ORIGINAL RESEARCH

Utilization and Cost-Effectiveness of Head Imaging for Acute and Chronic Headaches in the Primary Care Setting

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Introduction

In 2012, the Choosing Wisely campaign released a set of recommendations to reduce waste and improve value in healthcare. Of the 45 recommendations made, 24 were related to diagnostic imaging.[1] Since then, the number of recommendations has grown rapidly, but a focus on more judicious utilization of imaging remains.[2-3] With increased attention on value-based healthcare, diagnostic imaging has been clearly identified as an area of potential improvement given the dramatic increase in use of advanced imaging in recent years.[2-6] However, as physicians evaluate these recommendations within the scope of their own practice, questions remain about the degree of cost savings as well as how outcomes are affected. Recent studies suggest that there is considerable room for improvement in the diagnostic evaluation of headaches.[7-8] This is especially pertinent in the primary care setting where complaints of headache are common. Additionally, inappropriate head imaging, coupled with low rates of positive clinical findings on imaging, can lead to increased cost and unnecessary radiation exposure.[9-12] The American College of Radiology currently has guidelines on the appropriate use of head imaging for acute and chronic headaches, but it is unclear whether physicians are aware of or utilizing the guidelines. This is important because variability in management of acute and chronic headaches can lead to unnecessary cost and care. Quantifying cost and outcomes based on adherence to ACR guidelines may help reinforce high value care and incentivize quality improvement interventions in the primary care setting.

However, some are concerned that following current guidelines may miss intracranial pathology.[13-14]

Certainly, it is important to weigh the benefits of cost-savings against missing the opportunity to diagnose and treat brain tumors or other pathology. For primary care physicians (PCPs), this is especially important given how frequently PCPs evaluate headache.

This study seeks to examine whether applying ACR guidelines for head imaging for acute and chronic headaches in three primary care clinics can reduce unnecessary imaging without compromising patient care. We also analyze associated charges, keeping in mind potential quality improvement interventions

Methods

We performed a retrospective chart review of all head imaging ordered in three internal medicine primary clinics within a large academic medical center. All adult patients over 18 years of age who were diagnosed with acute or chronic headache, including migraine headache, tension headache, cluster headache, and/or minor head injury, during their visit between July 1, 2013 and May 31, 2014 were initially considered (Figure 1). Patients who did not have imaging performed or had imaging performed unrelated to the workup of headache were not included in the sample. Head imaging included studies using computed tomography (CT), magnetic resonance imaging (MRI), or magnetic resonance angiogram (MRA). Plain radiographic studies were not included.

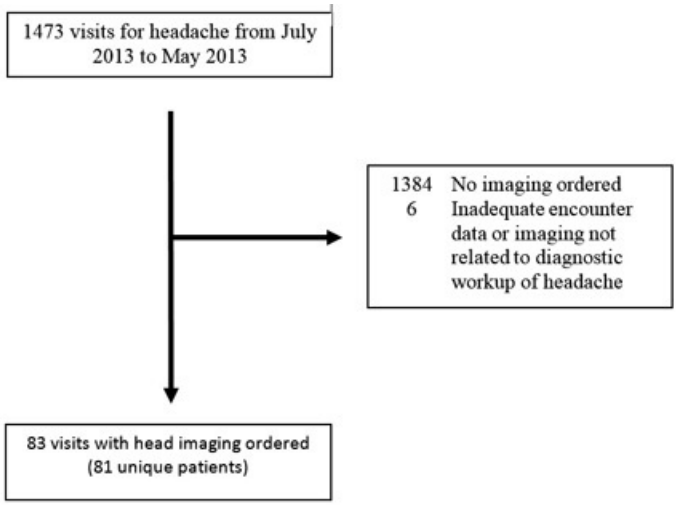

Figure 1: Inclusion and exclusion criteria.

The appropriate use of imaging was determined according to the American College of Radiology Appropriateness Criteria (2013).[15] Indications for imaging were evaluated based on documentation in the electronic health record (EHR) for every visit in which head imaging was ordered related to the diagnostic work-up of headaches. The ACR Appropriateness criteria contain 16 categories ("variants") that can be used to determine whether imaging was appropriately ordered for a particular clinical scenario such as positional headache. Imaging defined as "usually not appropriate" and "usually

appropriate" according to the Appropriateness Criteria were considered to be inappropriately ordered and appropriately ordered, respectfully. Imaging classified as "may be appropriate" under appropriateness criteria was determined to be appropriately ordered based on clinical judgement. Headaches not fitting any appropriateness category that were new in onset with no focal neurologic findings, were considered inappropriately ordered. Each case was reviewed by an attending physician, resident physician, and medical student to determine the most appropriate variant for classification in situations in which two variant categories were potentially applicable.

The findings of each study were categorized as positive or negative based on whether findings influenced and altered subsequent clinical treatment. Additionally, associated charges were determined using unadjusted list costs for CPT codes used by the billing department associated with the ordering of CTs, MRIs, and MRAs as of July 2014. The study was granted an exemption from the institutional review board.

Results

1473 total visits had an encounter diagnosis of headache in the three primary care clinics from July 2013 to May 2014. Head imaging was ordered during 89 visits (6%) for 87 unique patients. Six patients were removed from analysis because imaging was either unrelated to diagnostic work up of headache or information about the visit in which the order for imaging was placed was unavailable. After exclusions, 83 visits with 81 unique patients were considered for analysis.

The average age of the 81 unique patients was 51 years. 83% of imaging was ordered for the evaluation of "headaches" and 17% was ordered for "migraines." Physicians each ordered 4 head imaging studies on average during the study period with a standard deviation of 4 and a range of 1-14, indicating variability in physician ordering patterns. Imaging was completed on average 16 days after an order was placed.

Of the 83 studies ordered, 23 were not completed. Of the 60 completed studies, 5 (8%) resulted in positive findings and 55 (92%) resulted in negative findings (Table 1). Positive findings included a cystic lesion in the pineal cistern of a young adult female with new features associated with chronic migraine headaches, a right lateral occipital lobe hematoma in a young adult male with acute headaches and blurry vision, hemosiderin staining in the right temporal lobe of a middle-aged male with headache and blurry vision, suspected small ischemic event in left amygdaloid nucleus and parahippocampal gyrus in an elderly male with decreased vision and headache, and frontal convexity meningioma in an elderly female with visual problems and migraines.

Imaging Outcomes				
	Positive*	Negative	Not Completed	Total
Appropriately Ordered	5	39	12	56
Inappropriately Ordered	0	16	11	27
Total	5	55	23	83

* Positive defined as finding that influenced clinical treatment

Table 1: Appropriateness of Imaging Ordered and Associated Outcomes

Imaging was appropriately ordered for 56 visits (67%) and inappropriately ordered for 27 visits (33%) as seen in Table 1. Considering only completed imaging, 44 visits (73%) had imaging that was appropriately ordered and 16 (27%) had imaging that was inappropriately ordered. Of the 10 studies that were classified as "may be appropriate" according to ACR Appropriateness Criteria, 6 were determined to be appropriately ordered and 4 were determined to be inappropriately ordered based on clinical judgment. All studies with positive findings were appropriately ordered.

Imaging accounted for $144,483 in total charges among the three clinics during the study period (Figure 2). Studies with negative findings accounted for $130,322 in charges. Inappropriately ordered studies accounted for $22,728 in charges. If every inappropriately ordered study had been completed, the total charges would have been $45,045.

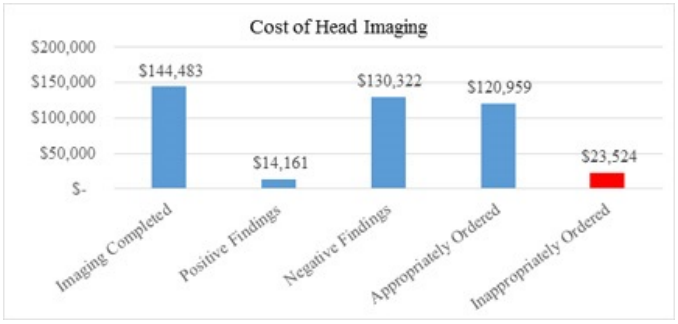

Figure 2: Charges for completed head imaging between three primary clinics at a major academic center. Positive findings were categorized based on whether findings from the imaging studies influenced subsequent clinical treatment. Studies were categorized as appropriately ordered or inappropriately ordered based on American College of Radiology Appropriateness Criteria for headaches.

Discussion

Head imaging may prove to be an area for significant health care cost savings. While imaging brings enhanced diagnostic value, overuse can result in unnecessary radiation exposure and cost. It is additionally important to recognize that the yield of

imaging is generally low.[11-12] In our study, 92% of findings were negative with total charges of $130,322. Better adherence to guidelines could have saved approximately $23,000 during the 11-month study period. All positive findings were from studies that were appropriately ordered. Additionally, all inappropriately ordered studies returned negative which suggests that reducing the number of inappropriately ordered studies may improve care without overlooking significant findings that would alter clinical treatment. However, with a small sample size, further research is needed.

Our findings suggest that there may be significant savings with adherence to the ACR guidelines. There are a few possible ways to implement change to take advantage of potential cost savings. A few notable interventions include clinical support tools and continuing medical education.

Recently, the Institute for Clinical Systems Improvement (ICSI) implemented a decision support tool for ordering systems which resulted in decreases in the inappropriate utilization of advanced imaging tests.[16] The use of the tool decreased MRI use by 23.4 % for lower back pain and 23.2% for headaches. A similar study showed that implementation of a traumatic brain injury (TBI) management guideline was effective in reducing inappropriate CT imaging for children.[17] The implementation of clinical support tools is dependent on the needs of each medical center, but general principles for effective development of clinical decision support tools is outlined in a set of Ten Commandments published in 2003 by David Bates that emphasizes short response times, anticipating the clinician's needs (e.g., most recent potassium levels shown before ordering digoxin), redirecting instead of stopping workflow, minimizing requests for additional information from the physician, and maintaining real-time monitoring of data and up-to-date knowledge bases.[18] Time and clinical experience have further informed effective implementation of support tools such as the need for diverse sources of evidence and brief, unambiguous, actionable items.[19] Current considerations include passive versus active decision support, rigidity of systems, and user interface design.[20]

Continuing medical education (CME) can also play a prominent role in staying current with recommended practice guidelines. A recent meta-analysis found that CME that is interactive, multi-faceted, and designed for small group settings appears to be more effective than broad, large scale interventions.[21] Interactive educational lectures and case conferences to faculty and resident physicians in the clinics may be serve as an effective small-scale intervention to better standardize physician ordering patterns, reduce unnecessary utilization, and save cost. Establishing groups to review the data periodically to give feedback to specific physicians may also be powerful learning lessons along the vein of quality improvement. Other ways to utilize CME include reviewing guidelines online, faculty enrichment sessions, and conference attendance around value-based care.

The limitations of this study include a small sample size, inadequate documentation in the EHR, and many incomplete studies. For purposes of generalizability, larger studies may yield more translatable results. While our results support the idea that better adherence to appropriateness criteria may result in better and more efficient care, larger-scale studies would further corroborate our findings. Additionally, differences between medical centers in ordering patterns, costs, and training may influence potential savings as well. However, current evidence exists that the increased utilization of imaging is a national concern with significant potential savings.[3,22-23]

Another point of consideration is that inadequate documentation in the EHR also may mask whether imaging was appropriately ordered. All analyses were based on physician documentation in the EHR and thus, inadequate documentation could have resulted in studies labeled as inappropriately ordered when the opposite was true. However, as EHR use becomes more ubiquitous and physician accountability heightens, proper EHR documentation becomes increasingly important for all physicians.

Lastly, we are not certain why 23 studies were not completed. It is possible that utilization review by health plans played a significant role, but we were not able to capture this information through the EHR. Alternatively, patients may have self-determined that imaging was unnecessary after the visit in which imaging was ordered. 47% of uncompleted imaging was ordered inappropriately, suggesting that appropriateness criteria may not be a sole explanatory factor in determining whether imaging was completed or not. However, while we are uncertain why 23 studies were not completed, the high number does demonstrate that there is a self-regulating component involved at some level.

In summary, radiologic imaging is an important clinical tool when used appropriately. The results of this study generally agree with other studies that imaging has low yield in the primary care setting, especially when not utilized appropriately.[24] Additionally, all inappropriately ordered imaging resulted in total chargesof $22,728 at a large academic medical center. Better adherence to evidence-based guidelines may reduce the amount of inappropriately ordered studies, reduce cost, and improve care. Further research and interventional initiatives may have significant benefit for healthcare systems and primary care practices that care for patients with acute and chronic headaches.

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