

A Quality Improvement Initiative to Reduce Unnecessary Dual-phase Head CT exams Elizabeth C. Robert, MD; Derek W. Anderson, MD; Ronald R. Price, PhD; Thomas S. Dina; MD, Megan K. Strother, MD

Purpose:

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The purpose of this study is to improve the quality and safety of patient care by implementing evidence-based medicine as it pertains to dual-phase (without and with contrast) head CT exams.

Background:

The ACR Appropriateness Criteria (ACR AC), which was first developed in 1993, provides scientific guidelines regarding the most appropriate use of radiology exams. The guidelines are targeted for referring clinicians and other health care providers in an effort to optimize patient care in radiology by delineating the best use of radiologic exams based on evidence-based medicine. Use of computed tomography (CT) has increased dramatically in recent years, accounting for a significant increase in radiation dose to patients. Recent studies have identified unnecessary multiphase exams as a source of unindicated radiation exposure. In this quality improvement study, we performed a phased initiative to eliminate unnecessary dual-phase head CT's by implementing ACR AC.

Methods:

This study included three phases. In phase I, baseline data on dual-phase head CT's was acquired and analyzed. The authors performed a retrospective review of the appropriateness of all head CT's performed on patients at least 18 years of age, acquired without and with contrast at Vanderbilt Medical Center over the preceding six months. The authors retrospectively reviewed ordering requests to assign an ACR AC rating scale to all studies which had indications covered by the ACR AC. In this scale, 1, 2, or 3 ratings are given to studies which are "usually not appropriate;" 4, 5, or 6 ratings are given to studies which "may be appropriate;" and 7, 8, or 9 ratings are given to studies which are "usually appropriate". For a given indication, if a dual-phase head CT exam was not given a rating, it was assigned a score of "0" for the purposes of this study. Studies with indications not covered by the ACR AC were labeled "ACR-noncodable."

In phase II, all clinicians at Vanderbilt who had ordered a head CT without and with contrast during the 12 months preceding the study were identified by a review of PACS. A peer-to-peer education program for these 121 referring clinicians and radiologists using the ACR AC was implemented through email. Following this education, a radiologist prospectively reviewed orders for head CT's without and with contrast. If the exam was not the most indicated study, a radiologist attempted to contact the referring clinician to discuss the case in light of the ACR AC recommendations. Radiologists served as an educational consult only. The referring clinician made all final decisions during phase II.

In the final phase, revised protocols were implemented requiring approval by a radiologist for all head CT's performed without and with contrast. The number of head CT's requested and performed without and with contrast and the impact of the phase d intervention on the appropriateness of studies performed was tracked. Also, the impact of this intervention on patient radiation and contrast exposure, and health-care costs was estimated.

Results:

Combined efforts in education, peer-to-peer utilization management, and protocol changes led to a 62% reduction in the number of dualphase head CT's performed. In phase II of the study, half of the physicians contacted agreed to change the CT study ordered to the indicated single-phase exam. During the phased initiative, the average number of dual-phase head CT's went from 1.4/day to 0.52/day (see Figure 1). During the two years of the study, the dual-phase head CT volume dropped, while the total head CT volume remained constant (see Figure 2).

In phase I, 184 CTs without and with contrast per day by month. were performed with indications that could be assigned an ACR AC rating. Of these 184 studies, 11 (5.98%) were the most appropriate CT study. In the remaining 173 studies, a single-phase CT had a higher ACR AC rating than the dual-phase CT performed. Only five of the 184 studies had a rating of seven for a dual-phase exam ("usually appropriate"), but for all of these studies a single-phase exam had a higher ACR AC rating.

In phase III of the study, 70 dual-phase head CT's were performed with indications which could be assigned an ACR AC rating. Of these 70 studies, 7 (10%) were the most appropriate CT study, with four of the dual-phase studies receiving an ACR AC rating of seven. In the remaining 60 studies, a single-phase CT had a higher rating.

The appropriateness of each study was tracked before and after intervention. The dual-phase head CT's performed following application of the ACR AC were more often recommended than the dual-phase head CT exams performed prior to quality improvement initiative, as shown in Figure 3.

More than 33% (132 out of 383) of the dual-phase head CT exams were noncodable by ACR AC (see Table 1).

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Of the 250 patients to whom we applied an ACR AC score, only 23 (9.2%) received the most appropriate head CT exam when imaged without and with contrast. The other 227 patients should have received a single-phase head CT exam, rather than the dual-phase exam. Comparison was not made to ACR AC ratings for brain magnetic resonance imaging (MRI). Unnecessary contrast was also monitored. In phase I, 33.5 % of patients (56 of

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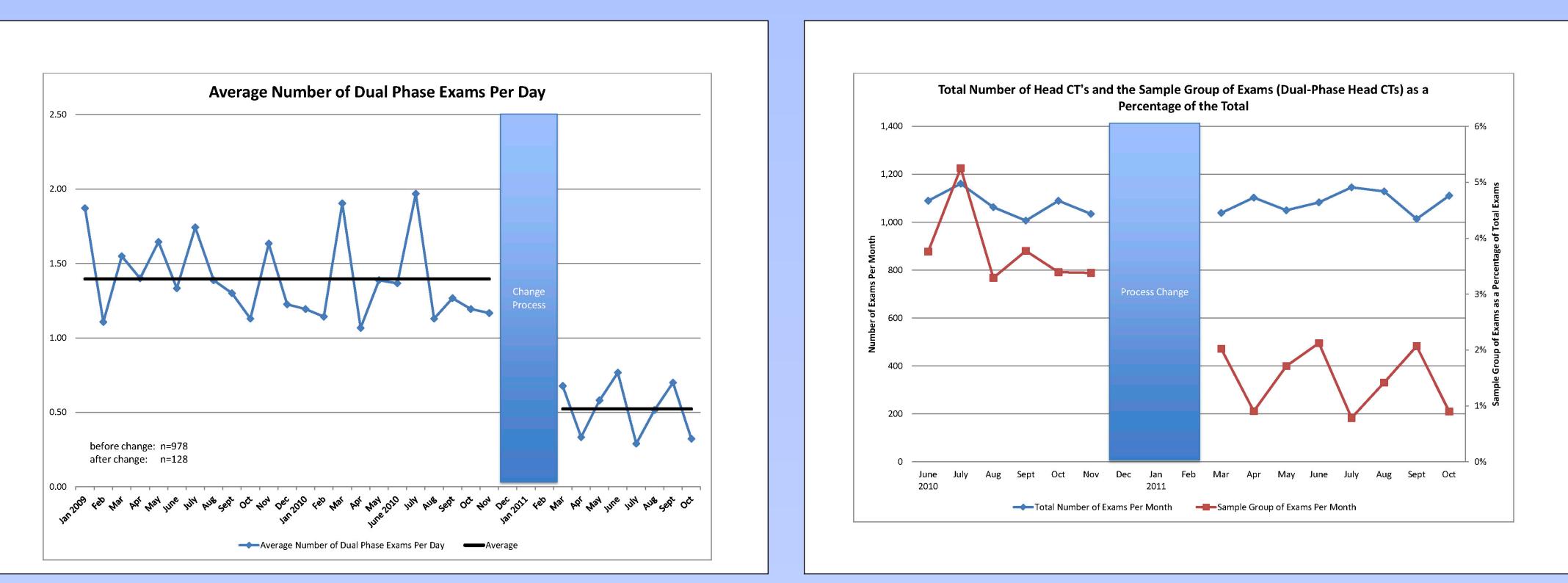


Figure 2: Total number of head CT's performed each month **Figure 1:** Average number of dual-phase head CT exams performed (blue) including single phase and dual-phase head CT's is plotted alongside the percentage of dual-phase head CT's (red).

Table 1: Noncodable Exams.	
Indication	Cases
Post-operative (surgery within past 1 month)	46
Known intracranial mass	30
Abscess (known or suspected)	17
Infection	12
Aneurysm	5
Extra-axial fluid collection	5
Clinical trial	4
Deep brain stimulator or ventriculostomy shunt	4
Pre-operative	2
Fibrous dysplasia	2
Other	5
Total	132

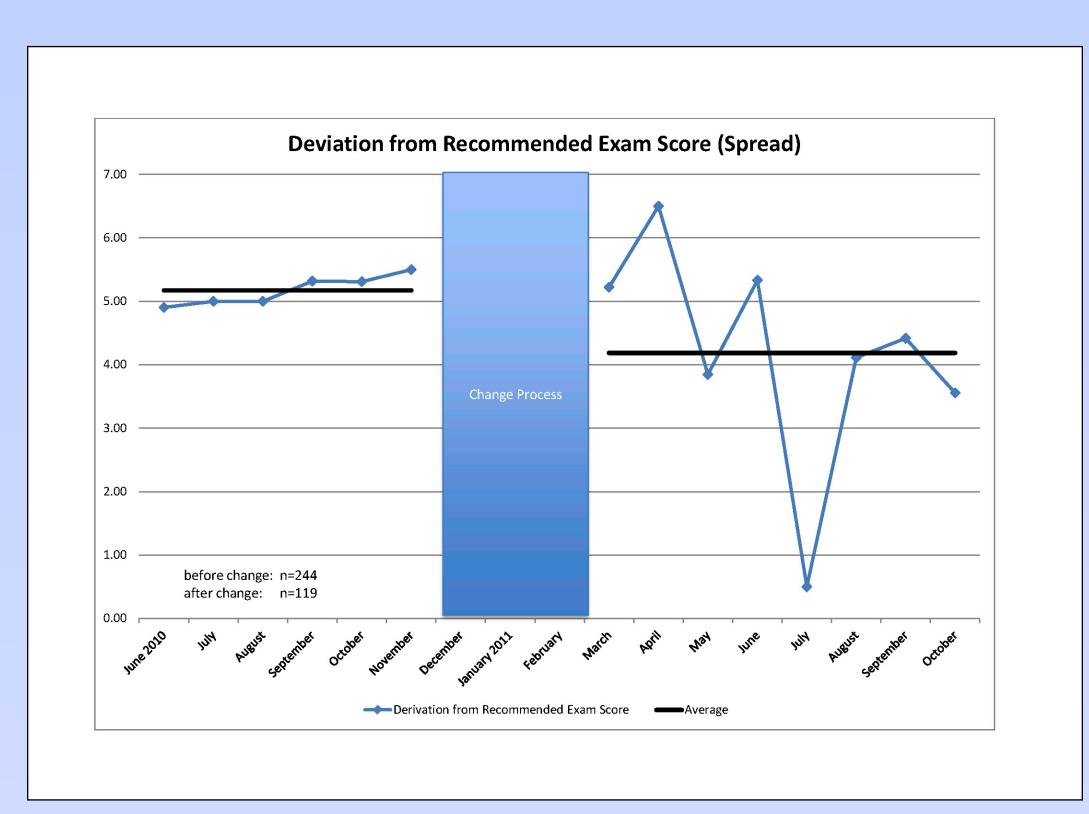


Figure 3: Differences between the ACR AC score of the dual-phase head CT's performed and the score for the recommended singlephase head CT exams are plotted by month. A score of "0" on the y-axis equates to perfect adherence to ACR guidelines.

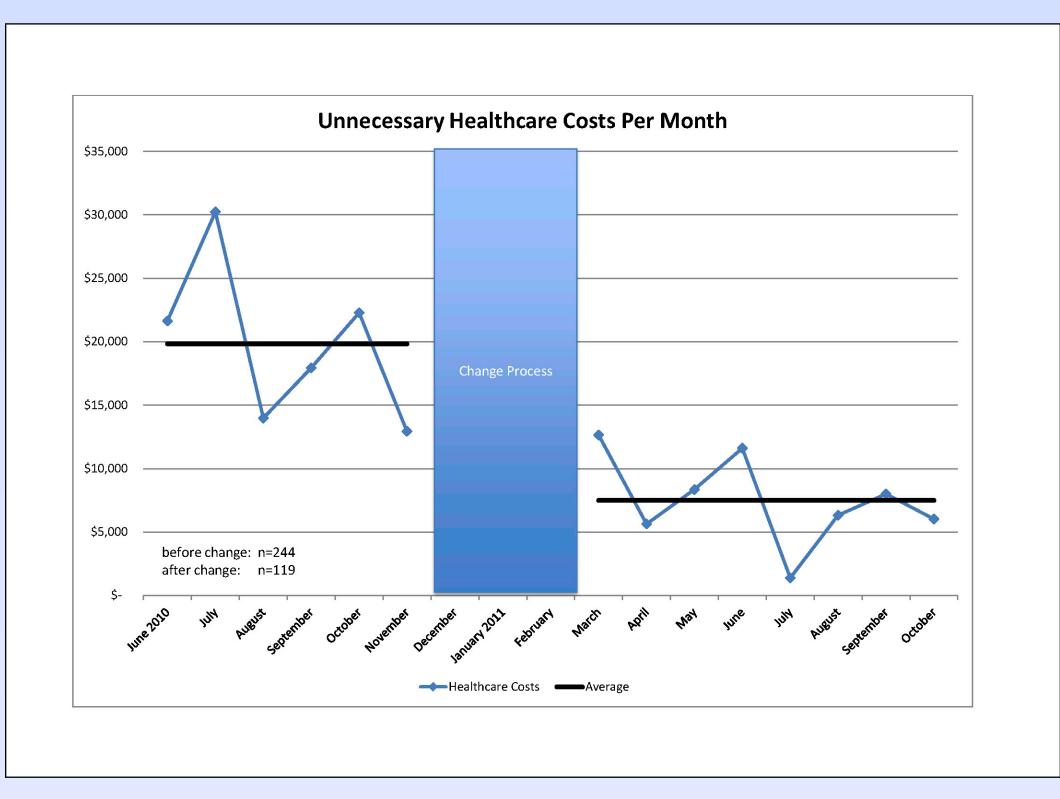


Figure 4: Added healthcare costs for unnecessary dual-phase exams are coded by month. A "\$ 0" on the y-axis corresponds to performance of the head CT exam most highly recommended by the ACR AC rating.

167 codable patients) received contrast when a non-contrasted head CT exam had a higher ACR AC rating. In phase III, 31.6% of patients (30 of 95 codable patients) received contrast when a noncontrasted exam had a higher ACR AC rating.

At our institution, dual-phase head CT's have higher technical and professional charges compared to single-phase head CT's. For each of the codable studies performed during phases I and III, the cost of the most recommended study was compared to the cost of the dual-phase study performed. Prior to the quality improvement initiative, the average additional health care costs accrued when performing an unnecessary dual-phase head CT's compared to the indicated single-phase head CT's was \$19,836/month. Following the quality improvement initiative,

the additional cost fell to an average of \$7,498/month (Figure 4).

Discussion:

In order to optimize patient care in radiology, imaging must be done effectively and efficiently. This study demonstrates the efficacy of educating referring clinicians and improving protocols to reduce unnecessary exams. Overall, unnecessary dual-phase head CT volume dropped approximately 62% following the quality initiative. At our institution, the dual-phase head CT exam is performed with the same scanning parameters before and after contrast, resulting in twice the radiation dose of a single-phase head CT exam. Contrast media exposure is also concerning for potential renal toxicity and contrast allergies. Improvements in radiation dose and contrast exposure were achieved. Additionally we reduced health care costs by \$148,000/year at our institution.

In this study, the most frequent clinical indication for a dual-phase CT head exam was screening and management of metastatic disease. ACR AC rates a contrasted MR of the head as a "9"; A single-phase contrasted CT of the head is rated a "7"; and the dual-phase head CT exam is not rated for this indication (thus assigned a score of "0" when performed in this study). Our data supports the ACR AC recommendations; dual-phase exam added information in less than one percent of dual-phase head CT exams performed to screen or manage metastases (1:123 patients with a hemorrhagic mass, which could have been mistaken as enhancement on a single-phase contrasted head CT).

In our study, dual-phase imaging for head CT's was overused despite education and protocol changes. We suggest that further studies be conducted for clinical indications that are currently noncodable under ACR AC. This quality improvement initiative will continue by focusing on systems improvement, including updating the algorithm built into the electronic ordering system for inpatients to better reflect the ACR AC and considering a formalized utilization management system mandating implementation of ACR AC guidelines. Some evidence suggests that systems changes are more effective than provider education.



Conclusion:

The American Board of Radiology (ABR) initiated a formal quality improvement requirement for all radiologists in 2007, as part of the Maintenance of Certification (MOC) process. This outcomesdriven study contributes to a growing national data repository on quality improvement regarding patient safety and technical standards with regards to dual-phase head CT's. In this study, quality improvement was achieved through both provider education and systems improvement.

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