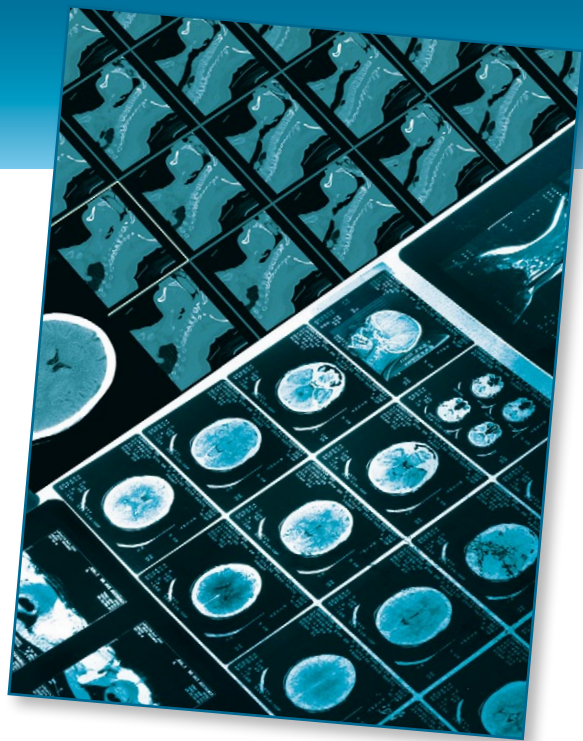


# Appropriate Use of CT in the Emergency Department

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CT is a valuable tool for timely diagnosis of many emergent conditions. However, overuse is a concern, due to financial cost and risks such as radiation exposure. The authors use clinical scenarios describing three ED patients with a possible need for neuroimaging to highlight the individual features and utility of the various published guidelines and criteria for determining the need for head CT. Strengths and limitations of these criteria are considered, as well as obstacles to their use by EPs. OP-15, the controversial imaging efficiency measure to be instituted by CMS, is also examined.

Use of CT in the ED has grown exponentially over the past decade, a trend that appears to be continuing. For Medicare patients, the number of ED visits during which a CT examination was performed increased from 2.7 million to 15.2 million over a 12-year period from 1995 to 2007, with the percentage of ED visits in which CT was performed increasing from 2.8% to 13.9%.<sup>1</sup> There are several reasons for this proliferation, including increased availability of CT scanners to EDs, increased capability of scanners resulting in higher throughput and greater variety of exams, and the practice of “defen-

sive medicine.” While outcomes data on increased utilization are scarce, multiple studies have demonstrated that the increased number of scans has significantly outpaced the number of positive cases, resulting in a decreased positivity rate.<sup>2,3</sup> In the ED, unnecessary CT examinations not only expose patients to radiation and create additional costs to the health care system; they also decrease efficiency and have a negative impact on hospital throughput. Moreover, unnecessary examinations can detect incidental findings that may require additional diagnostic studies, further increasing costs and patient anxiety.

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Multiple guidelines and published criteria—including recommendations from large multicenter trials and specialty societies—are available to assist the emergency physician in determining if imaging is necessary. However, due to conflicting guidelines and variations in practice patterns, a definitive understanding of what constitutes appropriate imaging is enigmatic. For example, there are at least six published guidelines available to determine the need for head CT in patients who have experienced minor head trauma. These are in addition to the guidelines from professional societies such as the American College of Emergency Physicians (ACEP) and the American College of Radiology (ACR).<sup>4-6</sup>

The increased utilization of CT in the ED and the associated increased overall cost have made CT a target for payers and regulatory agencies. The Centers for Medicare & Medicaid Services (CMS) has taken steps to curtail “inefficient imaging” in the ED through their outpatient quality measurement initiative. This proposed initiative would collect retrospective data on CT studies of the head that were ordered in the ED for nontraumatic headache and determine the “appropriateness” of the studies, based on the final diagnosis. CMS will make the results publicly available through its Web site Hospital Compare ([www.hospitalcompare.hhs.gov](http://www.hospitalcompare.hhs.gov)).

Using clinical scenarios involving the potential need for CT of the head, this article will discuss “appropriate” imaging in the ED and examine the resources that are available to assist the emergency physician in making a decision about ordering a CT scan. The current attempt by CMS to retrospectively evaluate utilization of imaging and to publicly rate practices underscores the imperative for emergency physicians to take an active role in this process.

## CLINICAL SCENARIOS

### Patient 1

A 64-year-old woman presents to the ED after a fall in which she struck her head on the ground. There was a brief reported loss of consciousness. Physical exam does not reveal any focal neurologic deficits. She has a Glasgow Coma Scale (GCS) score of 15.

### Patient 2

A 50-year-old woman presents to the ED with sudden onset of a severe headache. On physical examination, no focal neurologic deficits are identified.

### Patient 3

A 45-year-old man presents to the ED with mild headache, fever, and neck stiffness.

## GUIDELINES AND APPROPRIATENESS CRITERIA

Evidence-based guidelines have been established to determine the need for imaging in specific clinical scenarios, such as head CT in a patient with minor head trauma, as in the first patient presented. These include criteria that grade the appropriateness of imaging examinations for certain clinical presentations (eg,

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**FAST TRACK** *The current attempt by CMS to retrospectively evaluate utilization of imaging and to publicly rate practices underscores the imperative for emergency physicians to take an active role in this process.*

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sudden onset of severe headache). For the patient with minor head trauma, available clinical guidelines include those from the Netherlands, Scandinavia,<sup>7</sup> World Federation of Neurosurgical Societies (WFNS),<sup>8</sup> European Federation of Neurological Societies (EFNS),<sup>9</sup> United Kingdom National Institute for Clinical Excellence (NICE),<sup>10</sup> and Scottish Intercollegiate Guidelines Network (SIGN).<sup>11</sup> Many of these guidelines are based on the same published decision algorithms, including the Canadian CT Head Rule and the New Orleans Criteria (Table 1).<sup>12,13</sup> Direct comparison between the New Orleans and Canadian criteria demonstrated that while both sets of criteria had high sensitivity for clinically important brain injury, the Canadian rules were

**Table 1. Comparison of the Canadian CT Head Rule and the New Orleans Criteria for the Necessity of Head CT in an Adult Patient After Minor Head Trauma<sup>a</sup>**

**Canadian CT Head Rule**

- Age ≥65 years
- GCS score <15 at 2 h postinjury
- Signs of basal skull fracture (hemotympanum, racoon eyes, CSF otorrhea/rhinorrhea, Battle sign)
- Suspected skull fracture (open or depressed)
- Dangerous mechanism of injury (pedestrian or cyclist struck by a motor vehicle; occupant ejected from a motor vehicle; fall from a height >1 m or 5 stairs)
- >1 episode of vomiting
- Amnesia for events >30 min before incident

**New Orleans Criteria**

- Headache
- Vomiting
- Age >60 years
- Drug or alcohol intoxication
- Persistent anterograde amnesia
- Visible signs of trauma above the clavicle
- Seizure

<sup>a</sup>CT is considered warranted if any of the above criteria are met. CT = computed tomography; GCS = Glasgow Coma Scale; CSF = cerebrospinal fluid. Adapted from Stiell et al<sup>12</sup>; Haydel et al.<sup>13</sup>

more specific, offering a potential greater reduction in overall number of scans.<sup>14</sup> The potential reduction in imaging has been estimated to be as high as 25% to 50% with the adoption of the Canadian rules.<sup>12</sup> Smits and colleagues compared several guidelines (some of which were being updated at the time of comparison) as applied to 3,181 patients and demonstrated varying sensitivities for both positive findings and positive findings requiring neurosurgical intervention.<sup>4</sup> Overall, use of the NICE guidelines, which are based on the Canadian CT Head Rule, resulted in the lowest number of scans necessary to detect positive findings. However, research has shown that implementation of the NICE

guidelines led to increased resource utilization, leading to higher costs.<sup>15,16</sup>

The fact that there are multiple guidelines for head CT in minor trauma—originating from different subspecialty societies, published in different journals, and organized in different formats—makes it difficult for providers to remember or even efficiently reference them. However, it is recommended that each practice determine which criteria will be used and make these criteria readily available to their practitioners.

Limitations of guidelines may be more pronounced for clinical situations in which there are no well-defined criteria and fewer supporting evidence-based studies, such as sudden onset of headache, as in patient 2. Although recommendations exist regarding the need for imaging in headache,<sup>17,18</sup> most of the medical literature on this topic is based on nonacute headaches in the outpatient setting. ACEP has published clinical guidelines for the evaluation of adult patients presenting to the ED with headache (Table 2).<sup>5</sup> These recommendations are stratified based on the strength of evidence for the recommendation, with level A representing high clinical certainty, level B representing moderate clinical certainty, and level C representing evidence based on preliminary, conflicting, or inconclusive data. Patients in the level C category may have their CT study performed on an urgent outpatient basis (arranged but not performed as part of the ED visit); however, the exam usually is performed during the ED visit due to the uncertainty of follow-up.<sup>5</sup>

An alternative to the use of the previously mentioned clinical guidelines is the American College of Radiology (ACR) Appropriateness Criteria, which rate the appropriateness of a range of imaging examinations based on the presenting clinical scenario and suspected diagnosis. ACR Appropriateness Criteria exist for 850 variants of 175 clinical presentations and are available at the ACR Web site ([www.acr.org](http://www.acr.org)) or as downloads to mobile devices. Various radiologic procedures are rated from 1 to 9 (9 is the most appropriate) according to their utility in a particular clinical presentation. Exams rated 7 to 9 are considered “usually appropriate”; 4 to 6, “may be appropriate”; and 1 to 3, “usually not appropriate.” The ACR criteria provide appropriateness ratings not only for cases involving suspected pathol-

**Table 2. ACEP Guidelines by Level of Evidence for the Necessity of Imaging in Patients With Headache<sup>a</sup>**

Level of Evidence	Symptoms/Exam Results	Imaging Recommendation
Level A (no evidence)	NA	NA
Level B	Headache and new abnormal findings in a neurologic examination (eg, focal deficit, altered mental status, altered cognitive function)	Emergent noncontrast head CT
Level B	New sudden-onset severe headache	Emergent head CT
Level B	HIV-positive patients with a new type of headache	Emergent neuroimaging study
Level C	Age > 50 years and presenting with new type of headache but normal findings on neurologic examination	Urgent neuroimaging study

<sup>a</sup>Level A = high clinical certainty; level B = moderate clinical certainty; level C = preliminary, conflicting, or inconclusive evidence. ACEP = American College of Emergency Physicians; NA = not applicable; CT = computed tomography. Adapted from Edlow et al.<sup>5</sup>

ogy (eg, traumatic injury or possible subarachnoid hemorrhage) but also for cases such as patient 3, whose imaging findings will likely be normal but important to guide treatment (ie, to exclude intracranial pressure prior to lumbar puncture; see “Applying the Criteria to the Clinical Scenarios”).

While the ACR Appropriateness Criteria offer the advantage of being readily available for many clinical presentations, several limitations prevent routine use of these criteria. First, the criteria are not integrated with the ordering process, which means the emergency physician must access them separately when ordering an imaging study. In addition, the rating of examinations can be ambiguous: many procedures are categorized as “may be appropriate,” and multiple types of exams can be rated as appropriate in a particular scenario, but without clear direction for the preferred order of utilization. Finally, many emergency physicians are not aware that these criteria exist. A 2009 study of ordering physicians revealed that only 2.4% utilized the ACR Appropriateness Criteria to identify the most appropriate imaging technique as part of the ordering process.<sup>19</sup> This rate was significantly lower than for resources such as Google (27%), UpToDate (41%), or subspecialty journals (48%). Of note, the most commonly used resource was a consult with the radiologist (64%).<sup>19</sup>

### Barriers to Use

In addition to the limitations of the guidelines and criteria, there are further obstacles that prevent widespread use. First, the type of practice setting (community-based vs academic medical center) should be considered. Guidelines do not always apply to all types of practice, and a recommendation of MRI over CT is not meaningful to the ED practice that does not have MRI readily available. Specialty consultations (eg, with neurologists or orthopedists) frequently result in recommendations for advanced imaging exceeding those supported by guidelines. Once such recommendations have been documented in the medical record, it is difficult for the emergency physician to discharge a patient without obtaining the suggested imaging.

It is well known that the current medical-legal environment contributes to higher utilization of diagnostic testing. In 2005, Studdert et al found that up to 70% of emergency physicians admitted to ordering imaging examinations that were not clinically necessary, due to the threat of medical liability.<sup>20</sup> This higher utilization was confirmed by a 2011 study by Smith-Bindman and colleagues demonstrating that emergency physicians were 40% less likely to order neurologic imaging in states with medical liability reform.<sup>21</sup> Local variation in physician practice, even among members within the same group, as well as difficulty in documenting the



**FIGURE.** Centers for Medicare & Medicaid Services Outpatient Imaging Efficiency Measure OP-15

**OP 15: Brain CT in the Emergency Department for Atraumatic Headache**

*Definition: This measure calculates the percentage of ED visits for headache with a coincident brain CT study for Medicare beneficiaries.*

**Numerator**—Of ED visits identified in the denominator, visits with a coincident brain CT study (ie, brain CT studies on the same day for the same patient)

**Denominator**<sup>a</sup>—Number of ED patient visits with a primary diagnosis code of headache

<sup>a</sup>Denominator exclusions: (1) Claims with secondary diagnosis codes related to lumbar puncture, dizziness, paresthesia, lack of coordination, subarachnoid hemorrhage, complicated or thunderclap headache, focal neurologic deficit, pregnancy, trauma, HIV, tumor/mass and (2) imaging studies for ED patients admitted to the hospital.

CT= computed tomography; ED = emergency department. Reproduced from Centers for Medicare & Medicaid Services Outpatient Imaging Efficiency Measure OP-15.<sup>24</sup>

usage of guidelines and criteria in the medical record, compound the problem of potential liability.

Other barriers to the use of evidence-based guidelines include difficulty in altering current practices, resistance and criticism from colleagues, and lack of trust in the evidence or research behind the recommendations.<sup>22</sup>

**CMS MEASURE OP-15**

Regardless of the effect that voluntary adoption of existing guidelines and appropriateness criteria would have on rates of CT utilization, the number of studies that are currently performed and the associated cost have resulted in imaging becoming a target for payers and regulatory bodies. As CT of the head has been estimated to account for approximately 50% of all CT imaging performed in the ED setting, it should not be surprising that this examination has been identified as a potential target to both reduce overutilization and decrease cost.<sup>23,24</sup>

CMS estimates that each year, more than 7.8 million CT examinations of the head are performed on

Medicare beneficiaries.<sup>24</sup> CMS has recently proposed tracking the percentage of ED patients presenting with nontraumatic headache who undergo CT of the head during their ED visit through the recently added Outpatient Imaging Efficiency Measure OP-15. The definition of OP-15, including the list of exclusion criteria, is shown in the Figure.<sup>24</sup>

Using diagnosis codes, CMS will retrospectively collect these data from institutions and publish them in comparison to corresponding data from other institutions on a yearly basis. It is expected that—as has occurred with other CMS quality programs (such as the Physician Quality Reporting Initiative)—within a short time, financial penalties will be enacted for poor performance on this measure. ACEP has cautioned that this measure may result in missed diagnoses resulting from fewer scans being performed.<sup>25</sup> ACEP also warned that the CMS “measure developers have taken recommendations from studies that excluded older adults and guidelines that either recom-

mended CT scans in older adults or did not explicitly mention older adults, and inappropriately created a performance measure [OP-15] for a population that is largely age 65 and over.”<sup>26</sup> Although ACEP objected to OP-15 and National Quality Forum (NQF) rejected it, this measure is slated to go into effect as part of the CMS 2012 Hospital Outpatient Quality Data Reporting Program.

**CLINICAL DECISION SUPPORT SYSTEMS**

Whether through measure OP-15 or other regulation, it is only a matter of time before emergency practices will be “graded” on utilization of imaging, thus requiring individual emergency physicians to ensure the appropriateness of the imaging that they request. As previously discussed, the limitations of guidelines and appropriateness criteria have precluded their wide acceptance into clinical practice. However, with increasing use of the electronic medical record and computerized order entry (COE), there is a new opportunity for technology to help evaluate the appropriateness of imaging studies.

Clinical decision support (CDS) at the time of order offers feedback on the appropriateness of the imaging examination that has been ordered as well as recommendations for the most appropriate imaging that could be performed. Integrated decision support with order entry has been demonstrated to reduce the number of unnecessary imaging studies in both inpatient and outpatient settings.<sup>27,28</sup> A recent study by Drescher et al showed that use of COE with an embedded evidence-based CDS system for evaluation of suspected pulmonary embolism was associated with a higher positive yield of CT angiography for pulmonary embolism.<sup>29</sup>

While the initial data are promising, integrated CDS systems require time and resources to implement. Without appropriate planning and orchestration, initiating a CDS system in a busy ED can be challenging, and it will likely be poorly accepted by the emergency physician. The use of CDS systems is currently being discussed as a requirement for the second stage of the meaningful use incentives created by the federal HITECH (Health Information Technology for Economic and Clinical Health) Act.<sup>30</sup> Even with the pos-

sibility of such a mandate, widespread adoption is still several years off at best.

In the interim, a practice utilized by many imaging practices is “protocoling,” in which a radiologist reviews each order that is placed and “prescribes” the appropriate imaging examination. Research on the effectiveness of this practice has not been performed; however, requiring a radiologist to protocol the imaging study allows an opportunity for the order to be reviewed, ensuring that the safest and most effective imaging study is performed. The real-time communication between ordering physician and radiologist that may be necessary (eg, when additional information is required or a different exam needs to be ordered) is facilitated by the nature of an ED practice. However, configuring the imaging ordering process to provide accurate and adequate clinical history to the radiologist is essential in streamlining this process.

### APPLYING THE CRITERIA TO THE CLINICAL SCENARIOS

For patient 1, who presented with minor head trauma, application of the Canadian CT Head Rule indicated

that no imaging was necessary. This patient could be treated without the additional cost and risk of CT.

For patient 2, who presented with severe and sudden onset of headache, application of the ACEP guidelines indicated, with moderate clinical certainty, that head

**FAST TRACK** *Use of automated CDS systems at the time of ordering can have a positive impact in guiding the appropriate ordering of imaging, but implementing any COE in a hectic ED environment requires careful planning between the emergency physician and radiologist.*

CT was warranted. In this case, the risk and cost of CT would be considered worthwhile and less than the risk of missing a potential subarachnoid hemorrhage/ruptured aneurysm.

Patient 3, who presented with mild headache, fever, and neck stiffness, did not have signs or symptoms meeting the ACEP criteria for imaging in a patient with headache. However, the differential diagnosis in this patient included meningitis, and lumbar puncture was therefore warranted. Head CT was appropriate, not to search for the cause of the headache or to diagnose meningitis, but rather to exclude increased intracranial pressure so that the definitive diagnostic procedure, lumbar puncture, could be safely performed. The ACR appropriateness criteria rate CT as an appropriate study for a patient with headache and suspected meningitis/encephalitis.

## CONCLUSION

Greater availability and increased capabilities of CT in the past 2 decades have provided a powerful tool to the emergency physician for rapid diagnosis of an increasing number of emergent conditions. However, due to the medical-legal environment and the significant barriers to implementing existing evidence-based guidelines and imaging criteria, inappropriate use of imaging examinations continues. As a result, individual

patients are exposed to risks from increased radiation dose, as well as from any additional workup required by the detection of incidental findings. Moreover, greater use of imaging has led to an overall increase in health care costs.

To address these problems, there will be greater scrutiny of imaging that is performed in the ED. It is essential that emergency physicians understand the tools available to ensure appropriate imaging. Adoption and adherence to standardized criteria for the utilization of imaging, such as the Canadian CT Head Rule, is recommended. Use of automated CDS systems at the time of ordering can have a positive impact in guiding the appropriate ordering of imaging, but implementing any COE in a hectic ED environment requires careful planning between the emergency physician and radiologist. In the absence of such an automated solution, close collaboration between the emergency physician and the radiologist is essential. **EM**

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