Introduction:

The Centers for Medicare and Medicaid Services (CMS) Appropriate Use Criteria (AUC) program requires ambulatory and emergency department providers to consult AUC when ordering advanced medical imaging in the priority clinical areas. As the CMS certified Provider-Led-Entity, the University of Utah Health (UUH) has developed the AUC for adult headache.

Headache is one of the most common clinical complaints in general neurology clinics, primary care, or even emergency departments. In the United States, there are 50 million outpatient visits for headache. Patients are concerned that they may have serious conditions, such as brain tumors or aneurysms. Providers are concerned about missing “serious disease” even though the chance is very small. Imaging assures both patients and providers, though excessive imaging leads to unnecessary radiation and additional healthcare expenditures. This gives an excellent opportunity for evidence-based guideline development of the appropriate use criteria of advanced imaging.

For the AUC development, two fundamental questions that we should ask;
1) Who can safely avoid imaging?
2) If a patient with headache needs imaging, what imaging study should be done?

Low-risk features – Imaging is unnecessary
- Age < 50-year-old
- Features of typical primary headaches
- History of similar headache in the past
- No abnormal neurological findings
- No high-risk comorbid conditions
- No new features

High-risk features: SNOOP – Brain MR is preferred over Head CT
- S: Systemic symptoms – (fever, weight loss, cancer, pregnancy, immunocompromised state, including HIV
- N: Neurological Symptoms - (confusion, impaired alertness or consciousness, papilledema, focal neurologic symptoms or signs, meningismus, or seizures)
- O: Onset is new (Age >= 50) or Sudden (Thunderclap HA.)
- O: Other associated conditions (head trauma, illicit drug use, or toxic exposure; headache awakens from sleep, is worse with Valsalva maneuvers, or is precipitated by cough, exertion, or sexual activity)
- P: Previous HA history with the progression of intensity or severity

Headache imaging workups – general guidelines
- Acute HA presentation or post-trauma HA –
  - Start with non-contrast head CT to look for intracranial hemorrhage
  - If cerebral aneurysm rupture is suspected, head CTA to rule out aneurysm
• Pregnancy women – r/o PRESS or DVT, brain MR wo plus SWI or non-contrast MRV
  Please note MR contrast is contraindicated for pregnant women.

• Non-acute (subacute or chronic) HA.
  • Red flag (cancer, infection, immunocompromised) – brain MR w/wo
  • Papilloedema - r/o intracranial hypertension or DVT – brain MR w/wo & MRV
  • HA worsening in standing – r/o intracranial hypotension – CSF leak
  • Migraine – new or atypical features – Brain MR wo
  • Migraine without new or atypical features, normal Neurological Sx – NO IMAGING
  • Facial pain – r/o Trigeminal neuralgia - go to Facial Pain AUC

  w: with contrast, wo: without contrast

UU AUC for adult Headache

Key points:
Patients with migraine who present with no new or atypical features and normal neurological findings or prior normal structural imaging can safely avoid imaging
  (Evidence-Based)

For patients present with sudden onset of severe headache with neck stiffness or neck pain, start with non-contrast head CT to rule out subarachnoid hemorrhage
  (Consensus-based)

Negative head CT and CTA exclude aneurysm rupture with high accuracy; thus, lumbar puncture can be avoided.   (Consensus-based)

The University of Utah Adult Headache AUC is shown in Figure 1.
**AUC below is color-coded that the exams in blue are appropriate, those in yellow are moderately appropriate, and those in red are not appropriate**

<table>
<thead>
<tr>
<th>AUC</th>
<th>HA-AUC 1</th>
<th>HA-AUC 2</th>
<th>HA-AUC 3</th>
<th>HA-AUC 4</th>
<th>HA-AUC 5</th>
</tr>
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<tbody>
<tr>
<td>Presentation</td>
<td>Acute presentation</td>
<td>Acute presentation</td>
<td>Acute presentation</td>
<td>Acute/subacute</td>
<td>Neurological Symptoms or Seizure</td>
</tr>
<tr>
<td>History</td>
<td>Trauma</td>
<td>Hypertension or Anticoagulation</td>
<td>Sudden severe H.A., Thunderclap H.A., Worst HA Of life</td>
<td>New HA In Pregnant Women</td>
<td>Neurological Symptoms or Seizure</td>
</tr>
<tr>
<td>Scenario</td>
<td>Headache after Trauma, Look for traumatic injury</td>
<td>Look for SAH due to aneurysm rupture</td>
<td>Look for PRES, preeclampsia, DVT, pituitary apoplexy, ICH</td>
<td>Look for tumor, IDH</td>
<td>Look for acute ICH</td>
</tr>
<tr>
<td>AUC rules</td>
<td>CT Head wo</td>
<td>CT Head wo</td>
<td>CT head wo or CT head wo and CTA Head w</td>
<td>MR brain w/o with SWI</td>
<td>CT Head wo</td>
</tr>
<tr>
<td>Appropriate</td>
<td>CTA of H&amp;M if there is neurological deficit suspecting dissection, MRI brain wo for severe clinical symptoms with negative CT Head</td>
<td>CT head wo and CTA Head w if there is IDH, Brain MR wo, MRI Brain w/wo</td>
<td>Brain MR w/o, Brain MR w/o with MRA w/wo, Brain MR w/wo only when red flag is present</td>
<td>CT head wo, CT Head wo plus CTV, MRV head (if DVT is suspected)</td>
<td>Brain MR wo, Brain MR w/wo, CT Head wo plus CTA head (if IDH is present), CT head wo/wo if contraindication for MR</td>
</tr>
<tr>
<td>Moderately appropriate</td>
<td>CT Head wo/wo, MR Brain w/wo</td>
<td>CT Head w/wo</td>
<td>CT Head w/wo</td>
<td>Brain MR w or Brain MR w/wo (MR contrast is contraindication for pregnant women)</td>
<td></td>
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<tr>
<td>Not appropriate</td>
<td>w with contrast</td>
<td>ICH: Intracranial hemorrhage</td>
<td>SAH: subarachnoid hemorrhage</td>
<td>DVT: deep venous thrombosis</td>
<td></td>
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<tr>
<td>Abbreviation</td>
<td>w/o: without contrast</td>
<td>PRES: Posterior reversible encephalopathy syndrome</td>
<td>w/wo: with and without contrast</td>
<td>SWI: susceptibility weighted imaging</td>
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**University of Utah AUC for Adult Headache (HA)**

<table>
<thead>
<tr>
<th>AUC</th>
<th>HA-AUC 6</th>
<th>HA-AUC 7</th>
<th>HA-AUC 8</th>
<th>HA-AUC 9</th>
<th>HA-AUC 10</th>
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<tbody>
<tr>
<td>Presentation</td>
<td>Subacute to chronic</td>
<td>Subacute to chronic</td>
<td>Subacute to chronic</td>
<td>Subacute to chronic</td>
<td>Subacute to chronic</td>
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<tr>
<td>HA with Red Flag*</td>
<td>HA with papilloedema and vision changes</td>
<td>HA worse in standing or Nausea Vomiting</td>
<td>HA Migraine with atypical or new features</td>
<td>HA Migraine with no new features, normal neurological symptoms</td>
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<tr>
<td>Scenario</td>
<td>Red Flag - look for tumor, infection, or inflammation</td>
<td>Look for intracranial mass, DVT, ICH, infection/inflammation</td>
<td>Look for intracranial hypotension or CSF leak</td>
<td>Imaging can be safely avoided, particularly with prior negative CT or MR</td>
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<tr>
<td>AUC rules</td>
<td>MR brain w/wo</td>
<td>MR brain w/wo, MR brain w/wo plus MRV, MR brain w/wo</td>
<td>MR brain wo, MR brain w/wo plus MRV</td>
<td>MR brain wo, MR brain w/wo</td>
<td></td>
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<tr>
<td>Appropriate</td>
<td>Brain MR wo, Head CT wo, Head CT w with orbit w/wo, CT head w/wo</td>
<td>Brain MR w with orbit, CT head w/wo, CT head w/wo</td>
<td>CT head wo, CT head wo, CT head w/wo</td>
<td>CT head wo, CT head w/wo, MR brain w/wo, MR brain w/wo</td>
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<tr>
<td>Moderately appropriate</td>
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<tr>
<td>Not appropriate</td>
<td>Red flag h/o cancer, infection, immune compromised status</td>
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<tr>
<td>Abbreviation</td>
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Literature Review

To ensure that evidence reviews are performed systematically and reproducibly, the evidentiary review and appraisal for the development of specified AUC are performed by the **Translational Research: Implementation, Analysis & Design (TRIAD) Team** at the University of Utah Clinical & Translational Science Institute (CTSI).

The **Translational Research: Implementation, Analysis & Design (TRIAD) Team** is conversant with methodological standards and processes for systematic and other reviews, with their goal is to provide high-quality research and publications following sound methodology (National Institutes of Medicine, Cochrane Handbook, Agency for Healthcare Research and Quality, Joanna Briggs Institute, OHAT) and reporting guidelines (PRISMA, MOOSE).

We use the 2011 revision of the **Oxford Centre for Evidence-based Medicine (OCEBM) standard** to appraise the level of evidence.

Additional references:

- [http://www.ihs-headache.org/ichd-guidelines](http://www.ihs-headache.org/ichd-guidelines)
- Choosing Wisely Canada [https://choosingwiselycanada.org/headache/](https://choosingwiselycanada.org/headache/)
- National Institute for Health and Care Excellence (NICE) [https://www.nice.org.uk/guidance/cg150](https://www.nice.org.uk/guidance/cg150)


<table>
<thead>
<tr>
<th>Authors</th>
<th>Journal</th>
<th>Title</th>
<th>Summary</th>
<th>Level of Evidence</th>
</tr>
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<tbody>
<tr>
<td>Negro A, Delaruelli Z, Ivanova T A, Khan S, Ornello R, Raffaelli B, Terrin A, Reuter U, Mitsikostas DD</td>
<td>J Headache Pain. 2017 Oct 19;18(1):106. doi: 10.1186/s10194-017-0816-0.</td>
<td>Headache and pregnancy: a systematic review.</td>
<td>This systematic review summarizes headache and pregnancy with a scope on clinical headache phenotypes, treatment of headaches in pregnancy and diagnostics of headache in pregnancy. Headache during pregnancy can be both primary and secondary, and in the last case can be a symptom of a life-threatening condition. The most common secondary headaches are stroke, cerebral venous thrombosis, subarachnoid hemorrhage, pituitary tumor, choriocarcinoma, eclampsia, preeclampsia, idiopathic intracranial hypertension, and reversible cerebral vasconstriction syndrome. Migraine is a risk factor for pregnancy complications, particularly vascular events. Data regarding other primary headache conditions are still scarce. Early diagnostics of the disease manifested by headache is important for mother and fetus life. It is especially important to identify &quot;red flag symptoms&quot; suggesting that headache is a symptom of a serious disease. In order to exclude a secondary headache additional studies can be necessary: electroencephalography, brain MRI and MR angiography with contrast ophthalmoscopy and lumbar puncture. During pregnancy and breastfeeding the preferred therapeutic strategy for the treatment of primary headaches should always be a non-pharmacological one.</td>
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<tr>
<td>Carpenter CR, Hussain AM, Ward MJ, Zipfel GJ, Fowler S, Pines JM, Sivilotti ML</td>
<td>Acad Emerg Med. 2016 Sep;23(9):963-1003. doi: 10.1111/acem.12984.</td>
<td>Spontaneous Subarachnoid Hemorrhage: A Systematic Review and Meta-analysis Describing the Diagnostic Accuracy of History, Physical Examination, Imaging, and Lumbar Puncture With an Exploration of Test Thresholds.</td>
<td>BACKGROUND: Spontaneous subarachnoid hemorrhage (SAH) is a rare, but serious etiology of headache. The diagnosis of SAH is especially challenging in alert, neurologically intact patients, as missed or delayed diagnosis can be catastrophic. OBJECTIVES: The objective was to perform a diagnostic accuracy systematic review and meta-analysis of history, physical examination, cerebrospinal fluid (CSF) tests, computed tomography (CT), and clinical decision rules for spontaneous SAH. A secondary objective was to delineate probability of disease thresholds for imaging and lumbar puncture (LP). METHODS: PubMed, Embase, Scopus, and research meeting abstracts were searched up to June 2015 for studies of emergency department patients with acute headache clinically concerning for spontaneous SAH. QUADAS-2 was used to assess study quality and, when appropriate, meta-analysis was conducted using random effects models. Outcomes were sensitivity, specificity, and positive (LR+) and negative (LR-) likelihood ratios. RESULTS: A total of 5,022 publications were identified, of which 122 underwent full-text review; 22 studies were included (average SAH prevalence = 7.5%). Diagnostic studies differed in assessment of history and physical examination findings, CT technology, analytical techniques used to identify xanthochromia, and criterion standards for SAH. Study quality by QUADAS-2 was variable; however, most had a relatively low risk of biases. A history of neck pain (LR+ = 4.1; 95% confidence interval [CI] = 2.2 to 7.6) and neck stiffness on physical examination (LR+ = 6.6; 95% CI = 4.0 to 11.0) were the individual findings most strongly associated with SAH. Combinations of findings may rule out SAH, yet promising clinical decision rules await external validation. <strong>Noncontrast cranial CT within 6 hours of headache onset accurately ruled in (LR+ = 230; 95% CI = 6 to 8,700) and ruled out SAH (LR- = 0.01; 95% CI = 0 to 0.04); CT beyond 6 hours had a LR- of 0.07 (95% CI = 0.01 to 0.61).</strong> CSF analyses had lower diagnostic accuracy, whether using red blood cell (RBC) count or xanthochromia. CONCLUSIONS: Less than one in 10 headache patients concerning for SAH are ultimately diagnosed with SAH in recent studies. While certain symptoms and signs increase or decrease the likelihood of SAH, no single characteristic is sufficient to rule in or rule out SAH. Within 6 hours of symptom onset, noncontrast cranial CT is highly accurate, while a negative CT beyond 6 hours substantially reduces the likelihood of SAH. LP appears to benefit relatively few patients within a narrow pretest probability range. With improvements in CT technology and an expanding body of evidence, test thresholds for LP may become more precise, obviating the need for a post-CT LP in more acute headache patients. Existing SAH clinical decision rules await external validation, but offer the potential to identify subsets most likely to benefit from post-CT LP, angiography, or no further testing.</td>
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<tr>
<td>Evans RW, Burch RC, Frishberg BM, Marmura MJ, Mechtler LL, Silberstein SD, Turner DP</td>
<td>Headache. 2020 Feb;60(2):318-336. doi: 10.1111/head.13720. Epub 2019 Dec 31.</td>
<td>Neuroimaging for Migraine: The American Headache Society Systematic Review and Evidence-Based Guideline.</td>
<td><strong>OBJECTIVE:</strong> To provide updated evidence-based recommendations about when to obtain neuroimaging in patients with migraine. <strong>METHODS:</strong> Articles were included in the systematic review if they studied adults 18 and over who were seeking outpatient treatment for any type of migraine and who underwent neuroimaging (MRI or CT). Medline, Web of Science, and Cochrane Clinical Trials were searched from 1973 to August 31, 2018. Reviewers identified studies, extracted data, and assessed the quality of the evidence in duplicate. We assessed study quality using the Newcastle-Ottawa Scale. <strong>RESULTS:</strong> The initial search yielded 2269 publications. Twenty three articles met inclusion criteria and were included in the final review. The majority of studies were retrospective cohort or cross-sectional studies. There were 4 prospective observational studies. Ten studies evaluated the utility of CT only, 9 MRI only, and 4 evaluated both. Common abnormalities included chronic ischemia or atrophy with CT and MRI scanning, and non-specific white matter lesions with MRI. <strong>Clinically meaningful abnormalities requiring intervention were relatively rare.</strong> Clinically significant neuroimaging abnormalities in patients with headaches consistent with migraine without atypical features or red flags appeared no more common than in the general population. <strong>RECOMMENDATIONS:</strong> There is no necessity to do neuroimaging in patients with headaches consistent with migraine who have a normal neurologic examination, and there are no atypical features or red flags present. Grade A Neuroimaging may be considered for presumed migraine for the following reasons: unusual, prolonged, or persistent aura; increasing frequency, severity, or change in clinical features, first or worst migraine, migraine with brainstem aura, migraine with confusion, migraine with motor manifestations (hemiplegic migraine), late-life migraine accompaniments, aura without headache, side-locked headache, and posttraumatic headache. Most of these are consensus based with little or no literature support. Grade C.</td>
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<tr>
<td>Kamtchum-Tatuene J, Kenteu B, Fogang YF, Zafack JG, Nyaga UF, Noubiap JJ</td>
<td>J Neurol Sci. 2020 Sep 15;416:116997. doi: 10.1016/j.jns.2020.116997. Epub 2020 Jun 26.</td>
<td>Neuroimaging findings in headache with normal neurologic examination: Systematic review and meta-analysis.</td>
<td><strong>OBJECTIVE:</strong> To determine if pooled estimates of the prevalence of unexpected findings in patients with headache and normal neurologic examination support current expert opinion-based neuroimaging guidelines. <strong>METHODS:</strong> We searched PubMed and EMBASE for studies reporting neuroimaging findings in patients with headache and normal neurologic examination up to September 30, 2017. The overall and disease-specific prevalence of unexpected findings were pooled through random-effects meta-analysis. This study is registered with PROSPERO, registration number CRD42017079714. <strong>RESULTS:</strong> In forty-one studies including 15,760 participants, the overall prevalence of unexpected findings and normal variants was 17.5% (95% CI: 13.1-22.3). The prevalence was 26.6% (95% CI: 15.5-39.4) in studies using MRI only. The prevalence of vascular, neoplastic, and non-neoplastic findings was 6.6%, 1.4%, and 9.6%. The pooled disease-specific prevalence was 2.0% for stroke, 1.8% for aneurysms, 0.8% for subdural hematoma, 0.7% for hydrocephalus, 0.2% for glioma, and 0.1% for meningioma. In secondary analysis, there was 0.4% increase in the prevalence of vascular unexpected findings with each 1% increase in the proportion of migraine with aura (p-value for meta-regression = 0.005). <strong>CONCLUSIONS:</strong> In patients with headache and normal neurologic examination, important vascular and neoplastic unexpected findings are rare and better detected with MRI. This supports current American College of Radiology and European Headache Federation recommendations to avoid systematic imaging in such patients and prefer MRI when imaging is needed.</td>
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### Detsky ME, McDonald DR, Baerlocher MO, Tomlinson GA, McCrory DC, Booth CM


**Does this patient with headache have a migraine or need neuroimaging?**

**CONTEXT:** In assessing the patient with headache, clinicians are often faced with 2 important questions: Is this headache a migraine? Does this patient require neuroimaging? **OBJECTIVE:** To determine the usefulness of the history and physical examination that distinguish patients with migraine from those with other headache types and that identify those patients who should undergo neuroimaging. **DATA SOURCES AND STUDY SELECTION:** A systematic review was performed using articles from MEDLINE (1966-November 2005) that assessed the performance characteristics of screening questions in diagnosing migraine (with the International Headache Society diagnostic criteria as a gold standard) and addressed the accuracy of the clinical examination in predicting the presence of underlying intracranial pathology (with computed tomography/magnetic resonance imaging as the reference standard). **DATA EXTRACTION:** Two authors independently reviewed each study to determine eligibility, abstract data, and classify methodological quality using predetermined criteria. Disagreement was resolved by consensus with a third author. **DATA SYNTHESIS:** Four studies of screening questions for migraine (n = 1745 patients) and 11 neuroimaging studies (n = 3725 patients) met inclusion criteria. All 4 of the migraine studies illustrated high sensitivity and specificity if 3 or 4 criteria were met. The best predictors can be summarized by the mnemonic POUNDing (Pulsating, duration of 4-72 h, Unilateral, Nausea, Disabling). If 4 of the 5 criteria are met, the likelihood ratio (LR) for definite or possible migraine is 24 (95% confidence interval [CI], 1.5-388); if 3 are met, the LR is 3.5 (95% CI, 1.3-9.2), and if 2 or fewer are met, the LR is 0.41 (95% CI, 0.32-0.52). For the neuroimaging question, several clinical features were found on pooled analysis to predict the presence of a serious intracranial abnormality: **cluster-type headache (LR, 10.7; 95% CI, 2.2-52); abnormal findings on neurologic examination (LR, 5.3; 95% CI, 2.4-12); undefined headache (ie, not cluster-, migraine-, or tension-type) (LR, 3.8; 95% CI, 2.0-7.1); headache with aura (LR, 3.2; 95% CI, 1.6-6.6); headache aggravated by exertion or a valsala-like maneuver (LR, 2.3; 95% CI, 1.4-3.8); and headache with vomiting (LR, 1.8; 95% CI, 1.2-2.8).** No clinical features were useful in ruling out significant pathologic conditions. **CONCLUSIONS:** The presence of 4 simple historical features can accurately diagnose migraine. Several individual clinical features were found to be associated with a significant intracranial abnormality, and patients with these features should undergo neuroimaging.

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### Pandor A, Harnan S, Goodacre S, Pickering A, Fitzgerald P, Rees A


**Diagnostic accuracy of clinical characteristics for identifying CT abnormality after minor brain injury: a systematic review and meta-analysis.**

Clinical features can be used to identify which patients with minor brain injury need CT scanning. A systematic review and meta-analysis was undertaken to estimate the value of these characteristics for diagnosing intracranial injury (including the need for neurosurgery) in adults, children, and infants. Potentially relevant studies were identified through electronic searches of several key databases, including MEDLINE, from inception to March 2010. Cohort studies of patients with minor brain injury (Glasgow Coma Score [GCS], 13-15) were selected if they reported data on the diagnostic accuracy of individual clinical characteristics for intracranial or neurosurgical injury. Where applicable, meta-analysis was used to estimate pooled sensitivity, specificity and likelihood ratios. Data were extracted from 71 studies (with cohort sizes ranging from 39 to 31,694 patients). **Depressed or basal skull fracture were the most useful clinical characteristics for the prediction of intracranial injury in both adults and children (positive likelihood ratio [PLR], >10).** Other useful characteristics included focal neurological deficit, post-traumatic seizure (PLR >5), persistent vomiting, and coagulopathy (PLR 2 to 5). Characteristics that had limited diagnostic value included loss of consciousness and headache in adults and scalp hematoma and scalp laceration in children. Limited studies were undertaken in children and only a few studies reported data for neurosurgical injuries. In conclusion, this review identifies clinical characteristics that indicate increased risk of intracranial injury and the need for CT scanning. Other characteristics, such as headache in adults and scalp laceration of hematoma in children, do not reliably indicate increased risk.
<p>| Steffens S, Tucker P, Evans DD | Adv Emerg Nurs J. 2018 Apr/Jun;40(2):78-86. doi: 10.1097/TME.0000000000000191. | Acute Headache in the Emergency Department: Is Lumbar Puncture Still Necessary to Rule Out Subarachnoid Hemorrhage? | The purpose of the Research to Practice column is to review current primary journal articles that directly affect the practice of the advanced practice nurse (APN) in the emergency department. This review examines the findings of Carpenter et al. (2016) from their article, “Spontaneous Subarachnoid Hemorrhage: A Systematic Review and Meta-Analysis Describing the Diagnostic Accuracy of History, Physical Exam, Imaging, and Lumbar Puncture With an Exploration of Test Thresholds.” The authors concluded that although no history or physical examination finding can be used to rule in or rule out spontaneous subarachnoid hemorrhage (SAH), the complaint of neck stiffness can increase the likelihood of SAH. In addition, the authors concluded that noncontrast head computed tomography (CT) is accurate in ruling out/in SAH when performed within 6 hr of symptom onset in adults with symptoms consistent with SAH and that the traditional gold standard of confirmatory lumbar puncture after a negative head CT scan is only helpful in patients with a very high pretest probability of SAH. By applying the evidence-based criteria presented in this study, the emergency department APN can confidently rule out SAH and reduce patient risks from unnecessary invasive and costly testing. | 2 |
| Mitsikostas DD, Ashina M, Craven A, Diener HC, Goadsby PJ, Ferrari MD, Lampl C, Paemeleire K, Pascual J, Siva A, Olesen J, Osipova V, Martelletti P | J Headache Pain. 2015;17:5. doi: 10.1186/s10194-016-0596-y. Epub 2016 Feb 9. | European Headache Federation consensus on technical investigation for primary headache disorders. | The diagnosis of primary headache disorders is clinical and based on the diagnostic criteria of the International Headache Society (ICHD-3-beta). However several brain conditions may mimic primary headache disorders and laboratory investigation may be needed. This necessity occurs when the treating physician doubts for the primary origin of headache. Features that represent a warning for a possible underlying disorder causing the headache are new onset headache, change in previously stable headache pattern, headache that abruptly reaches the peak level, headache that changes with posture, headache awakening the patient, or precipitated by physical activity or Valsalva manoeuvre, first onset of headache ≥50 years of age, neurological symptoms or signs, trauma, fever, seizures, history of malignancy, history of HIV or active infections, and prior history of stroke or intracranial bleeding. All national headache societies and the European Headache Alliance invited to review and comment the consensus before the final draft. The consensus recommends brain MRI for the case of migraine with aura that persists on one side or in brainstem aura. Persistent aura without infarction and migrainous infarction require brain MRI, MRA and MRV. Brain MRI with detailed study of the pituitary area and cavernous sinuses, is recommended for all TACs. For primary cough headache, exercise headache, headache associated with sexual activity, thunderclap headache and hypnic headache apart from brain MRI additional tests may be required. Because there is little and no good evidence the committee constructed a consensus based on the opinion of experts, and should be treated as imperfect. | 5 |</p>
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Journal/Ref.</th>
<th>Title</th>
<th>Background:</th>
<th>Results:</th>
<th>Notes:</th>
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<tr>
<td>American College of Emergency Physicians Clinical Policies Subcommittee (Writing Committee) on Acute Headache: Godwin SA, Cherkas DS, Panagos PD, Shih RD, Byyny R, Wolf SJ</td>
<td>Ann Emerg Med, 2019 Oct;74(4):e41-e74. doi: 10.1016/j.annemergmed.2019.07.009.</td>
<td>Clinical Policy: Critical Issues in the Evaluation and Management of Adult Patients Presenting to the Emergency Department With Acute Headache</td>
<td>This clinical policy focuses on critical issues in the evaluation and management of patients with acute headache. A MEDLINE search was performed, abstracts were reviewed, and appropriate full-text articles were read; references from reviewed articles were searched for additional material. This policy focuses on 4 areas of current interest and/or controversy in acute headache management: (1) response to headache therapy as an indicator of underlying pathology, (2) clinical findings predictive of increased intracranial pressure, (3) indications for emergent neuroimaging in patients with a complaint of headache, and (4) indications to pursue emergent diagnostic studies in patients with thunderclap headache but with normal findings on a head computed tomography (CT) scan and negative findings on a lumbar puncture. Recommendations for patient management are provided for each of these 4 topics based on strength of evidence. Level A recommendations represent patient management principles that reflect a high degree of clinical certainty, Level B recommendations represent patient management principles that reflect moderate clinical certainty, and Level C recommendations represent other patient management strategies based on preliminary, inconclusive, or conflicting evidence, or based on panel consensus. This guideline is intended for physicians working in hospital-based emergency departments. For CTA, the main positive point is that many of the negatives associated with the performance of LP can be avoided. In addition, CTA appears to be an excellent test for detecting cerebral aneurysms. The major disadvantage of using the CTA diagnostic strategy is that this test diagnoses aneurysms and not bleeding. The aneurysm may be an incidental finding and may lead to unnecessary invasive cerebral procedures. In addition, CTA exposes the patient to additional radiation risk and decreased LP diagnosis of certain medical diseases</td>
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<td>Cyntia Lemmens, M. Christien van der Linden, Korné Jellema</td>
<td>Front. Neurol., 10 May 2021</td>
<td>The Value of Cranial CT Imaging in Patients With Headache at the Emergency Department</td>
<td>Background: Headache is among the most prevalent complaints in patients presenting to the emergency department (ED). Clinicians are faced with the difficult task to differentiate primary (benign) from secondary headache disorders, since no international guidelines currently exist of clinical indicators for neuroimaging in headache patients. Methods: We performed a retrospective review of 501 patients who presented at the ED with headache as a primary complaint between April 2018 and December 2018. Primary outcomes included the amount of diagnostic imaging, the different conclusions provided by diagnostic imaging, and the clinical factors associated with abnormal imaging results. Results: About half of the patients were diagnosed with a primary headache disorder. Cranial CT imaging at the ED was performed regularly (61% of the patients) and led to the diagnosis of underlying pathology in 1 in 7.6 patients. In a multivariate model, factors significantly associated with abnormal cranial CT results were age 50 years or older, presentation within 1 h after headache onset, clinical history of aphasia, and focal neurological deficit at examination. Conclusions: As separate clinical characteristics have limited value in detecting severe underlying headache disorders, cranial imaging is regularly performed in the ED. Clinical prediction model tools applied to headache patients may identify patients at risk of intracranial pathology prior to diagnostic imaging and reduce cranial imaging in the future.</td>
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### Headache and Neuroimaging: Why We Continue to Do It

**SUMMARY:** The appropriate imaging of patients with headache presents a number of important and vexing challenges for clinicians. Despite a number of guidelines and studies demonstrating a lack of cost-effectiveness, clinicians continue to image patients with chronic nonfocal headaches, and the trend toward imaging is increasing. The reasons are complex and include the fear of missing a clinically significant lesion and litigation, habitual and standard of care practices, lack of tort reform, regulatory penalties and potential impact on one’s professional reputation, patient pressures, and financial motivation. Regulatory and legislative reforms are needed to encourage best practices without fear of professional sanctions when following the guidelines. The value of negative findings on imaging tests requires better understanding because they appear to provide some measure of societal value. Clinical decision support tools and machine intelligence may offer additional guidance and improve quality and cost-efficient management of this challenging patient population.

### Cerebral Aneurysm Exclusion by CT Angiography Based on Subarachnoid Hemorrhage Pattern: A Retrospective Study

**Background:** To identify patients with spontaneous subarachnoid hemorrhage for whom CT angiography alone can exclude ruptured aneurysms.

**Methods:** An observational retrospective review was carried out of all consecutive patients with non-traumatic subarachnoid hemorrhage who underwent both CT angiography and catheter angiography to exclude an aneurysm. CT angiography negative cases (no aneurysm) were classified according to their CT hemorrhage pattern as "aneurysmal", "perimesencephalic" or as "no-hemorrhage."

**Results:** Two hundred and forty-one patients were included. A CT angiography aneurysm detection sensitivity and specificity of 96.4% and 96.0% were observed. All 35 cases of perimesencephalic or no-hemorrhage out of 78 CT angiography negatives also had negative angiography findings.

**Conclusions:** CT angiography is self-reliant to exclude ruptured aneurysms when either a perimesencephalic hemorrhage or no-hemorrhage pattern is identified on the CT within a week of symptom onset.
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| Small Intracranial Aneurysms: Diagnostic Accuracy of CT Angiography | **Purpose:** To assess the accuracy of computed tomographic (CT) angiography for diagnosis of cerebral aneurysms 5 mm or smaller, with digital subtraction angiography (DSA) as the reference standard, in a large patient cohort.  
**Materials and Methods:** This retrospective study was approved by the local institutional review board with a waiver of written informed consent. A total of 1366 patients who underwent cerebral CT angiography followed by DSA were included. The performance of CT angiography for depiction of aneurysms was evaluated by two readers on a per-patient and per-aneurysm basis and based on size of aneurysm, location, and status of rupture. The performance of CT angiography for diagnosis of aneurysms of different size, location, and rupture status was compared by using \( \chi^2 \) test. \( \kappa \) statistic was used to assess interreader agreement for diagnosis of aneurysms.  
**Results:** Of 1366 patients, 579 patients had 711 small aneurysms at DSA. By using DSA as the reference standard, the respective sensitivity, specificity, and accuracy of CT angiography for readers 1 and 2 for detection of small aneurysms on a per-patient basis were 97.1% (562 of 579) and 97.4% (564 of 579), 98.5% (451 of 458) and 99.1% (454 of 458), and 97.7% (1013 of 1037) and 98.2% (1018 of 1037) and those on a per-aneurysm basis were 95.2% (677 of 711) and 95.4% (678 of 711), 96.6% (451 of 467) and 97.0% (454 of 468), and 95.8% (1128 of 1178) and 96.0% (1132 of 1179). The sensitivities of CT angiography were lower for detection of aneurysms smaller than 3 mm and unruptured compared with aneurysms that were 3–5 mm and ruptured \( (P < .001) \). No difference existed for the sensitivities of CT angiography for diagnosis of aneurysms in the anterior versus posterior circulation \( (P > .0167) \). Excellent or good interreader agreement was found for detection of intracranial aneurysms on a per-patient \( (\kappa = 0.982) \) and per-aneurysm \( (\kappa = 0.748) \) basis.  
**Conclusion:** This large cohort study demonstrated that CT angiography had high accuracy for detection of small cerebral aneurysms, including those smaller than 3 mm. |
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No one involved in developing the neck pain AUC has a relevant conflict of interest.