# Headache Emergencies: Diagnosis and Management

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Headaches are a common reason for visiting a neurologist, a primary care provider, or an emergency department. Most headaches that cause a medical visit are benign in nature in that the pain is self-limited and mortality or irreversible morbidity is unlikely. These benign headaches may be one of the primary headache disorders, such as migraine, tension-type headache, or cluster headache, or a secondary cause of headache, such as viral rhinosinusitis or cervicogenic headache. For most of these benign headaches, pain and other symptoms can be treated with over-the-counter or prescription medication. Occasionally, the pain from the benign headaches can be so severe and unremitting as to constitute a true emergency. This subject will be discussed later. At times, headaches are symptomatic of an underlying process that requires prompt diagnosis and urgent treatment to reduce threats to life or limb. Suspicion of these disorders mandates emergent diagnostic testing to exclude the disease. In this article, the authors review the 6 most common presentations for worrisome headaches and briefly discuss the differential diagnosis. The authors then review the specific etiologic categories of headaches most commonly sought in the differential diagnosis of a worrisome headache.

## CLINICAL PRESENTATIONS OF CONCERN

In this section, the authors describe a series of relatively common headache presentations that raise the specter of worrisome headache. These presentations may occur

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in isolation or in various combinations. For example, progressive headache may develop with evolving focal features in a worrisome combination.

### First, Worst, or Sudden Onset

Most patients who present to a clinician with a new-onset headache will have a benign cause. However, the physician should be cautious about attributing the headache to a benign syndrome without a well-defined headache history. A low threshold for diagnostic imaging is warranted in patients who present with a new headache type, even though many of these will prove to be either self-limited or one of the defined recurrent headache syndromes.

The headaches of cerebrovascular catastrophes are often described as abrupt onset or the worst headache of the patients' life. The differential diagnosis for sudden-onset headache is broad and includes benign causes, such as migraine. However, a "worst headache of my life" or a sudden-onset headache should cause the clinician to consider hemorrhagic stroke, including aneurysmal subarachnoid hemorrhage, cervical artery dissection, venous sinus thrombosis, pituitary apoplexy, and other forms of intracranial hemorrhage.

### Progressive Headache

A progressive, gradually worsening subacute headache raises concern for an enlarging space-occupying lesion. Intracranial mass lesions often produce focal signs and symptoms. Masses located outside the substance of the brain or in selected intra-parenchymal regions, such as the anterior frontal lobe, cerebellum, or intrahemi-spheric fissure, may grow large without producing focal features. Neuroimaging is warranted to exclude a primary or metastatic tumor, subdural hematoma, hydroceph-alus, abscess, and other intracranial mass lesions.[1] Although many patients will ultimately be given a benign diagnosis, such as transformed migraine, medication overuse headache, or new daily persistent headache, these diagnoses require the exclusion of space-occupying lesions.

### Headache Associated with Focal Signs and Symptoms

Headaches associated with focal signs and symptoms require a thorough work-up to exclude mass lesions, ischemic or hemorrhagic stroke, a vascular pathologic condition, or infection. The differential diagnosis of headache plus focal findings is broad and work-up should be guided by the patients' profile of other risk factors. Symptomatic malignancy is usually visualized on routine noncontrast head computed tomography (CT). Cervical artery dissection requires dedicated imaging of the cervical arteries, whereas cerebral venous sinus thrombosis requires dedicated imaging of the cerebral venous system. Idiopathic intracranial hypertension requires the measurement of cerebral spinal fluid pressure. Infections, such as cryptococcal meningitis or Lyme meningitis, require spinal fluid analysis. Risk factors for these various illnesses and the appropriate work-up are discussed later.

### Headache Associated with Fever and Stiff Neck

Meningitis classically presents with fever, meningismus, and altered mental status.[2] Patients with meningitis and an intact sensorium usually report headache. Pyogenic or sterile meningitis must be considered in patients who present with a headache, fever, or stiff neck. Less commonly, encephalitis, brain abscess, collagen vascular disease, and carcinomatous meningitis may cause these symptoms.

### New-Onset Headache after 55 Years of Age

Beginning in the sixth decade of life, giant cell arteritis begins to emerge on the differential diagnosis of headaches. Concern for malignancy and atherosclerotic vascular disease also increases. Clinicians should consider ordering serum markers of inflammation, such as an erythrocyte sedimentation rate and a C-reactive protein, and neuroimaging in patients aged older than 55 years with a new-onset headache.[3]

### New-Onset Headache in a Person with Cancer, HIV, or Immunosuppression

Rarer infectious causes of headaches are a concern in immunosuppressed patients. Cryptococcal meningitis may present with nothing more than an indolent headache. Toxoplasmosis usually causes focal neurologic symptoms along with the headache, whereas patients with a brain abscess often will not seem toxic. Mycobacterium, syphilis, and HIV itself may also cause headaches.[4] HIV is a risk factor for central nervous system (CNS) lymphoma. Patients with known malignancy are at risk for CNS metastases, particularly from primary malignancies of the lung, breast, and gastrointestinal tract.[5]

## CAUSES OF CONCERN: HEADACHE AND CEREBROVASCULAR EMERGENCIES
### Aneurysmal Subarachnoid Hemorrhage

Cerebrovascular aneurysms are present in 2% of the population,[6] whereas national data reveal that 30,000 Americans suffer a subarachnoid hemorrhage each year.[7] Aneurysmal subarachnoid hemorrhage is a devastating illness, with mortality rates approaching 50% and substantial morbidity.[7] Patients suffering from subarachnoid hemorrhage who have the best prognosis are those who are diagnosed while neurologically intact.[8] Because the rebleed rate is substantial, it is essential to diagnose and treat these patients emergently. In patients who are obtunded or present with focal neurologic impairment, the indication for head imaging is obvious. The difficulty arises in determining which neurologically intact patients who present with headache require an emergent and complete work-up.

Some authorities advocate casting a very wide net in the pursuit of aneurysmal subarachnoid hemorrhage.[8] Conducting a work-up of all patients who present with a first, worst, or changed headache will make missing subarachnoid hemorrhage unlikely and may be appropriate for a practice that sees mostly high-acuity patients or sees headaches only infrequently. Risk stratifying based on features of the headache history may also be a reasonable strategy. For example, the headache of subarachnoid hemorrhage usually peaks in intensity rapidly. Headaches that take more than several minutes to peak in intensity are substantially less likely to be a subarachnoid hemorrhage.[9] Unlike the primary headache disorders, subarachnoid hemorrhage is less common in patients younger than 45 years.[10] Clinical decision rules can be used to help decide which patients who present to an emergency department with acute-onset headache require an emergent work-up (**Box 1**). Although severe pain, occipital location, vomiting, elevated blood pressure, and neck symptoms in conjunction with headache have been identified as high-risk features, the absence of any one of these does not preclude the disease.[10]

A noncontrast head CT will diagnosis most cases of subarachnoid hemorrhage, particularly if performed soon after the ictus. The sensitivity of head CT for subarachnoid blood decreases with time because the hemoglobin within the cerebrospinal fluid (CSF) is metabolized and diluted. If performed within 6 hours, the sensitivity of head CT approaches 100%, although this diminishes to the low 90s by 24 hours and less than 75% within several days.[11] To exclude the diagnosis of subarachnoid hemorrhage

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**Box 1**
**Clinical decision rules for the diagnosis of nontraumatic subarachnoid hemorrhage**

Canadian subarachnoid decision rule

Each of these 3 rules were 100% sensitive for identifying subarachnoid hemorrhage in a population of patients with nontraumatic headache that peaked in intensity within 1 hour. These rules have yet to be validated in a distinct population.

Rule 1

Aged older than 40 years

Complaint of neck pain or stiffness

Witnessed loss of consciousness

Onset with exertion

Rule 2

Arrival by ambulance

Aged older than 45 years

Vomiting at least once

Diastolic blood pressure greater than 100 mm Hg

Rule 3

Arrival by ambulance

Systolic blood pressure greater than 160 mm Hg

Complaint of neck pain or stiffness

Aged 45 to 55 years

Perry JJ, Stiell IG, Sivilotti ML, et al. High risk clinical characteristics for subarachnoid haemorrhage in patients with acute headache: prospective cohort study. BMJ 2010;341:c5204. doi: 10.1136/bmj.c5204.

Clinical predictors associated with any bad outcome

Taken together, these 3 clinical features identified 98.6% of all pathologic headaches that presented to one emergency department over a 14-month period.

Aged older than 50 years

Sudden-onset headache

Any neurologic abnormality on physical examination

*From* Perry JJ, Stiell IG, Sivilotti ML, et al. High risk clinical characteristics for subarachnoid haemorrhage in patients with acute headache: prospective cohort study. BMJ 2010;341:c5204; with permission.

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definitively, a spinal fluid analysis is required in which the evidence of bleeding is sought. This evidence may be in the form of red blood cells not attributable to trauma from the lumbar puncture itself or xanthochromia, the yellowish tinge that CSF acquires from the metabolism of red blood cells. As a cautionary note, xanthochromia may take hours to develop, so a lumbar puncture within several hours of the bleed may not demonstrate xanthochromia. Alternatively, rather than a lumbar puncture, a CT angiogram or magnetic resonance (MR) angiogram may be used to evaluate for a causative aneurysm. Although these imaging modalities are not 100% sensitive for causative aneurysms, the combination of either of these tests with a normal

noncontrast head CT is sufficiently sensitive, given that the first test is searching just for blood and the second is searching for an aneurysm.[11] Because a causative aneurysm is managed differently than a small incidentally discovered aneurysm, an abnormal CT or MR angiogram should be followed with a lumbar puncture if there is no evidence of bleeding on imaging.

Definitive treatment of a leaking aneurysm involves identifying the aneurysm and excluding it from the circulatory system. For aneurysms that are amenable to neurosurgical and cerebrovascular interventional procedures, the latter results in better long-term outcomes, assuming sufficient local expertise.[12] Nimodipine, a calcium channel blocker, should be started soon after a diagnosis of aneurysmal subarachnoid hemorrhage is made to lessen the likelihood of vasospastic-induced ischemic outcome.[13] Antifibrinolytics (eg, aminocaproic acid) do not improve the overall outcome because the reduction in the rate of rebleeding is offset by an increase in poor outcome caused by cerebral ischemia.[14] Similarly, corticosteroids have not been demonstrated to be of benefit.[15] The ideal management of blood pressure is not clearly understood, although some amount of blood pressure modulation is likely to be of benefit. Opioid analgesia and antiemetics should be used to make patients comfortable. Clinically evident seizures should be treated with anticonvulsants but the prophylactic use of these drugs is controversial.[16]

### Cervical Artery Dissection

Carotid and vertebral artery dissections are a rare cause of stroke and an even rarer cause of isolated headache,[17] although they should be considered higher in the differential diagnosis of nonelderly patients who present with headache, neck, or facial pain with neurologic deficits. Classically, carotid artery dissection will present with a partial Horner syndrome, retinal or cerebral ischemic symptoms, pulsatile tinnitus, or cranial neuropathies in patients with a history of minor neck trauma or Valsalva maneuvers.[18] Vertebral artery dissection is more likely to cause brain stem ischemic symptoms.[18] However, the presentation or cervical artery dissections can be quite variable. This disease may present with little more than a headache, facial pain, or carotidynia. Spontaneous, atraumatic dissections are common. Therefore, cervical artery dissection should be on the differential diagnosis of any patient with a new-onset cluster headache or trigeminal neuralgia.

The prevalence of this disease is probably underappreciated because patients who present with pain but no focal neurologic impairment are less likely to receive an aggressive work-up. There is often a delay of at least 1 day between the time of the injury and the presentation to a physician,[19,20] suggesting that the progression or persistence of symptoms result in a visit rather than the initial symptoms and that some patients may improve spontaneously. Pain may precede neurologic findings by days in patients who ultimately develop ischemic symptoms.[20,21] The headache has been described as a pulsating pain and as a steady or constrictive pain.[20] It can be sudden or acute onset, progressive, or intermittent. It may be associated with nausea and vomiting.[17]

Diagnosis is readily made with CT or MR angiography. Ultrasonography lacks the sensitivity of these other imaging modalities but can be used to confirm the diagnosis when it is clinically apparent.[22]

Prognosis is generally good and associated with both traditional cerebrovascular risk factors and neurologic impairment at diagnosis.[23,24] Ischemic or hemorrhagic stroke can occur. It is unclear how common these outcomes are in carotid dissection because diagnosis is often contingent on the presence of focal neurologic signs and symptoms. Most ischemic strokes in the setting of carotid dissection are thought to be

embolic, although watershed ischemia and low-flow strokes can also occur. Patients are usually treated with anticoagulation or antiplatelet therapy. Randomized comparative studies do not exist, therefore, it is impossible to be certain which therapy is preferable. However, a Cochrane synthesis of the literature suggests anticoagulants may be more effective at preventing death and disability than antiplatelet agents.[25] The role of endovascular stenting is ill defined.[26]

### Cerebral Venous Sinus Thrombosis

Cerebral venous sinus thrombosis is a rare cause of stroke with neurologic symptoms that often presage the headache. It is eminently treatable, although diagnosis may be difficult because of a subtle or indolent presentation. Risk factors for this illness are those that predispose patients to thromboembolic disease. Thus, patients with venous sinus thrombosis are substantially younger than other patients who suffer ischemic or hemorrhagic stroke and have a different set of comorbidities than patients with traditional atherosclerotic stroke. Specifically, the use of oral contraceptives; the puerperium; genetic mutations associated with thrombophilia, such as factor V Leiden deficiency; and medical illness associated with thrombophilia, such as systemic lupus erythematosus or inflammatory bowel disease; place patients at risk of venous sinus thrombosis. Also, the extension of head and face infections as well as neurosurgical procedures can cause the sinus thrombosis to develop.[27]

Cerebral venous sinus thrombosis may present with a thunderclap headache, although the headache is more commonly gradual in onset.[28] Seizure and focal neurologic signs and symptoms develop as intracranial pressure increases. Papilledema may also be present as the disease progresses.

Diagnosis is often difficult because the disease is rare, the headache may be nonspecific, and the pathologic condition is not readily apparent on routine head imaging. To be assured of excluding the diagnosis, imaging of the cerebral sinuses is required; this is most commonly done with MR venography. Serum markers of fibrinolysis, specifically the D dimer, may be used to exclude thromboembolic processes in patients at low risk of disease, particularly if the symptoms are of shorter duration.[29,30]

Treatment of this disease includes addressing the acute thrombus; addressing the symptoms caused by the thrombus, such as headache, nausea, and seizures; identification of the factors that placed patients at risk of thrombus development; and optimizing therapy to prevent future thromboembolic events. Anticoagulation is considered standard therapy for this disease, although there is an associated risk of intracranial hemorrhage. For most patients, the benefit of therapy with unfractionated or low-molecular-weight heparin outweighs the risk. Thrombolysis, particularly local thrombolysis achieved by the administration of the thrombolytic directly to the thrombus, may be useful, although it also carries the associated risk of hemorrhage.[31]

### Giant Cell Arteritis

Giant cell arteritis (or temporal arteritis) is a disease exclusively of patients in the second half of life, can cause permanent visual loss and, thus, needs to be excluded as the diagnosis in all patients aged older than 50 years who present with new-onset headache. Visual loss in this disorder is usually caused by anterior optic neuropathy but posterior optic neuropathy, central retinal artery, and cortical blindness may occur. This disease is an inflammatory arteriopathy affecting the aorta, occasionally the vertebral arteries, and branches of the external carotid artery, most notably the temporal artery. The specific cause or inciting event is currently unknown. The inflammatory infiltration of blood vessel walls leads to luminal narrowing and ischemic events downstream.[32] Giant cell arteritis is comorbid with polymyalgia rheumatica.

Headache is present in 75% of patients with temporal arteritis and is frequently the presenting chief complaint. The headache of temporal arteritis is variable. It may affect just the temple but it may also extend to the occiput or generalize.[33] It may be isolated to the occipital area.[34] It is often described as achy and persistent. New-onset stabbing headache has also been described.[35] International Headache Society criteria attribute the headache to temporal arteritis only if the headache responds to corticosteroid therapy.[36]

Jaw claudication (pain in the proximal jaw most notable with vigorous chewing) is an uncommon but highly suggestive feature. Diplopia and ophthalmoparesis may occur. The absence of visual symptoms or of headache does not rule out the disease.[37] On physical examination, beading, prominence, engorgement, or tenderness of the temporal artery are predictive of a positive biopsy result.[37]

The American College of Rheumatology diagnostic criteria are standard and require 3 of the following 5 items: greater than or equal to 50 years of age; a new headache type; temporal artery abnormalities, including tenderness or decreased pulsations not attributable to atherosclerosis; a Westergren erythrocyte sedimentation rate greater than or equal to 50 mm/h; and a biopsy specimen showing vasculitis characterized by a predominance of mononuclear cell infiltration or granulomatous inflammation. Based on these criteria, patients can be diagnosed with temporal arteritis without a biopsy result. Furthermore, a positive biopsy by itself does not define the disease without the other criteria.[38]

Giant cell arteritis can largely be excluded from diagnostic consideration with normal blood tests. Although neither a normal erythrocyte sedimentation rate nor a normal C-reactive protein excludes the diagnosis definitely, the combination of 2 normal results makes the diagnosis substantially less likely.[39,40] Patients who remain at high suspicion for disease despite normal laboratory values should still be referred for temporal artery biopsy.

Patients with giant cell arteritis are at high risk of permanent visual loss in 1 or both eyes and, therefore, corticosteroid therapy should be initiated promptly. The optimal agent, dose, and route of delivery of corticosteroids is not established, although high doses of oral agents are commonly used. Earlier initiation of therapy improves outcomes.[41]

### Reversible Cranial Vasoconstriction Syndrome

Reversible cranial vasoconstriction syndrome has been known by a variety of names over the years, including Call-Fleming syndrome, postpartum angiopathy, and migrainous vasospasm. It is characterized by discrete areas of vasoconstriction within the cerebral vasculature that normalize within 3 months. On imaging studies, the cerebral vasculature assumes a sausage-on-a-string or beads-on-a-string appearance representing multiple discrete areas of vasoconstriction. Reversible cranial vasoconstriction syndrome is thought to cause a recurrent thunderclap headache and is associated with ischemic and hemorrhagic stroke. The true population prevalence is unknown; it is only identified in patients who have suffered a stroke or in patients who have experienced a thunderclap headache and receive a thorough work-up. For most patients with a thunderclap headache, a specific cause is not discovered[42]; this syndrome may be the cause of many of them. On the other hand, this syndrome could be rare; case series may be the result of thorough work-ups in regional referral centers.

A severe acute-onset headache is the predominant symptom of reversible cranial vasoconstriction syndrome. Some patients experience neurologic symptoms, including transient or lasting focal deficits and seizures, or recurrent thunderclap

headaches. The headache is usually bilateral. Associated symptoms included nausea, vomiting, agitation, and photophobia. An antecedent use of vasoactive substances, including cannabis, selective serotonin-norepinephrine reuptake inhibitors, and nasal decongestants, is commonly reported.

It is currently uncertain how to manage this disease once it is diagnosed. By definition, the disease is self-limited, although transient ischemia or hemorrhage leaves a minority of patients with permanent focal deficits or cognitive impairment. Calcium channel blockers are used to decrease vasospasm and, thereby, presumably improve outcomes. Glucocorticoids also have been used to treat patients. The population at risk of poor outcome and, therefore, whom to treat has not yet been defined.[43,44]

## CAUSES OF CONCERN: HEADACHE AND SPACE-OCCUPYING LESIONS
### Intracranial Neoplasm

Brain tumor is often on the mind of patients who present to a clinician with a new mild or moderate headache. For many of these patients, clear reassurance that they do not have a brain tumor is as important as a specific diagnosis and treatment.[3] A multitude of different types of tumors can cause a headache. Secondary headache may be caused by neoplasms that originate from the brain, meninges, or skull, or may have metastasized from a more distant location, most commonly lung, breast, gastrointestinal tract, or kidneys.[5]

Intracranial neoplasms commonly present with headache along with focal neurologic deficits, seizures, or neurocognitive deficits. It is less common for patients to present with an isolated headache and no other neurologic complaints, although this becomes more common in the geriatric population because brain atrophy allows more space for a malignancy to grow asymptomatically. Classically, brain neoplasm present with a nocturnal headache that awakens patients from sleep, morning headaches, vomiting, and headaches that worsen with the Valsalva maneuver. This classic presentation is uncommon and should not be relied on. The headache of brain neoplasms may be quite variable; it has been described as throbbing, pressurelike, and shooting. Commonly, these headaches are not constant, severe, or progressive.[45]

The diagnosis of intracranial neoplasm is often readily apparent on routine noncontrast head CT, although sometimes contrast is needed to identify or delineate the primary process. The question for the physician invariably is how aggressively to pursue neuroimaging in patients with a new headache and a normal neurologic examination. Some expert opinion and guideline statements recommend imaging all patients with a new headache type and certainly those patients aged older than 50 years.[1,8]

Symptoms usually respond to corticosteroids, such as dexamethasone, which are quite effective at decreasing the resultant edema. Definitive treatment depends on tumor size, type, location, and overall patient prognosis. Antiepileptic drugs are reserved for patients who develop seizures and should not be administered prophylactically.[46]

### Posttraumatic Hematoma

A headache in the setting of blunt head trauma raises the concern of an intracranial hematoma, particularly if the trauma was of sufficient severity to cause alterations in level of consciousness. Blood may collect in the brain parenchyma, the subarachnoid space, the subdural space, or the epidural space. In addition, minor head trauma may also result in a postconcussive syndrome consisting of headache, neurocognitive deficits, and dizziness. However, the focus here is on the identification of

patients who require emergent neurosurgical intervention. A noncontrast head CT is a highly sensitive test for identifying clinically significant posttraumatic hematomas. The challenge with this illness is to identify which patients require emergent neuroimaging.

A common clinical scenario is the patient who complains of headache in the immediate posttraumatic period. Most patients who experience minor or minimal head trauma will have a normal head CT and will not require neurosurgical intervention. Headache itself in the setting of minor head trauma does not help discriminate between those patients with a normal versus abnormal head CT.[47] Two high-quality competing clinical decision rules have been published that identify a low-risk population of patients who are exceedingly unlikely to require neurosurgical intervention (**Box 2**).[48,49] The New Orleans criteria is the more conservative of the two rules, requiring imaging in all victims on minor blunt head trauma with a Glasgow Coma Scale of less than 15, with a headache, or with any stigmata of trauma above the clavicles.[49] As a result, this clinical decision rule requires more head CTs to be performed; application of this rule in an emergency department population would allow CT to be avoided in only 10% of patients.[47] The Canadian CT head rule potentially allows 50% of head CTs to be avoided, although its sensitivity may be less than 85% in

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**Box 2**
**Clinical decision rules for the diagnosis of clinically important neurotraumatic processes**

New Orleans criteria

    All patients with positive CT scans had at least 1 of the following:

        Headache

        Vomiting

        Aged older than 60 years

        Drug or alcohol intoxication

        Deficits in short-term memory

        Physical evidence of trauma above the clavicles

        Seizure

Canadian CT head rule

    CT head is only required for patients with minor head injuries with any 1 of the following:

        GCS score less than 15 at 2 hours after injury

        Suspected open or depressed skull fracture

        Any sign of basal skull fracture (hemotympanum, raccoon eyes, CSF otorrhea/rhinorrhea, Battle sign)

        Vomiting 2 episodes or more

        Aged 65 years or older

        Amnesia before impact greater than or equal to 30 minutes

        Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height more than 3 ft or 5 stairs)

*From* Haydel MJ, Preston CA, Mills TJ, et al. Indication for computed tomography in patients with minor head injury. N Engl J Med 2000;343:100–5; with permission.

a population of very high-risk head trauma patients.[50] Although not tested in an outpatient setting, the Canadian rule supports infrequent neuroimaging in a population of neurologically intact victims of minor head trauma who walk into a clinic and whose symptomatology includes only mild or moderate headache.

### Pituitary Apoplexy

A Hemorrhagic infarct of the pituitary may cause a devastating presentation of headache, bitemporal visual field deficits, ophthalmoplegia, and cardiovascular collapse. A headache, usually sudden onset, is a prominent feature in patients who have not lost mental status.[51] Pituitary apoplexy occurs most often within an abnormal pituitary, often because of an adenoma. A precipitating factor may be identified, such as initiation or withdrawal of medical pituitary therapy, major surgery, parturition, anticoagulant therapy, or head trauma.[52] A history of pituitary adenoma is a feature of the past medical history that can help the clinician arrive at the correct diagnosis; however, for most patients with pituitary apoplexy, the apoplexy is the presenting event.[53] A noncontrast head CT can usually visualize large pituitary adenomas, although magnetic resonance imaging optimizes sensitivity. Emergency medical management is directed toward replacement of corticosteroids to ensure hemodynamic stability. Emergent neurosurgical decompression is often performed to restore lost or worsening vision.[54]

### CAUSES OF CONCERN: HEADACHE AND INCREASED INTRACRANIAL PRESSURE WITHOUT A MASS LESION
### Idiopathic Intracranial Hypertension

Compared with other headache disorders, idiopathic intracranial hypertension (IIH) is a relatively uncommon neurologic disease seen primarily in young obese women of childbearing age. Because the headache pattern is chronic and because visual complaints are common, the headache may be carelessly ascribed to chronic migraine with aura. However, visual loss with this disease can be dramatic, rapidly progressive, and irreversible, so this diagnosis cannot be missed.[55]

A headache is the most prominent symptom of IIH. The headache is often nonspecific or may mimic migraine. Visual complaints are common but may be fleeting or waxing and waning. Patients also may complain of pulsatile tinnitus. As the disease progresses, the physical examination will reveal papilledema and visual field defects, including an enlarged blind spot initially, followed by loss of peripheral vision.

A thorough neurologic examination searching for papilledema, visual field deficits, and ophthalmoplegias will identify most cases of IIH. The finding of papilledema then warrants neuroimaging to ensure no intracranial mass is causing the papilledema and a lumbar puncture to measure the opening pressure of the cerebral spinal fluid. Pressures more than 220 mm are consistent with IIH. Cerebral venous sinus imaging will ensure that the elevated opening pressure is not caused by impaired venous return.

Symptomatic treatment includes lowering intracranial pressure and relieving the headache. Lumbar puncture is the mainstay for accomplishing this goal, although long-term management goals include minimizing the number of lumbar punctures performed. Visual loss may be ameliorated with optic nerve sheath fenestration or CSF diversion. Acetazolamide is used to mitigate chronic symptoms. Some data indicate good long-term outcomes in those patients who continue to use acetazolamide, although clinical trial data are not yet available.[56] Corticosteroids also have been used, although rebound headache may occur when doses are tapered.

## CAUSES OF CONCERN: HEADACHE AND SYSTEMIC ILLNESS
### *Hypertensive Headache*

The link between hypertension and headache is well established in the public mind, although epidemiologic studies do not support this association.[57] No data are available to support or refute the common practice of using antihypertensives for patients with elevated blood pressure who present to a physician with an acute headache. It is clear, however, that certain antihypertensives, such as the beta-blockers and angiotensin receptor blockers, decrease the frequency of headaches when used prophylactically in patients with frequent disabling migraines.[58,59] Similar uncertainty surrounds the common clinical scenario of patients who present with a headache, an elevated blood pressure, and no history of hypertension. The International Headache Society defines a hypertensive headache as one in which there is a paroxysmal increase in systolic or diastolic blood pressure to greater than 160 mm HG or 120 mm HG, respectively.[36] The headache must be either bilateral or pulsating or precipitated by physical activity. It must develop during the hypertensive period and resolve within 1 hour after normalization of blood pressure. Absent the signs of encephalopathy, it is unclear if these patients should be treated with analgesics, antimigraine medication, or with antihypertensive medication. One treatment option the authors have found useful is to use intravenous (IV) metoclopramide, a medication with both antimigraine and anti-headache efficacy, which is also known to lower blood pressure.

## CAUSES OF CONCERN: HEADACHE AND INFECTION
### *Meningitis/Encephalitis*

CNS infections run the gamut from severe and life threatening to self-limited and benign. The diagnosis at times may be obvious based on physical appearance of patients and other times may present with little more than a subacute headache or a fever. A spinal fluid analysis is the definitive test to diagnose meningitis but it is not always necessary to perform a lumbar puncture to dictate management; at times, treatment must be initiated before the definitive diagnosis is available.

Bacterial meningitis is a life-threatening illness that requires early suspicion and prompt antimicrobial therapy. Classically, bacterial meningitis presents with fever, nuchal rigidity, and altered mental status, although the presence of the complete triad is variable and in some cohorts has been present in fewer than 50% of patients.[2,60] Headache is a common feature of bacterial meningitis, but no classic headache pattern has been described.

Lyme meningitis is a subtle illness. Therefore, practitioners in endemic regions need to maintain an awareness of the typical presentation to ensure that the diagnosis will be made. Headache and meningismus may be no worse than moderate. Arthralgias and malaise may be the most prominent symptoms. A history of erythema migraines is usually present. Neuropathic or radicular sensory symptoms and cranial neuropathies, particularly facial nerve palsy, may be present.[61]

Cryptococcal meningitis is, for the most part, a disease of the immunocompromised, although occasional cases in immunocompetent patients are reported. One needs to have a high index of suspicion for this illness as T cells decrease because the initial presentation can be nonspecific, often no more than a mild headache with low-grade fevers and malaise. As the illness progresses, nuchal rigidity, cranial neuropathies, and altered mental status occur. Patients using immunotherapy for solid organ transplant or on chronic corticosteroids are also at risk of cryptococcal infection.[62,63]

Viral meningitis can be a painful and functionally disabling illness but is unlikely to be life threatening in immunocompetent adults without evidence of encephalitis or

myelitis. Common causes are enteroviruses, herpes simplex viruses, and varicella-zoster virus. When headache is a prominent component of what otherwise seems like an acute viremia, a spinal fluid analysis may not influence management, although it is often difficult to exclude bacterial meningitis on clinical grounds alone. Unlike in bacterial meningitis whereby alterations in consciousness are a prominent component of the patients' presentation, headache is usually the most prominent feature of viral meningitis. Hospital admission may be required for pain control, antiemetics, and IV fluid therapy.

## EMERGENCY PRESENTATIONS OF PRIMARY HEADACHE DISORDERS
### Status Migrainosus

Although status migrainosus does not threaten life or limb, this unremitting, unbear-able headache should be treated expeditiously and effectively. For some of these patients, oral, inhaled, or rectal medications will suffice. Others should be referred to an infusion center or an emergency department for parenteral treatment. While treating the patients' pain, the clinician should be sure to eliminate secondary head-ache from the differential diagnosis. Gradual onset of the patients' typical migraine, which ultimately was simply not responsive to the patients' usual medication, is a reas-suring history. However, a new headache type in a known migraineur should not be automatically attributed to migraine.

A wide variety of parenteral medications are available to treat status migrainosus (**Table 1**), although no high-quality evidence for the treatment of status migrainosus has been published. Treatment decisions are based on open-label studies or on randomized, double-blind trials of therapies for acute migraine. The Raskin protocol has long been used with success.[64] This combination of IV dihydroergotamine and metoclopramide administered every 8 hours is used successfully in many inpatient headache units. The antiemetic dopamine antagonists droperidol and prochlorpera-zine are highly effective and can be substituted for metoclopramide.[65] Corticosteroids

| Table 1 | | |
|---|---|---|
| Intravenous medications that may be used for status migrainosus | | |
| **Medication** | **Dose** | **Cautions/Side Effects** |
| Dihydroergotamine | 1 mg | Administer with antiemetic; contraindicated in patients with severe hypertension, coronary artery disease, pregnancy, recent use of sumatriptan, or currently using macrolide antibiotics or retroviral therapy |
| Metoclopramide | 10 mg to be infused over 15 min | Akathisia may be treated with diphenhydramine or midazolam |
| Prochlorperazine | 10 mg to be infused over 15 min | Akathisia may be treated with diphenhydramine or midazolam |
| Droperidol | 2.5 mg to be infused over 15 min | Akathisia may be treated with diphenhydramine or midazolam; may cause QT prolongation, which can lead to clinically significant arrhythmia |
| Ketorolac | 30 mg IV push | Caution in patients with chronic kidney disease or peptic ulcer disease |
| Valproic Acid | 1 mg to be infused over 10–15 min | Contraindicated in pregnancy, use cautiously in patients with liver disease |
| Dexamethasone | 10 mg slow IV push | |

decrease the recurrence of headache after initial successful parenteral treatment[66] and, barring contraindications, should be used in patients with migraines of sufficient severity to require hospitalization. Parenteral nonsteroidal antiinflammatory drugs, such as ketorolac, can be coadministered with dihydroergotamine and the dopamine-antagonists. IV valproic acid may also have a role for some patients with unremitting migraine.[67] Finally, aggressive IV fluid rehydration, particularly in migraineurs suffering substantial nausea and vomiting, may be effective.

If relief has not been obtained from any of the therapies listed previously, opioids are a reasonable last resort. Opioids are effective, safe, and well-tolerated analgesics. They are generally avoided as initial migraine therapy for fear of exacerbating the underlying migraine disorder but should not be withheld on principle when patients are suffering.

## AN APPROACH TO HEADACHE WORK-UP

Most headaches that present de novo in any practice setting will be benign. For most patients, management should consist of identifying the headache disorder and providing patients with a specific diagnosis, identifying causative or contributing factors, and initiating appropriate treatment. For some patients, the headache is a warning sign of a more ominous underlying disorder. The astute clinician needs to diagnose the malignant secondary causes of headache without unnecessarily exposing every headache patient to the expense, inconvenience, and side effects of a full work-up; postlumbar puncture headache is common, contrast-induced nephropathy or allergic complications of CT scans with contrast can be serious, and our understanding of long-term medical imaging–induced radiation toxicity is evolving. Furthermore, excess diagnostic testing leads to the discovery of incidental findings or equivocal results, which can only be addressed with further testing. Thus, diagnostic testing should not be undertaken lightly.

On the other hand, the differential diagnosis of headache is finite, and most pathologic causes of headache can be diagnosed with neurovascular imaging and a few well-chosen blood tests, such as an erythrocyte sedimentation rate, a C-reactive protein, and a D dimer. In patients who, based on history and physical examination, are at high risk of secondary headaches, the complete work-up should be pursued emergently.

A middle-of-the-road approach is to perform a noncontrast head CT followed by a lumbar puncture in all neurologically intact patients who present with a first, worst, or changed headache, plus an erythrocyte sedimentation rate and a C-reactive protein in patients aged 50 years and older. This pathway will identify all but the rarest of the secondary headaches.

Practice patterns should depend on the case mix at individual sites and characteristics of the individual patient. Practices that see predominantly high-acuity patients need to have streamlined pathways to facilitate a diagnostic work-up. Clinicians who see predominantly low-acuity patients need to maintain the diseases discussed in this article within their differential diagnoses.

## SUMMARY

In conclusion, headache may be a warning sign of a wide variety of malignant processes. Careful attention to the patients' history and physical examination and a thoughtful approach to the differential diagnosis will help guide diagnostic work-up and management. Although benign causes of headaches are more common

than malignant secondary processes, appropriate management of the headache depends on excluding malignant secondary processes.

## REFERENCES

1. Edlow JA, Panagos PD, Godwin SA, et al. Clinical policy: critical issues in the evaluation and management of adult patients presenting to the emergency department with acute headache. Ann Emerg Med 2008;52(4):407–36.
2. Attia J, Hatala R, Cook DJ, et al. The rational clinical examination. Does this adult patient have acute meningitis? JAMA 1999;282(2):175–81.
3. Frishberg BM. The utility of neuroimaging in the evaluation of headache in patients with normal neurologic examinations. Neurology 1994;44(7):1191–7.
4. Gladstone J, Bigal ME. Headaches attributable to infectious diseases. Curr Pain Headache Rep 2010;14(4):299–308.
5. Kirby S, Purdy RA. Headache and brain tumors. Curr Neurol Neurosci Rep 2007; 7(2):110–6.
6. Rinkel GJ, Djibuti M, Algra A, et al. Prevalence and risk of rupture of intracranial aneurysms: a systematic review. Stroke 1998;29(1):251–6.
7. Bederson JB, Connolly ES Jr, Batjer HH, et al. Guidelines for the management of aneurysmal subarachnoid hemorrhage: a statement for healthcare professionals from a special writing group of the Stroke Council, American Heart Association. Stroke 2009;40(3):994–1025.
8. Edlow JA, Caplan LR. Avoiding pitfalls in the diagnosis of subarachnoid hemorrhage. N Engl J Med 2000;342(1):29–36.
9. Linn FH, Rinkel GJ, Algra A, et al. Headache characteristics in subarachnoid haemorrhage and benign thunderclap headache. J Neurol Neurosurg Psychiatry 1998;65(5):791–3.
10. Perry JJ, Stiell IG, Sivilotti ML, et al. High risk clinical characteristics for subarachnoid haemorrhage in patients with acute headache: prospective cohort study. BMJ 2010;341:c5204.
11. McCormack RF, Hutson A. Can computed tomography angiography of the brain replace lumbar puncture in the evaluation of acute-onset headache after a negative noncontrast cranial computed tomography scan? Acad Emerg Med 2010; 17(4):444–51.
12. van der Schaaf I, Algra A, Wermer M, et al. Endovascular coiling versus neurosurgical clipping for patients with aneurysmal subarachnoid haemorrhage. Cochrane Database Syst Rev 2005;4:CD003085.
13. Dorhout Mees SM, Rinkel GJ, Feigin VL, et al. Calcium antagonists for aneurysmal subarachnoid haemorrhage. Cochrane Database Syst Rev 2007;3: CD000277.
14. Roos Y, Rinkel G, Vermeulen M, et al. Antifibrinolytic therapy for aneurysmal subarachnoid hemorrhage: a major update of a Cochrane review. Stroke 2003; 34(9):2308–9.
15. Feigin VL, Anderson N, Rinkel GJ, et al. Corticosteroids for aneurysmal subarachnoid haemorrhage and primary intracerebral haemorrhage. Cochrane Database Syst Rev 2005;3:CD004583.
16. Riordan KC, Wingerchuk DM, Wellik KE, et al. Anticonvulsant drug therapy after aneurysmal subarachnoid hemorrhage: a critically appraised topic. Neurologist 2010;16(6):397–9.
17. Arnold M, Cumurciuc R, Stapf C, et al. Pain as the only symptom of cervical artery dissection. J Neurol Neurosurg Psychiatry 2006;77(9):1021–4.

18. Schievink WI. Spontaneous dissection of the carotid and vertebral arteries. N Engl J Med 2001;344(12):898–906.
19. Ahmad HA, Gerraty RP, Davis SM, et al. Cervicocerebral artery dissections. J Accid Emerg Med 1999;16(6):422–4.
20. Silbert PL, Mokri B, Schievink WI. Headache and neck pain in spontaneous internal carotid and vertebral artery dissections. Neurology 1995;45(8):1517–22.
21. Campos CR, Evaristo EF, Yamamoto FI, et al. Spontaneous cervical carotid and vertebral arteries dissection: study of 48 patients. Arq Neuropsiquiatr 2004; 62(2B):492–8 [in Portuguese].
22. Nebelsieck J, Sengelhoff C, Nassenstein I, et al. Sensitivity of neurovascular ultrasound for the detection of spontaneous cervical artery dissection. J Clin Neurosci 2009;16(1):79–82.
23. Fischer U, Ledermann I, Nedeltchev K, et al. Quality of life in survivors after cervical artery dissection. J Neurol 2009;256(3):443–9.
24. Lee VH, Brown RD Jr, Mandrekar JN, et al. Incidence and outcome of cervical artery dissection: a population-based study. Neurology 2006;67(10):1809–12.
25. Lyrer P, Engelter S. Antithrombotic drugs for carotid artery dissection. Cochrane Database Syst Rev 2010;10:CD000255.
26. Pham MH, Rahme RJ, Arnaout O, et al. Endovascular stenting of extracranial carotid and vertebral artery dissections: a systematic review of the literature. Neurosurgery 2011;68(4):856–66.
27. Ferro JM, Canhao P, Stam J, et al. Prognosis of cerebral vein and dural sinus thrombosis: results of the International Study on Cerebral Vein and Dural Sinus Thrombosis (ISCVT). Stroke 2004;35(3):664–70.
28. de Bruijn SF, Stam J, Kappelle LJ. Thunderclap headache as first symptom of cerebral venous sinus thrombosis. CVST Study Group. Lancet 1996;348(9042):1623–5.
29. Crassard I, Soria C, Tzourio C, et al. A negative D-dimer assay does not rule out cerebral venous thrombosis: a series of seventy-three patients. Stroke 2005; 36(8):1716–9.
30. Kosinski CM, Mull M, Schwarz M, et al. Do normal D-dimer levels reliably exclude cerebral sinus thrombosis? Stroke 2004;35(12):2820–5.
31. Einhaupl K, Stam J, Bousser MG, et al. EFNS guideline on the treatment of cerebral venous and sinus thrombosis in adult patients. Eur J Neurol 2010;17(10): 1229–35.
32. Nordborg E, Nordborg C. Giant cell arteritis: epidemiological clues to its pathogenesis and an update on its treatment. Rheumatology (Oxford) 2003;42(3): 413–21.
33. Solomon S, Cappa KG. The headache of temporal arteritis. J Am Geriatr Soc 1987;35(2):163–5.
34. Pfadenhauer K, Weber H. Giant cell arteritis of the occipital arteries–a prospective color coded duplex sonography study in 78 patients. J Neurol 2003;250(7):844–9.
35. Rozen TD. Brief sharp stabs of head pain and giant cell arteritis. Headache 2010; 50(9):1516–9.
36. International Headache Society Classification Subcommittee. The international classification of headache disorders- 2nd edition. Cephalalgia 2004;24(Suppl 1): 1–151.
37. Smetana GW, Shmerling RH. Does this patient have temporal arteritis? JAMA 2002;287(1):92–101.
38. Hunder GG, Bloch DA, Michel BA, et al. The American College of Rheumatology 1990 criteria for the classification of giant cell arteritis. Arthritis Rheum 1990; 33(8):1122–8.

39. Parikh M, Miller NR, Lee AG, et al. Prevalence of a normal C-reactive protein with an elevated erythrocyte sedimentation rate in biopsy-proven giant cell arteritis. Ophthalmology 2006;113(10):1842–5.
40. Walvick MD, Walvick MP. Giant cell arteritis: laboratory predictors of a positive temporal artery biopsy. Ophthalmology 2011;118(6):1201–4.
41. Gonzalez-Gay MA, Blanco R, Rodriguez-Valverde V, et al. Permanent visual loss and cerebrovascular accidents in giant cell arteritis: predictors and response to treatment. Arthritis Rheum 1998;41(8):1497–504.
42. Savitz SI, Levitan EB, Wears R, et al. Pooled analysis of patients with thunderclap headache evaluated by CT and LP: is angiography necessary in patients with negative evaluations? J Neurol Sci 2009;276(1–2):123–5.
43. Calabrese LH, Dodick DW, Schwedt TJ, et al. Narrative review: reversible cerebral vasoconstriction syndromes. Ann Intern Med 2007;146(1):34–44.
44. Chen SP, Fuh JL, Wang SJ. Reversible cerebral vasoconstriction syndrome: an under-recognized clinical emergency. Ther Adv Neurol Disord 2010;3(3):161–71.
45. Valentinis L, Tuniz F, Valent F, et al. Headache attributed to intracranial tumours: a prospective cohort study. Cephalalgia 2010;30(4):389–98.
46. Tremont-Lukats IW, Ratilal BO, Armstrong T, et al. Antiepileptic drugs for preventing seizures in people with brain tumors. Cochrane Database Syst Rev 2008;2: CD004424.
47. Stiell IG, Clement CM, Rowe BH, et al. Comparison of the Canadian CT Head Rule and the New Orleans Criteria in patients with minor head injury. JAMA 2005;294(12):1511–8.
48. Stiell IG, Wells GA, Vandemheen K, et al. The Canadian CT Head Rule for patients with minor head injury. Lancet 2001;357(9266):1391–6.
49. Haydel MJ, Preston CA, Mills TJ, et al. Indications for computed tomography in patients with minor head injury. N Engl J Med 2000;343(2):100–5.
50. Smits M, Dippel DW, de Haan GG, et al. External validation of the Canadian CT Head Rule and the New Orleans Criteria for CT scanning in patients with minor head injury. JAMA 2005;294(12):1519–25.
51. Randeva HS, Schoebel J, Byrne J, et al. Classical pituitary apoplexy: clinical features, management and outcome. Clin Endocrinol (Oxf) 1999;51(2):181–8.
52. Semple PL, Jane JA Jr, Laws ER Jr. Clinical relevance of precipitating factors in pituitary apoplexy. Neurosurgery 2007;61(5):956–61 [discussion: 961–2].
53. Sibal L, Ball SG, Connolly V, et al. Pituitary apoplexy: a review of clinical presentation, management and outcome in 45 cases. Pituitary 2004;7(3):157–63.
54. Ayuk J, McGregor EJ, Mitchell RD, et al. Acute management of pituitary apoplexy–surgery or conservative management? Clin Endocrinol (Oxf) 2004; 61(6):747–52.
55. Friedman DI. Idiopathic intracranial hypertension. Curr Pain Headache Rep 2007; 11(1):62–8.
56. Kesler A, Hadayer A, Goldhammer Y, et al. Idiopathic intracranial hypertension: risk of recurrences. Neurology 2004;63(9):1737–9.
57. Weiss NS. Relation of high blood pressure to headache, epistaxis, and selected other symptoms. The United States Health Examination Survey of Adults. N Engl J Med 1972;287(13):631–3.
58. Hansson L, Smith DH, Reeves R, et al. Headache in mild-to-moderate hypertension and its reduction by irbesartan therapy. Arch Intern Med 2000;160(11): 1654–8.
59. Evers S, Afra J, Frese A, et al. EFNS guideline on the drug treatment of migraine– revised report of an EFNS task force. Eur J Neurol 2009;16(9):968–81.

60. van de Beek D, de Gans J, Spanjaard L, et al. Clinical features and prognostic factors in adults with bacterial meningitis. N Engl J Med 2004;351(18):1849–59.

61. Pachner AR, Steiner I. Lyme neuroborreliosis: infection, immunity, and inflammation. Lancet Neurol 2007;6(6):544–52.

62. Jarvis JN, Harrison TS. HIV-associated cryptococcal meningitis. AIDS 2007; 21(16):2119–29.

63. Pappas PG, Perfect JR, Cloud GA, et al. Cryptococcosis in human immunodeficiency virus-negative patients in the era of effective azole therapy. Clin Infect Dis 2001;33(5):690–9.

64. Raskin NH. Repetitive intravenous dihydroergotamine as therapy for intractable migraine. Neurology 1986;36(7):995–7.

65. Kelly AM, Walcynski T, Gunn B. The relative efficacy of phenothiazines for the treatment of acute migraine: a meta-analysis. Headache 2009;49(9):1324–32.

66. Colman I, Friedman BW, Brown MD, et al. Parenteral dexamethasone for acute severe migraine headache: meta-analysis of randomised controlled trials for preventing recurrence. BMJ 2008;336(7657):1359–61.

67. Leniger T, Pageler L, Stude P, et al. Comparison of intravenous valproate with intravenous lysine-acetylsalicylic acid in acute migraine attacks. Headache 2005;45(1):42–6.