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Test your skills: Which imaging studies would you order for these neurologic complaints?

These 3 cases illustrate how to use clinical assessment tools and radiology criteria to determine the need for imaging when you suspect intracranial disorders.

PRACTICE RECOMMENDATIONS

› *Use clinical decision tools and American College of Radiology Appropriateness Criteria to determine levels of evidence for ordering specific imaging studies. (A)*

› *Consider ordering an imaging study when headache is accompanied by a new neurologic symptom. Computed tomography (CT) without contrast is best for patients who are acutely ill. In the non-emergent setting, magnetic resonance imaging (MRI) with contrast is the optimal study. (A)*

› *Order structural neuroimaging as part of the initial work-up of suspected dementia. MRI is the test of choice. (A)*

Strength of recommendation (SOR)

- (A)** Good-quality patient-oriented evidence
- (B)** Inconsistent or limited-quality patient-oriented evidence
- (C)** Consensus, usual practice, opinion, disease-oriented evidence, case series

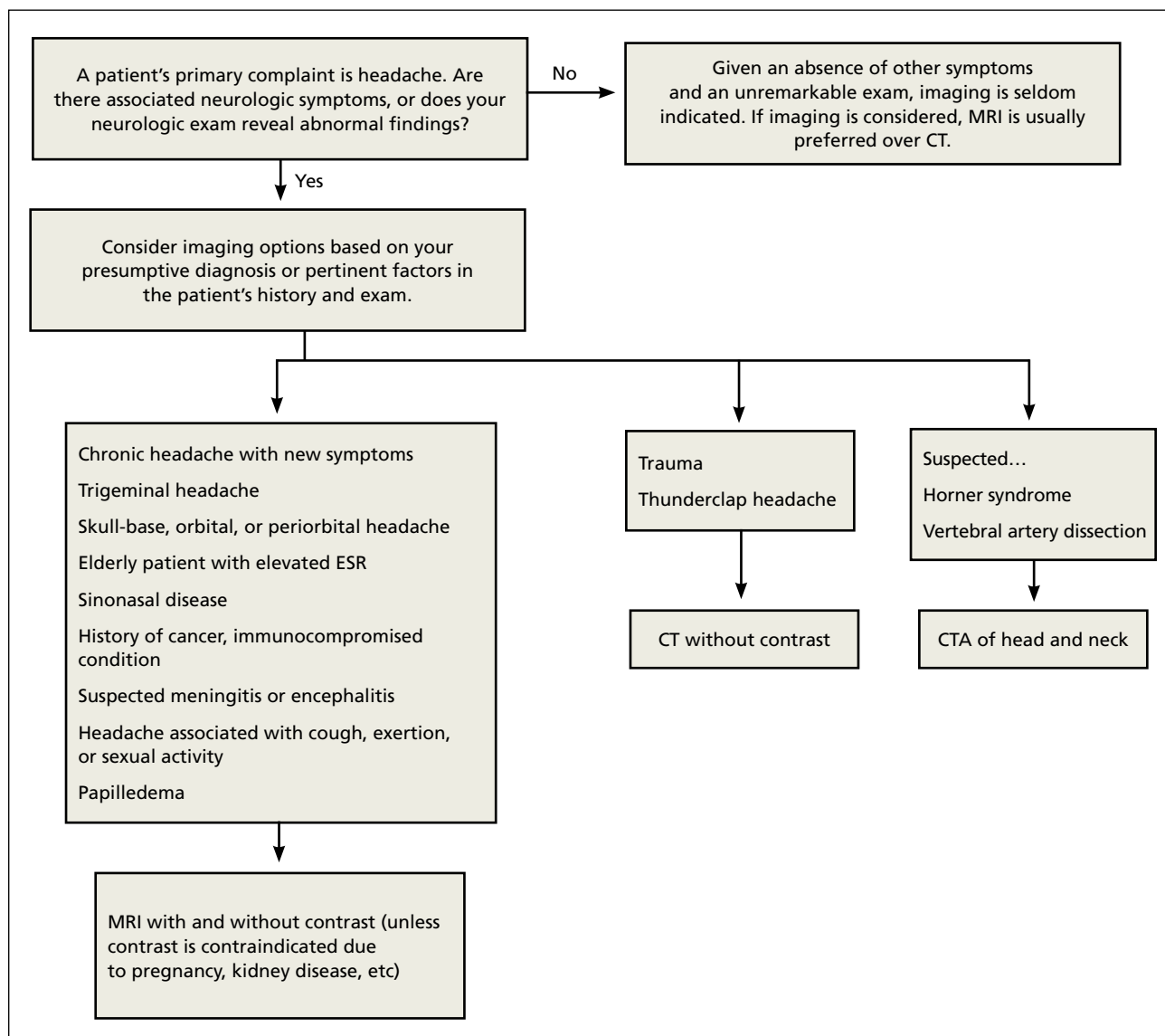
When patients present with neurologic complaints in outpatient primary care practice, 2 key questions often arise: Should brain imaging be ordered, and if so, which study? Careful history-taking and physical exam findings can suggest differential diagnoses and help determine whether imaging studies could identify potential underlying causes. Further considerations in making a decision are the type of information each modality offers, the possible need for contrast media, benefits vs radiation exposure risks, potential contraindications, and cost and local availability. In this article, we present 3 common outpatient scenarios, and in each case we describe the evidence to support clinical decision-making about imaging.

The American College of Radiology (ACR) Appropriateness Criteria Web site (<https://acssearch.acr.org/list>) provides radiation exposure information, numerical ratings of imaging studies for individual clinical scenarios, evidence tables, and reference tables for each of its recommendations.¹ ACR's recommendations were developed by expert panels of diagnostic radiologists, interventional radiologists, and radiation oncologists, and designed to help physicians order the most appropriate imaging studies based on patients' clinical conditions.² We used these criteria to develop an evaluation strategy for each of our clinical scenarios.

CASE 1 ▶ Carrie D is a 45-year-old woman with a history of migraine without aura generally controlled with Excedrin (acetaminophen, aspirin, and caffeine). She arrives at your office with a 2-day history of severe headache over the top of her head and associated tingling sensation over the left side of her face, but with no vision changes, weakness, or slurred speech. She denies any prior history of numbness or tingling with past headaches. She is a business executive and reports that in the last few weeks, her company has been involved in a high-profile merger. On physical exam, her vital signs are with-

ALGORITHM

Selecting intracranial imaging studies to investigate headache¹³



CT, computed tomography; CTA, computed tomography angiogram; ESR, erythrocyte sedimentation rate; MRI, magnetic resonance imaging.

in normal limits. She does not appear acutely ill, but on exam she reports diminished sensation to light touch over the left side of her face, left arm, and left leg compared with the right side.

»» What imaging options might you consider?

A prospective review of physicians in an ambulatory family practice setting found that

neurologic imaging was typically ordered for patients with headache who were suspected of having a brain tumor or subarachnoid hemorrhage.³ For our patient, who has a history of migraines without aura and whose current severe headache is accompanied by an abnormal sensation on one side of the face, the following questions are relevant: Is this presentation part of her primary headache syndrome or could there be a different

TABLE 1

Glasgow Coma Scale¹⁸

Head injury is classified as mild (13-15), moderate (9-12), or severe (≤ 8) after totaling the scores for each of the 3 features below.

Eye response	Score
Does not open eyes	1
Opens eyes to painful stimulus	2
Opens eyes to verbal stimulus	3
Opens eyes spontaneously	4
Speech	
Makes no sounds	1
Is incomprehensible	2
Uses words inappropriately	3
Is disoriented or confused	4
Is oriented; speech is normal	5
Movement	
Does not move	1
Exhibits abnormal extension to painful stimulus (decerebrate response)	2
Exhibits abnormal flexion to painful stimulus (decorticate response)	3
Withdraws from painful stimulus	4
Responds locally to painful stimulus	5
Obeys verbal commands	6

cause? If there is a different cause, is it likely to be detected with brain imaging such as computed tomography (CT) or magnetic resonance imaging (MRI)?

Patients with isolated headache and an absence of neurologic symptoms or abnormalities on neurologic exam are unlikely to have a clinically significant intracranial abnormality.⁴⁻¹⁰ Imaging of the brain is typically not indicated for these patients.² However, given that this patient does have a positive focal neurologic finding, a CT or MRI is indicated, as findings are more likely to influence management decisions.

The decision to order CT or MRI should be based on how acutely ill the patient is. CT without contrast is an excellent tool to rule out suspected emergent intracranial abnormalities such as an intracranial hemorrhage, hydrocephalus, or a mass.¹¹ In patients presenting with symptoms suggesting

acute illness such as carotid or vertebral artery dissection, the most appropriate test would be CT angiography of the head and neck.²

However, the list of less dire causes of headache is vast. Included in this list would be trauma, other vascular disorders such as arteriovenous malformation or temporal arteritis, infection, abnormal intracranial pressure (mass, pseudotumor cerebri, intracranial hypotension), and disorders of the head/face/spine (eg, temporomandibular joint disorder).¹²

In the non-acute setting where a patient has stable vital signs and is not in acute distress, an MRI with contrast would be the most appropriate test to identify such causes. Avoid contrast only if there is a firm contraindication, such as pregnancy, severely impaired renal function, or known allergy to gadolinium. If history and physical exam findings suggest possible stroke, arrange for MRI and MR angiography with contrast, even if the result of a head CT scan is negative. The **ALGORITHM**¹³ offers guidance for choosing imaging studies for headache based on history, physical exam, and laboratory findings.

»» And you order...

...an MRI of the brain with contrast.

Though Ms. D does have a focal neurologic finding in addition to her headache, she does not appear to be acutely ill. Ordering an MRI with contrast is the best first step.

CASE 2 ▶ Anne B is a 72-year-old woman with a history of hypertension, hyperlipidemia, and type 2 diabetes. Her daughter brings her in to see you because she is concerned about Ms. B's memory. Ms. B's daughter reports that she has become increasingly forgetful over the past 6 months, often forgetting recent events. At first the forgetfulness was occasional, but now it seems to happen daily and interfere with activities of daily living (ADLs). The week before this visit, Ms. B left a pot heating on the stove because she forgot she had started cooking. She realized what had happened only when her smoke alarm went off. Ms. B's daughter also thinks her mother may be taking some of her medications incorrectly.

Physical exam and laboratory findings are unremarkable. On the mental status exam, Ms. B has difficulty with registration and recall.

»» What imaging options might you consider?

Ms. B has exhibited progressive memory loss over 6 months and it is now affecting her ADLs. Her symptoms could be secondary to any one of many reversible medical causes, such as adverse medication effects, depression, or vitamin B12 deficiency. If clinical and laboratory evaluations exclude these reversible causes, consider dementia.

With numerous disorders having overlapping symptoms, the diagnosis of degenerative central nervous system (CNS) disease can be extremely tricky. Complicating the issue is the fact that a single patient can have 2 or more concurrent neurodegenerative diseases. Clinical testing is essential in the diagnosis and management of degenerative CNS diseases, but testing sensitivity and specificity are highly variable depending upon the disease.¹⁴

Neuroimaging is an important supplement to clinical testing in excluding intracranial abnormalities. There are significant negative consequences of missing reversible causes of memory problems and incorrectly assigning a clinical diagnosis of dementia. Neuroimaging can be subdivided into struc-

TABLE 2
New Orleans Criteria (NOC)¹⁹

Head CT without contrast indicated if GCS=15 plus any of the following:

Age >60 years
Headache
Vomiting
Seizure
Trauma above the clavicles
Intoxication
Anterograde amnesia

CT, computed tomography; GCS, Glasgow Coma Scale.

tural and functional imaging, and structural imaging is the first step in evaluation.¹⁵

The American Academy of Neurology recommends the use of structural neuroimaging with CT or MRI in the initial evaluation of patients with dementia to detect such treatable problems as a subdural hematoma, frontal lobe mass, or hydrocephalus.¹² Structural imaging may also identify anatomic changes characteristic of degenerative CNS diseases such as Alzheimer’s disease, dementia with Lewy bodies, frontotemporal dementia, vascular dementia, Creutzfeldt-Jakob disease, and Huntington’s disease; however, sensitivities and specificities of testing are low.¹⁴

>
Patients with isolated headache and no other symptoms on neurologic exam are unlikely to have a significant intracranial abnormality.

TABLE 3
Canadian CT Head Rule (CCHR)²⁰

Head CT without contrast indicated if GCS ≥13 plus any of the following:

Loss of consciousness
Anterograde amnesia
Confusion
High risk for surgical intervention
<ul style="list-style-type: none"> • Age ≥65 years • GCS <15 after 2 hours • Vomiting ≥2 episodes • Suspected open/depressed fracture or signs of skull base fracture
Moderate risk for surgical intervention
<ul style="list-style-type: none"> • Anterograde amnesia >30 minutes • Dangerous mechanism of injury

CT, computed tomography; GCS, Glasgow Coma Scale.

CONTINUED

➤
For patients with symptoms suggesting acute illness such as carotid or vertebral artery dissection, order CT angiography of the head and neck.

➤➤ And you order...

...an MRI of the brain without contrast.

In Ms. B's case, structural neuroimaging is indicated as part of the initial work-up of supposed dementia. An MRI without contrast is recommended over CT because it is more sensitive in detecting white matter changes in vascular dementia.¹⁶ In cases where an MRI is unavailable or contraindicated (eg, a patient with a pacemaker), a CT is a reasonable alternative.

CASE 3 ▶ Bob C is a 78-year-old man with a history of chronic obstructive pulmonary disease and hypertension who arrives at your walk-in clinic accompanied by his home health aide a few hours after having tripped and fallen over a rug at home. At baseline, Mr. C is ambulatory and independent in ADLs.

He takes all of his medications, including a daily baby aspirin (81 mg). Mr. C says he did not lose consciousness at the time of the fall and insists he feels fine, but you notice a bruise developing over his right temporal skull.

➤➤ What imaging options might you consider?

With acute head trauma deemed severe enough clinically to warrant imaging, non-contrast CT is the most appropriate initial test to identify possible intracranial hemorrhage.¹¹ The Glasgow Coma Scale (GCS) is the tool most widely used for clinical evaluation¹⁷ (TABLE 1¹⁸). The score is based on an assessment of 3 features: eye response, speech, and movement. Head

injury is classified as mild (13-15), moderate (9-12), or severe (≤ 8). It is universally agreed that patients with moderate or severe head injury should be further evaluated with a head CT.

With mild head injury, recommendations for follow-up are less straightforward. The New Orleans Criteria (NOC) and Canadian CT Head Rule (CCHR) are commonly used in triaging patients with minor head trauma in a cost effective way¹¹ (TABLES 2¹⁹ and 3²⁰). The cost-effectiveness of these assessment tools is still questionable, but both have very high sensitivity for identifying patients who will require neurosurgery intervention.^{21,22} Although the NOC is slightly more sensitive at identifying patients with nonsurgical clinically significant abnormalities, it has a greatly reduced specificity compared with the CCHR.²³⁻²⁵

➤➤ And you order...

...a non-contrast head CT.

Mr. C presents with a GCS of 15, indicating mild head trauma. However, in elderly patients, especially ones taking anticoagulation medication, even mild trauma can result in clinically significant abnormalities such as a subdural hematoma.¹ Although Mr. C's physical and neurologic exams are not worrisome, both the NOC and CCHR recommend further evaluation with a non-contrast head CT based on his age. **JFP**

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