45]. With early diagnosis and institution of therapy, prognosis may be improved. Indications for and timing of lumbar puncture are beyond the scope of this document.

CT Head
Noncontrast head CT is useful to assess for space-occupying processes, such as intracranial hemorrhage, mass effect, macroadenoma causing optic chiasm compression, and hydrocephalus. Although findings such as high-attenuation within the venous sinuses may be evident, there is wide variability of venous anatomic differences, and noncontrast CT is not as accurate as dedicated venographic imaging for detection of venous sinus thrombosis [46,47]. The use of contrast should be for venographic assessment, detailed in CT venogram (CTV) below. Postcontrast head CT may be considered for patients unwilling or unable to undergo MRI for comprehensive parenchymal evaluation.

CTV Head
The CPT code for CTV is inclusive of both a noncontrast head CT, the venous phase scan, and 3-D reconstructions. In the setting of optic disc edema, this is a comprehensive evaluation for cerebral venous thrombosis. Venographic imaging techniques are complementary to anatomic imaging and comparable to accuracy of catheter angiography [48]. There is substantial literature regarding technique and pitfalls of interpretation, which is beyond the scope of this document. Head-to-head comparisons between CTV and MRV for diagnosis of cerebral venous thrombosis are historic, given that changes in technology with both methods show superb accuracy [49,50].

MRI Head
MRI provides more accurate differentiation than CT of parenchymal or meningeal processes, which may be contributing to symptoms. Findings such as pituitary flattening and optic nerve sheath thickness may persist without clinically evident papilledema [51]. Brain MRI and MRV have been shown to increase the diagnostic certainty for idiopathic intracranial hypertension when one or more of the following are present: partially empty sella, flattening of the posterior ocular globe margins, and/or transverse sinus stenosis [52].

MRV Head
Dedicated MRV is complementary to the brain MRI evaluation and may be performed without or with IV contrast depending on institutional preference. There is substantial literature regarding technique and pitfalls of interpretation, which is beyond the scope of this document. 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 [53].

Arteriography Cervicocerebral
There is no relevant literature to support the use of arteriography in the initial imaging evaluation of a patient in this setting.

Variant 3: New or progressively worsening headache with one or more of the following 'red flags': subacute head trauma, related activity or event (sexual activity, exertion, position), neurological deficit, known or suspected cancer, immunosuppressed or immunocompromised state, currently pregnant, or 50 years of age or older. Initial imaging.

"Red flag" signs, symptoms, and comorbidities have been proposed as a means to increase specificity of imaging in new or progressively worsening headaches [20,54-57]; however, the many proposed factors have not been independently validated. The prevailing "red flag" is a new neurologic deficit. If a patient is presenting with symptoms of a possible transient ischemic attack or acute stroke, the use of imaging should be guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4], not that the patient has a headache. Similarly, patients with suspected meningitis or encephalitis are beyond the scope of this guideline.

Imaging in the setting of acute head trauma should be guided by the ACR Appropriateness Criteria® topic on "Head Trauma" [5], noting the discrepancy that headache is an independent high-risk factor in the New Orleans Criteria [58], but not in the Canadian CT Head Rule [59]. Post-traumatic headache begins within 7 days of the injury and may mimic primary headache. A single prospective study with a cohort of 543 patients with history of traumatic brain injury reported a prevalence of headache of 49% at 1 year follow-up [60].

Headaches associated with cough, exertion, or sexual activity are uncommon and often a primary headache syndrome. However, imaging has shown posterior fossa processes or SAH in some cases [61] and symptoms attributed to venous stenoses [62] and reversible cerebral vasoconstriction syndrome in others [63,64].

Manifestations of spontaneous intracranial hypotension are variable [65-67]. Comprehensive diagnostic criteria encompassing the varied manifestations of spontaneous intracranial hypotension have been proposed [68] based on symptoms, lumbar puncture, imaging (CT myelography, MRI, MR myelography, or radionuclide cisternography), and response to epidural blood patch.

Patients with known cancer should have head imaging when a headache develops or if there is a change in headache characteristics [69].

Given risk for central nervous system infections, immunosuppressed and immunocompromised patients presenting with a new or progressive headache will often undergo cerebrospinal fluid analysis. Indications for lumbar puncture are beyond the scope of this document.

Pregnant patients with new, progressive, or changes in chronic headache patterns have higher yields of abnormalities on imaging [70]; although, much of the literature on headache in pregnancy is centered on examination rather than imaging findings [71-74]. Please see the *Safety Considerations in Pregnant Patients* section below for details. For imaging of suspected pituitary apoplexy, see the ACR Appropriateness Criteria® topic on "Neuroendocrine Imaging" [9].

CT Head
In all of these circumstances, noncontrast CT can be sufficient to exclude new hemorrhage, significant mass effect, or hydrocephalus. Please see the *Safety Considerations in Pregnant Patients* section below for details. There is no evidence to support the use of CT head with contrast as the initial imaging procedure in this clinical setting.

CTA Head
There is no relevant literature to support the use of CTA in the initial imaging evaluation of a patient in this setting.

MRI Head
MRI is a more comprehensive alternative to CT and depending on severity of symptoms and patient stability could be the initial imaging procedure. In the setting of known malignancy, immunosuppressed, or immunocompromised state, the addition of postcontrast imaging further helps in evaluation of any parenchymal or meningeal process.

Please see the *Safety Considerations in Pregnant Patients* section below for details. For imaging specific to suspected pituitary apoplexy, see the ACR Appropriateness Criteria® topic on "Neuroendocrine Imaging" [9].

MRA Head
There is no relevant literature to support the use of MRA in the initial imaging evaluation of a patient in this setting.

Arteriography Cervicocerebral
There is no relevant literature to support the use of arteriography in the initial imaging evaluation of a patient in this setting.

Variant 4: New headache. Classic migraine or tension-type primary headache. Normal neurologic examination. Initial imaging.

Migraine and tension-type headaches have been ranked in the top 5 most prevalent disorders in the world [75]. The International Classification of Headache Disorders-3 notes overlap in symptoms of tension-type and mild forms of migraine [10]. Prevalence studies on migraine show that genetic factors and gender differences are related to migraines and affect approximately 15% to 18% of women and 6% of men [76]. Studies performed under low pretest probability conditions may be more likely to result in false-positive results [19,23,77,78], with the consequential risk of additional and unnecessary procedures.

The ACR in the Choosing Wisely campaign (http://www.choosingwisely.org) recommends against imaging for primary headache. For patients meeting criteria of these primary headache syndromes, having no red flags and a normal neurological examination, neuroimaging is not necessary based upon the current available data [79].

Clinically, a patient presenting with a new migraine with aura can mimic transient ischemic attack or acute stroke [80]. If there is a new neurologic deficit, imaging should be guided by the ACR Appropriateness Criteria® topic on "Cerebrovascular Disease" [4], not that the patient has a headache.

CT Head
Head CT scans have been shown to yield positive results in only 0.4% of patients that are referred with a nontraumatic headache [81].

CTA Head
There is no relevant literature to support the use of CTA in the initial imaging evaluation of a patient in this setting.

CTV Head
There is no relevant literature to support the use of CTV in the initial imaging evaluation of a patient in this setting.

MRI Head
Several studies have assessed prevalence of white matter lesions in patients with migraines compared with other headache patterns and normal populations; however, the extent and distribution have not correlated with symptoms or affected management [82-85]. Population cohorts in Australia [86] and the United Kingdom [87] have not shown any clinical value in imaging of patients with migraine with aura.

MRA Head
Studies evaluating MRA have shown no contribution to diagnosis or management for migraine with or without aura [88].

MRV Head
There is no relevant literature to support the use of MRV in the initial imaging evaluation of a patient in this setting.

Arteriography Cervicocerebral
There is no relevant literature to support the use of arteriography in the initial imaging evaluation of a patient in this setting.

Variant 5: New primary headache of suspected trigeminal autonomic origin. Initial imaging.

Trigeminal autonomic cephalalgia is a primary headache disorder characterized by unilateral trigeminal distribution pain with ipsilateral cranial autonomic signs and symptoms. Cluster headache is the only relatively common member of this headache disorder family. The others are rare and are characterized by short attacks: paroxysmal hemicrania, hemicrania continua, short unilateral neuralgiform headache attacks with unilateral conjunctival injection and tearing, and short-lasting unilateral neuralgiform headache with cranial autonomic symptoms. Paroxysmal hemicranias are more frequent, and individual attacks are shorter in duration when compared with cluster headache.

There is an unexplained association with pituitary macroadenomas, which are found in 4% of cluster headache patients [89]. Microvascular compression has also been associated [90] and the ophthalmic form of trigeminal neuralgia may be confused with these entities [91,92]; however, imaging in trigeminal neuralgia should be guided by the ACR Appropriateness Criteria® topic on "Cranial Neuropathy" [6].

CT Head
CT may reveal suprasellar extent of a pituitary mass; however, it is less sensitive than MRI for evaluation of sella processes.

CTA Head
There is no relevant literature to support the use of CTA in the initial imaging evaluation of a patient in this setting.

MRI Head
Brain MRI without and with IV contrast is usually appropriate to perform at least once in an individual's lifetime when presenting with a primary headache of suspected trigeminal autonomic origin, inclusive of evaluation for a pituitary mass [90,93]. Imaging for suspected vascular compression on the trigeminal nerve is guided by the ACR Appropriateness Criteria® topic on "Cranial Neuropathy" [6].

MRA Head
There is no relevant literature to support the use of MRA in the initial imaging evaluation of a patient in this setting. Imaging in the setting of suspected trigeminal neuralgia should be guided by the ACR Appropriateness Criteria® topic on "Cranial Neuropathy" [6].

Arteriography Cervicocerebral
There is no relevant literature to support the use of arteriography in the initial imaging evaluation of a patient in this setting.

Variant 6: Chronic headache. No new features. No neurologic deficit. Initial imaging.

Chronic daily headache may be one of the primary headache subtypes or may be secondary to another disease process; however, is characterized by long-duration of having headaches on 15 or more days per month.

Chronic migraine comprises 3% of all migraines, with a prevalence rate of 0.67% [94,95]. These headaches often worsen in the setting of medication overuse whether analgesic or antimigraine medications [96]. In adult with migraine, with no recent change in attack pattern, history of seizures, or other focal neurological symptoms or signs, the routine use of neuroimaging is usually not warranted [57]. The yield of detecting abnormal, treatable lesions by CT or MRI in patients with headache but normal neurological examination has been found to be low, reported as 0.18% by Frishberg [81]. The American Headache Society guidelines advise against the use of neuroimaging in patients with stable headaches that meet criteria for migraines [22]. The American College of Radiology Ten Things Physicians and Patients Should Question document states: "Don't do imaging for uncomplicated headache. Imaging in headache patients absent specific risk factors for structural disease is not likely to change management or improve outcome [97]."

Sempere et al [23] reported a 0.9% probability for a significant intracranial finding in chronic headache (as defined as lasting at least 4 weeks) with a normal neurologic examination. The incidence of pathology identified by imaging in the chronic headache group is similar to that encountered in the general population, reported as 0.7% to 6.5% [98,99].

In the face of increased imaging utilization, Gilbert et al [19] published an overall decrease in diagnostic yield for intracranial pathology in atraumatic headache patients. They reviewed the trends in CT and MRI use in the United States for emergency department patients with atraumatic headache from 1998 to 2008 and reported that the percentage of this patient group who underwent imaging increased from 12.5% to 31%, whereas the prevalence of intracranial pathology detected decreased from 10.1% to 3.5%. They noticed an important demographic difference in the yield of the examination with conditions associated with intracranial pathology detected in 10.4% in patient's ≥50 years of age, but only a 2.3% yield in the patient group <50 years of age. Patients presenting with a nonmigraine type headache had a 5.2% yield of conditions associated with intracranial pathology on imaging, whereas imaging in the migraine patient group had a yield of 1.0%. They also reported an increased length of stay in the emergency department for patients who received imaging.

CT Head
In the evaluation of patients with chronic headache with no new features and no concerning findings on clinical or physical examination, there is no relevant literature to support the use of CT head in the initial evaluation.

The American Headache Society guidelines and the Choosing Wisely Campaign advise against the use of neuroimaging in patients with stable headaches that meet criteria for migraines [22]. This document went on to state that many headache patients have previously undergone imaging and that "in many situations, it is very unlikely that a repeat imaging study of the head will identify any abnormality that will alter management."

The American College of Radiology Ten Things Physicians and Patients Should Question document states "Don't do imaging for uncomplicated headache. Imaging in headache patients absent specific risk factors for structural disease is not likely to change management or improve outcome [97]."

The yield of detecting abnormal, treatable lesions by CT or MRI in patients with headache and a normal neurological examination was found to be very low as reported by Frishberg [81] and Sempere [23]. Additionally, the incidence of pathology identified by imaging in the chronic headache group is similar to that encountered in the general population [98,99]. Further, a study by Miller et al [100] found no increase in missed diagnosis proportions in association with an overall 9.6% decrease in head CT utilization in patients presenting to the emergency department with headache.

CTA Head
There is no role for CTA in patients with chronic headache with no new features and no concerning findings on clinical or physical examination.

CTV Head
There is no role for CTV in patients with chronic headache with no new features and no concerning findings on clinical or physical examination.

MRI Head
In the evaluation of patients with chronic headache with no new features and no concerning findings on clinical or physical examination, there is no relevant literature to support the use of MRI head in the initial evaluation.

The American Headache Society guidelines and the Choosing Wisely Campaign advise against the use of neuroimaging in patients with stable headaches that meet criteria for migraines [22]. This document went on to state that many headache patients have previously undergone imaging and that "in many situations, it is very unlikely that a repeat imaging study of the head will identify any abnormality that will alter management."

The American College of Radiology Ten Things Physicians and Patients Should Question document states "Don't do imaging for uncomplicated headache. Imaging in headache patients absent specific risk factors for structural disease is not likely to change management or improve outcome [97]."

The yield of detecting abnormal, treatable lesions by CT or MRI in patients with headache and a normal neurological examination was found to be very low as reported by Frishberg [81] and Sempere [23]. Additionally, the incidence of pathology identified by imaging in the chronic headache group is similar to that encountered in the general population [98,99].

MRA Head
There is no role for MRA in patients with chronic headache with no new features and no concerning findings on clinical or physical examination.

MRV Head
There is no role for MRV in patients with chronic headache with no new features and no concerning findings on clinical or physical examination.

Arteriography Cervicocerebral
There is no role for arteriography in patients with chronic headache with no new features and no concerning findings on clinical or physical examination.

Variant 7: Chronic headache. New features or increasing frequency. Initial Imaging.

In cases with underlying pathology, patients typically present with new headache features or focal neurological symptoms. In a retrospective review of the presentation of 111 patients with brain tumors, headache was a symptom in 48% equally for primary and metastatic tumors [101]. Headaches were similar to tension-type in 77%, migraine type in 9%, and other types in 14%. The typical headache was bifrontal but worse ipsilaterally and headache was the worst symptom in 45% of patients [101]. Further workup is indicated including neurologic imaging in patients for whom the frequency, severity, or character of headache changes in the setting of a prior history of benign headaches [17,102]. Headache increasing in frequency or severity is considered a "red flag" [55].

CT Head
Noncontrast CT can be sufficient to exclude new hemorrhage, significant mass effect, or hydrocephalus. The American Headache Society recommends "against CT when MRI is available, except in emergency situations" [22,103]. CT with IV contrast should not be performed as the sole imaging test in the acute setting; contrast material may obscure hemorrhage(s). CT without and with IV contrast may be helpful to exclude acute intracranial hemorrhage and evaluate for potential leptomeningeal or dural enhancing lesion(s).

CTA Head
There is no relevant literature to support the use of CTA in the initial imaging evaluation of a patient in this setting.

CTV Head
There is no relevant literature to support the use of CTV in the initial imaging evaluation of a patient in this

setting.

MRI Head
MRI is a more comprehensive alternative to CT and in the setting of a stable patient should be the initial imaging procedure. American Headache Society recommends "against CT when MRI is available, except in emergency situations" [22,103]. 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.

MRA Head
There is no relevant literature to support the use of MRA in the initial imaging evaluation of a patient in this setting.

Arteriography Cervicocerebral
There is no relevant literature to support the use of arteriography in the initial imaging evaluation of a patient in this setting.

Summary of Recommendations

- **Variant 1**: In patients with sudden, severe headache or worst headache of their life, CT head without IV contrast is usually appropriate for initial imaging. The panel did not agree on recommending CTA head with IV contrast for patients in this clinical setting. There is insufficient medical literature to conclude whether or not these patients would benefit from this procedure. The use of CTA head with IV contrast as an initial imaging approach in this patient population is controversial but may be appropriate.
- **Variant 2**: In patients with new headache and optic disc edema, MRI head without and with IV contrast, MRI head without IV contrast, or CT head without IV contrast are usually appropriate for the initial imaging. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 3**: In patients with new or progressively worsening headache with one or more of the following "red flags" of subacute head trauma, related activity or event (sexual activity, exertion, position), neurological deficit, known or suspected cancer, immunosuppressed or immunocompromised state, age 50 years or older, CT head without IV contrast, MRI head without and with IV contrast, or MRI head without IV contrast is usually appropriate for the initial imaging. Pregnancy is also considered a "red flag" condition, with separate considerations for radiation and contrast exposure. These procedures are equivalent alternatives (ie, only one procedure will be ordered to provide the clinical information to effectively manage the patient's care).
- **Variant 4**: Imaging is usually not appropriate for the initial imaging of patients with new primary migraine or tension-type headache, with normal neurologic examination.
- **Variant 5**: In patients with new primary headache of suspected trigeminal autonomic origin, MRI head without and with IV contrast is usually appropriate for the initial imaging.
- **Variant 6**: Imaging is usually not appropriate for the initial imaging of patients with chronic headache, no new features and with no neurologic deficit.
- **Variant 7**: In patients with chronic headache presenting with new features or increasing frequency, MRI head without and with IV contrast or MRI head without IV contrast is usually appropriate for the initial imaging. These procedures are equivalent alternatives.

Supporting Documents
The evidence table, literature search, and appendix for this topic are available at https://acsearch.acr.org/list. The appendix includes the strength of evidence assessment and the final rating round tabulations for each recommendation.

For additional information on the Appropriateness Criteria methodology and other supporting documents go to www.acr.org/ac.

Safety Considerations in Pregnant Patients
Imaging of the pregnant patient can be challenging, particularly with respect to minimizing radiation exposure and risk. For further information and guidance, see the following ACR documents:

- ACR–SPR Practice Parameter for the Safe and Optimal Performance of Fetal Magnetic Resonance Imaging (MRI) [104]
- ACR-SPR Practice Parameter for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation [105]
- ACR-ACOG-AIUM-SMFM-SRU Practice Parameter for the Performance of Standard Diagnostic Obstetrical Ultrasound [106]
- ACR Manual on Contrast Media [107]
- ACR Guidance Document on MR Safe Practices; 2013 [108]

Appropriateness Category Names and Definitions

Appropriateness Category Name	Appropriateness Rating	Appropriateness Category Definition
Usually Appropriate	7, 8, or 9	The imaging procedure or treatment is indicated in the specified clinical scenarios at a favorable risk-benefit ratio for patients.
May Be Appropriate	4, 5, or 6	The imaging procedure or treatment may be indicated in the specified clinical scenarios as an alternative to imaging procedures or treatments with a more favorable risk-benefit ratio, or the risk-benefit ratio for patients is equivocal.
May Be Appropriate (Disagreement)	5	The individual ratings are too dispersed from the panel median. The different label provides transparency regarding the panel's recommendation. "May be appropriate" is the rating category and a rating of 5 is assigned.
Usually Not Appropriate	1, 2, or 3	The imaging procedure or treatment is unlikely to be indicated in the specified clinical scenarios, or the risk-benefit ratio for patients is likely to be unfavorable.

Relative Radiation Level Information

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, because of both organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared with those specified for adults (see Table below). Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document [109].

Relative Radiation Level Designations		
Relative Radiation Level*	**Adult Effective Dose Estimate Range**	**Pediatric Effective Dose Estimate Range**
O	0 mSv	0 mSv
☢	<0.1 mSv	<0.03 mSv
☢☢	0.1-1 mSv	0.03-0.3 mSv
☢☢☢	1-10 mSv	0.3-3 mSv
☢☢☢☢	10-30 mSv	3-10 mSv
☢☢☢☢☢	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

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