

Table 11. Evidence about Overuse of Imaging for the Evaluation of Children with Primary Headache

Type of Evidence	Key Findings	Level of Evidence (USPSTF Ranking*)	Citations
Systematic review	<p>Alexiou et al. conducted a systematic review of the literature to assess the value of neuroimaging in children with headache. Seventeen studies met inclusion criteria; the majority had low quality of evidence. CT was conducted in 754 children and MRI in 2,098. Abnormal findings were noted in 476 (15%). Of 476 cases with abnormal neuroimaging, 82 (2.5%) had a change in management. Of the 82 children with neuroimaging findings that required a change in management, only 4 (5%) had a normal neurological examination.</p>	II	<p>Alexiou GA, Argyropoulou MI. Neuroimaging in childhood headache: A systematic review. <i>Pediatr Radiol</i> 2013; 43:777-784.</p>
Appropriateness criteria	<p>The ACR has completed multiple comprehensive, evidence-based reviews of radiologic literature, clinical practice literature, and expert consultation. In summary, the ACR has advised that headaches in the absence of documented neurologic signs or symptoms that suggest intracranial hemorrhage usually do not require evaluation with imaging.</p>	III	<p>American College of Radiology Expert Panel on Pediatric Imaging: Hayes LL, Coley BD, Karmazyn B, et al. ACR Appropriateness Criteria: Headache — child. American College of Radiology, revised 2012. Available at: https://acsearch.acr.org/docs/69439/Narrative/ accessed April 21, 2015.</p>
Practice parameter	<p>Lewis et al. reviewed the available evidence on diagnostic testing of the child with recurrent headaches and made recommendations for evaluation of children, 3 to 18 years old, with headaches, based on this evidence. The authors concluded that headaches occur commonly in children and are diagnosed on a clinical basis. They specifically recommend the following regarding neuroimaging:</p> <ol style="list-style-type: none"> 1) Obtaining a neuroimaging study on a routine basis is not indicated in children with recurrent headaches and a normal neurologic examination. 2) Neuroimaging should be considered in children with an abnormal neurologic exam (e.g., focal findings, signs of increased intracranial pressure, significant alteration of consciousness), the coexistence of seizures, or both. 3) Neuroimaging should be considered in children in whom there are historical 	III	<p>Lewis DW, Ashwal S, Dahl G, et al. Practice parameter: Evaluation of children and adolescents with recurrent headaches: Report of the Quality Standards Subcommittee of the American Academy of Neurology and the Practice Committee of the Child Neurology Society. <i>Neurology</i> 2002; 59(4):490-498.</p>

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	<p>features to suggest the recent onset of severe headache, change in the type of headache, or if there are associated features that suggest neurologic dysfunction.</p>		
Retrospective study	<p>DeVries et al. conducted a retrospective, observational cohort analysis using more than 15,000 commercial claims related to the care of children ages 3 to 17 years old with recurrent headache compiled from HealthCore. One quarter of children with recurrent headache in the cohort underwent CT imaging. Twenty-three percent of children in the cohort underwent MRI during the study period. Although ED visits were associated with CT scans, two-thirds of patients with CT scans had no ED use. There were a variety of provider types seen for the index diagnosis of headache including pediatrics (43%), family medicine (30%), neurology (3%), and other (23%).</p>	II	<p>DeVries A, Young PC, Wall E, et al. CT scan utilization patterns in pediatric patients with recurrent headache. <i>Pediatrics</i> 2013; 132(1):e1-e8.</p>
Retrospective study	<p>Lateef et al. examined the records of 364 children 2 to 5 years of age who presented with headache to a large urban ED between July 1, 2003 and June 30, 2006. Of these children, 58 (16%) had a primary headache. CT imaging was obtained in 16 of the 58 children with primary headache; only one CT scan yielded abnormal results. The child with abnormal results on the CT scan also had abnormalities on neurologic examination.</p>	II	<p>Lateef TM, Grewal M, McClintock W, Chamberlain J, Kaulas H, Nelson KB. Headache in young children in the emergency department: Use of computed tomography. <i>Pediatrics</i> 2009; 124(1): e12-e17.</p>
Retrospective study	<p>Broder et al. conducted a retrospective review of the radiology database at a tertiary care academic medical center with a children's hospital and a level I trauma center, identifying CT scans of all body regions performed on children <18 years old evaluated in the ED from July 2000 to June 2006. Head CTs were obtained in roughly 4% of all ED evaluations over the study period. Head CTs were the most commonly obtained type of CT scan, accounting for about half of all CT scans obtained for children in the ED each year.</p>	II	<p>Broder J, Fordham LA, Warshauer DM. Increasing utilization of computed tomography in the pediatric emergency department, 2000-2006. <i>Emerg Radiol</i> 2007; 14:227-232.</p>

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Retrospective study	Graf et al. calculated neuroimaging rates among children ages 3 to 18 years with nonacute headache and normal neurologic examination evaluated in a single pediatric neurology clinic in 1992, 1996, 2000, and 2004. Charts were reviewed for 400 patients, and 46% underwent neuroimaging. Half (51%) of children with an imaging study underwent CT, 36% underwent MRI, and 11% underwent both CT and MRI. Of the 185 children with neuroimaging studies, 78% were normal, 22% had “remarkable” findings, and none were abnormal. Primary care physicians were the most common origin of neuroimaging requests, ranging from 66%-87% over the study years. One fifth to one quarter of imaging studies were ordered by child neurologists, and 3% to 9% were requested by emergency physicians or other providers.	II	Graf WD, Kayyali HR, Alexander JJ, Simon SD, Morriss MC. Neuroimaging-use trends in nonacute pediatric headache before and after clinical practice parameters. <i>Pediatrics</i> 2008;122:e1001-e1005.
Retrospective study	Chu and Shinnar reviewed charts of 104 children with onset of headaches before 7 years of age who were seen by a neurologist before 10 years of age between July 1983 and July 1989. Migraine was the predominant headache type, present in 75% of cases where headaches could be classified. Thirty children underwent CT scans (n=23) or MRI (n=7) and abnormalities were found in five cases. Three of the five cases had previous abnormal CT scans.	II	Chu ML, Shinnar SI. Headaches in children younger than 7 years of age. <i>Arch Neurol</i> 1992;49(1):79-82.
Retrospective study	Gandhi et al. completed a retrospective medical record review of children 2 to 18 years of age referred to an outpatient neurology clinic between 2004 and 2009 for evaluation of “headache” or “migraine.” They randomly selected 141 charts for review out of a possible 1,076 patient records. CT scans were ordered in 34 patients, and none had any significant findings. None of the CT scans changed headache diagnosis or management. One third of CT scans were ordered by neurologists, 44% by community physicians, and 24% by emergency physicians.	II	Gandhi R, Lewis EC, Evans JW, Sell E. Investigating the necessity of computed tomographic scans in children with headaches: A retrospective review. <i>CJEM</i> 2015;17(2):148-153.

Note: USPSTF criteria for assessing evidence at the individual study level are as follows: I) Properly powered and conducted randomized controlled trial (RCT); well-conducted systematic review or meta-analysis of homogeneous RCTs. II) Well-designed cohort or case-control analytic study. III) Opinions of respected authorities, based on clinical experience; descriptive studies or case reports; reports of expert committees.

Figure 1

**American College of Radiology
ACR Appropriateness Criteria®**

Clinical Condition: Headache — Child

Variant 1: Primary headache (chronic or recurrent headache including migraine without permanent neurologic signs or signs of increased intracranial pressure).

Radiologic Procedure	Rating	Comments	RRL*
MRI head without contrast	3		O
MRI head without and with contrast	3		O
CT head without contrast	2		☼☼☼
CT head with contrast	1		☼☼☼
CT head without and with contrast	1		☼☼☼☼
CTA head with contrast	1		☼☼☼☼
MRA head without contrast	1		O
MRA head without and with contrast	1		O
Arteriography cerebral	1		☼☼☼☼
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Figure 2

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼☼	0.1-1 mSv	0.03-0.3 mSv
☼☼☼	1-10 mSv	0.3-3 mSv
☼☼☼☼	10-30 mSv	3-10 mSv
☼☼☼☼☼	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies".		

From: American College of Radiology Expert Panel on Pediatric Imaging: Hayes LL, Coley BD, Karmazyn B, et al. ACR Appropriateness Criteria: Headache — Child. American College of Radiology, revised 2012. Available at: <https://acsearch.acr.org/docs/69439/Narrative/> accessed April 21, 2015.

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