

# Impact of Provider-led, Technology-enabled Radiology Management Program on Imaging

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## ABSTRACT

**OBJECTIVE:** The study objective was to assess the impact of a provider-led, technology-enabled radiology medical management program on high-cost imaging use.

**METHODS:** This study was performed in the ambulatory setting of an integrated healthcare system. After negotiating a risk contract with a major commercial payer, we created a physician-led radiology medical management program to help address potentially inappropriate high-cost imaging use. The radiology medical management program was enabled by a computerized physician order entry system with integrated clinical decision support and accountability tools, including (1) mandatory peer-to-peer consultation with radiologists before order completion when test utility was uncertain on the basis of order requisition; (2) quarterly practice pattern variation reports to providers; and (3) academic detailing for targeted outliers. The primary outcome measure was intensity of high-cost imaging, defined as the number of outpatient computed tomography (CT), magnetic resonance imaging (MRI), and nuclear cardiology studies per 1000 patient-months in the payer's panel. Chi-square test was used to assess trends.

**RESULTS:** In 1.8 million patient-months from January 2004 to December 2009, 50,336 eligible studies were performed (54.1% CT, 40.3% MRI, 5.6% nuclear cardiology). There was a 12.0% sustained reduction in high-cost imaging intensity over the 5-year period ( $P < .001$ ). The number of CT studies performed decreased from 17.5 per 1000 patient-months to 14.5 ( $P < .01$ ); nuclear cardiology examinations decreased from 2.4 to 1.4 ( $P < .01$ ) per 1000 patient-months. The MRI rate remained unchanged at 11 studies per 1000 patient-months.

**CONCLUSION:** A provider-led radiology medical management program enabled through health information technology and accountability tools may produce a significant reduction in high-cost imaging use.

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**KEYWORDS:** Health information technology; Health policy; Imaging use

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In the hotly debated healthcare reform discussion, considerable interest exists within the federal administration in curtailing the growth of medical imaging expenditures. Among Medicare beneficiaries, the volume of imaging has

grown by 80% between 2000 and 2009, a rate that surpasses all other physician services, including evaluation and management, major and other procedures, and laboratory testing.<sup>1</sup> Despite the tremendous benefits of diagnostic imaging in advancing the understanding, diagnosis, and management of a vast array of diseases,<sup>2</sup> there is concern about its suboptimal use leading to waste and diminished quality of care. Some have even suggested that 30% to 40% of all imaging studies performed in the United States may be unnecessary.<sup>3</sup> Congress has been examining using prior authorization to manage use and curb costs associated with high-cost imaging. The Medicare Payment Advisory Commission has estimated that a prior authorization

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program would reduce federal program funding by approximately \$50 million in the first year and \$1 billion over 5 years, without affecting beneficiaries' access to clinically appropriate advanced imaging services.<sup>1</sup>

Prior authorization as a strategy attempts to influence clinical decision-making by requiring explicit approval before a service is rendered, with approval preferably based on consistency with some predetermined clinical guidelines. Although prior authorization has been used as a mainstay strategy for managing inpatient hospital services for many years, evidence for its effectiveness remains scarce. The Department of Health and Human Services previously has raised concerns over the administrative burden of prior authorization services and its applicability to Medicare.<sup>4</sup> Further, the current prior authorization process, typically delivered through a third-party vendor contracted by the payer, has limited basis in public domain evidence on appropriateness and is disruptive to physician workflow. It is estimated that the average physician practice devotes 1 hour of physician time, 13.1 hours of nursing time, and 6.3 hours of clerical time to prior authorization processes each week.<sup>5</sup>

Automated decision-support systems have been proposed as more patient-centric, physician-friendly, evidence-based alternatives to improve patient care and ensure appropriate imaging use.<sup>6</sup> In 2004, after negotiating an at-risk contract with a large commercial insurer, Brigham and Women's Hospital created a provider-led, technology-enabled radiology medical management program for the insurer's 26,000 patients whose primary care physician was affiliated with the Brigham and Women's Hospital as a substitute for the payer-led prior authorization program that was being deployed in our region. The radiology management program was accountable for both the cost and the quality of care for the defined population of patients. The radiology medical management was enabled through a computerized physician order entry system with integrated clinical decision support and accountability tools. This study aims to assess the impact of such a physician-led, technology-enabled radiology medical management program on high-cost imaging use for an at-risk commercial population.

## MATERIALS AND METHODS

### Study Population and Site

The study population included all adult patients who were enrolled in 1 large Massachusetts commercial third-party

payer health plan and had a primary care physician who was affiliated with Brigham and Women's Hospital between January 1, 2004, and December 31, 2009. Brigham and Women's Hospital consists of an integrated health system with a 777-bed university-affiliated tertiary care hospital with 44,000 inpatient admissions, 950,000 ambulatory visits, and 54,000 emergency department visits accounting for more than 500,000 imaging studies annually. The institution's outpatient network spans more than 183 practices with 1200 physicians. The requirement to obtain informed consent was waived by the institutional review board for this Health Insurance Portability and Accountability Act-compliant study.

### Radiology Imaging Order System

The institution has a web-based computerized physician order entry system for imaging (Percipio, Medicalis Corp, San Francisco, Calif) that is fully integrated into the enterprise information technology infrastructure. Details of the implementation have been described.<sup>7</sup> In brief, office staff members, nurses, physician assistants, residents, and staff physicians are permitted to place an imaging order using the computerized physician order entry system. On the basis of the inputted clinical history from the order entry, the system launches real-time clinical decision support to aid the requesting provider in choosing the best diagnostic strategy, if such evidence is available. The clinical decision support generation is dependent on the particular examination, patient, and clinical context/presentation. Evidence embedded in clinical decision support was derived from public domain literature, including published peer-reviewed journals and various specialty clinical practice guidelines. For example, an order for CT angiogram of the chest in a patient with suspected pulmonary embolism may trigger a low-utility message if the d-dimer level is normal.<sup>8</sup> When faced with the clinical decision support, clinicians may choose to cancel the request or proceed with the order.

### Radiology Medical Management Program

The payer agreed to waive the requirement to participate in an imaging prior authorization program if we instituted the radiology medical management program. The program was enabled in the existing computerized physician order entry clinical decision support system and contained accountability tools, including the following: (1) required peer-to-peer consultation with radiologists before order completion

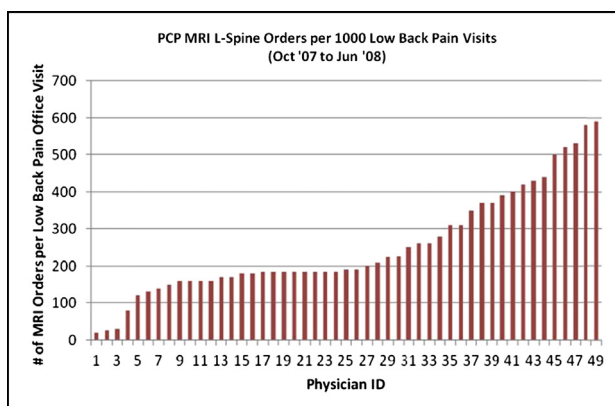
### CLINICAL SIGNIFICANCE

- The implementation of a provider-led radiology medical management program, enabled through health information technology and accountability tools, was associated with a sustained 12% reduction in high-cost diagnostic imaging.
- The radiology medical management infrastructure may provide the necessary tools to help manage the imaging component of new care delivery models, such as envisioned in Accountable Care Organizations, using an approach that is more evidence-based and less disruptive than payer-led prior authorization programs.

when test utility was deemed uncertain or inappropriate by clinical decision support; (2) quarterly practice pattern variation reports to individual primary care physicians depicting and comparing each physician's use of high-cost imaging versus comparison with their peers (**Figure 1** shows an example report); and (3) academic detailing<sup>9</sup> for outliers with a subspecialty radiologist by reviewing and discussing the utility of a sample of imaging studies requested by the targeted physician to help avoid overuse of imaging in the future. In cases with strong evidence against the need for imaging, the computerized physician order entry clinical decision support system provided real-time feedback to the orderer about its appropriateness. In clinical circumstances where clear published evidence was lacking, a peer-to-peer consultation with subspecialized radiologists (ie, neuroradiology, abdomen/pelvis, thoracic, cardiovascular) was required at the time of order entry if the utility of the requested imaging study was deemed uncertain by clinical decision support. The requesting physician retained the final decision on whether to proceed with imaging after considering the input of the consulting radiologist. **Figure 2** is an example of a peer-to-peer consultation message embedded in the computerized physician order entry system.

## Data Collection and Analysis

The primary outcome measure was the intensity of high-cost imaging, defined as the number of outpatient high-cost imaging tests (computed tomography [CT], magnetic resonance imaging [MRI], and nuclear cardiology studies) per 1000 patient-months in the payer's patient panel as determined by claims paid by the payer. Positron emission tomography scan was excluded because of its low volume. The imaging study may have been performed at the study institution or outside the system. Outcome parameters included the aggregate volumes of advanced imaging studies performed during each year, classified by modality and anatomy.



**Figure 1** Example of a practice pattern variation report for lumbar spine MRI orders among primary care providers. MRI = magnetic resonance imaging; PCP = primary care provider.

Claims data were provided by the third-party payer for patients who underwent one of the specified imaging examinations between January 1, 2004, and December 31, 2009. The study design is a time series with 1 year of benchmark data before implementation of the radiology medical management program (January 1, 2004, to December 31, 2004) and 5 years post-implementation (January 1, 2005, to December 31, 2009).

Statistical analyses were performed using Microsoft Excel 2003 (Microsoft, Redmond, Wash) and JMP 8 (SAS Institute, Inc, Cary, NC). Chi-square tests were applied to the pre- and post-data to determine differences in imaging use over time. A 2-tailed  $P$  value  $< .05$  was defined as statistically significant.

## RESULTS

A total of 1.8 million patient-months were included in the study population: 275,851 patient-months in the pre-implementation period and 1,548,953 in the post-implementation period. The average patient age was 42 years, and approximately 60% of patients were female.

Overall, 50,336 high-cost imaging studies were performed (54.1% CT, 40.3% MRI, 5.6% nuclear cardiology) over the study period. In 2004, 17.5 CT studies per 1000 patient-months, 10.7 MRI studies per 1000 patient-months, and 2.4 cardiac nuclear studies per 1000 patient-months were performed. In contrast, in the post-implementation period, 14.4 CT studies, 11.1 MRI studies, and 1.4 cardiac nuclear studies per 1000 patient-months were performed. Peer-to-peer consultation was triggered in 15.7% of high-cost imaging orders placed between 2005 and 2009 (**Figure 3** shows the annual trend of peer-to-peer consultation).

There was a 12.0% sustained reduction in the intensity of high-cost imaging over the study period ( $P < .001$ ). The number of CT studies per 1000 patient-months decreased by 17.5% ( $P < .01$ ). Likewise, the rate of nuclear cardiology examinations decreased by 43.0% ( $P < .01$ ). The change in MRI use was not statistically significant ( $P = .05$ ). **Figure 4** shows the comparison in high-cost imaging use pre- and post-radiology medical management program implementation. **Figure 5** shows the trend of use over the study period. Spine/pelvis, abdomen, and chest were the most common CT studies, and upper extremities, chest, and head/neck were the most common MRI examinations (**Figure 6**).

## DISCUSSION

Health policy experts, care providers, and the public all have high expectations that the widespread adoption and meaningful use of health information technology will reduce healthcare costs and improve quality. It has been estimated that a fully interoperable healthcare information exchange system can yield a net value as much as \$77.8 billion annually.<sup>10</sup> One of the potential cost-saving mechanisms is by decreasing expensive, unnecessary diagnostic studies.

**A**

**Decision Support**

Based on published evidence MRI is not recommended in the absence of clinical "red flags". If symptoms are disabling, consider consultation with the comprehensive spine center at 617 732-

**Clinical guidelines from the American College of Physicians and American Pain Society:**  
Clinicians should perform diagnostic imaging and testing for patients with low back pain when severe or progressive neurologic deficits are present or when serious underlying conditions are suspected on the basis of history and physical examination (strong recommendation, moderate-quality evidence).

Please note that the information is presented to assist you in providing care to your patients. We do not provide advice regarding the appropriateness of coding, billing or claims processing. We make no representations regarding the payment or reimbursement for services rendered.

[Add Indications](#) [Ignore](#) [Cancel](#)

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**B**

**Decision Support**

A peer-to-peer consultation is required in order to submit an order.

Peer-to-peer consultation is available Monday - Friday 8 am - 6 pm. Please page Percipio Support at pager # during off-hours.  
For a faster response, please be sure to enter a direct call back number in the space provided below.

Click the "SEND PAGE" button for peer-to-peer consultation.

Name:	Lumbar Spine, Mri
Telephone:	None
Pager:	
Call Back #:	(e.g. 1112223333) <a href="#">SEND PAGE</a>

Enter the peer-to-peer consultation number here:

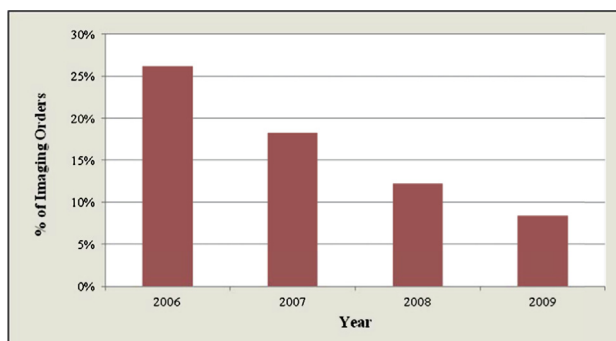
Please note: If you have not received a callback within 15 minutes of clicking the "SEND PAGE" button, please page Percipio Support at pager #

[Submit](#) [Reset Order](#)

[More Info](#)  
[Feedback](#)

**Figure 2** Example screenshot of clinical decision support and peer-to-peer consultation at time of order entry.

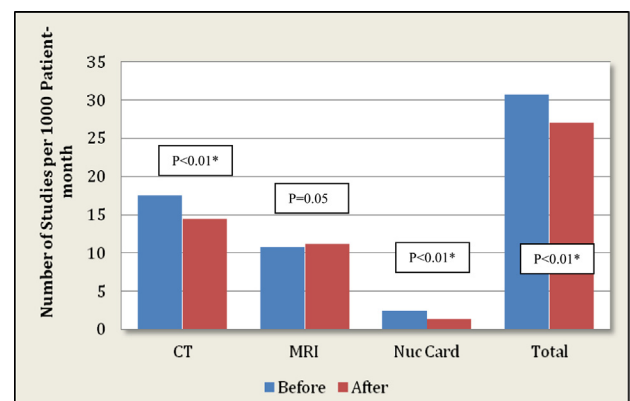
After instituting a physician-led, technology enabled radiology medical management program in lieu of a payer-led imaging prior authorization program, we found a significant and sustainable 12% decrease (from 30.7 studies per 1000 patient-months to 27.0 studies per 1000 patient-months) in overall use of high-cost imaging examinations ( $P < .001$ ) in a commercial payer population. This finding suggests that a provider-led, technology-enabled radiology medical management program can have a significant cost-saving impact. The radiology medical management infrastructure may provide the necessary tools to help manage the imaging



**Figure 3** Trend of high-cost imaging orders triggering peer-to-peer consultation during study period.

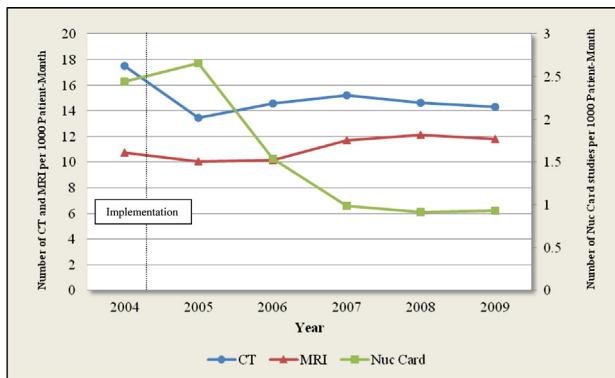
component of new care delivery models, such as envisioned in Accountable Care Organizations, using an approach that is more evidence-based and less disruptive than payer-led prior authorization programs.

Previous studies have examined the impact of computerized physician order entry-clinical decision support systems<sup>11-13</sup> or third-party radiology benefit management programs<sup>14,15</sup> in controlling the escalating use of advanced



**Figure 4** Intensity of high-cost imaging pre- and post-implementation of a provider-led radiology medical management program.





**Figure 5** Trend of high-cost imaging over study period. CT = computed tomography; MRI = magnetic resonance imaging.

imaging. Although these 2 methods are both found to be moderately effective, data also suggest that radiology benefit management models may be only shifting costs to physicians without having a net impact on societal costs.<sup>16</sup> To the best of our knowledge, no literature has studied a comprehensive radiology medical management program that is physician-led and technology-enabled.

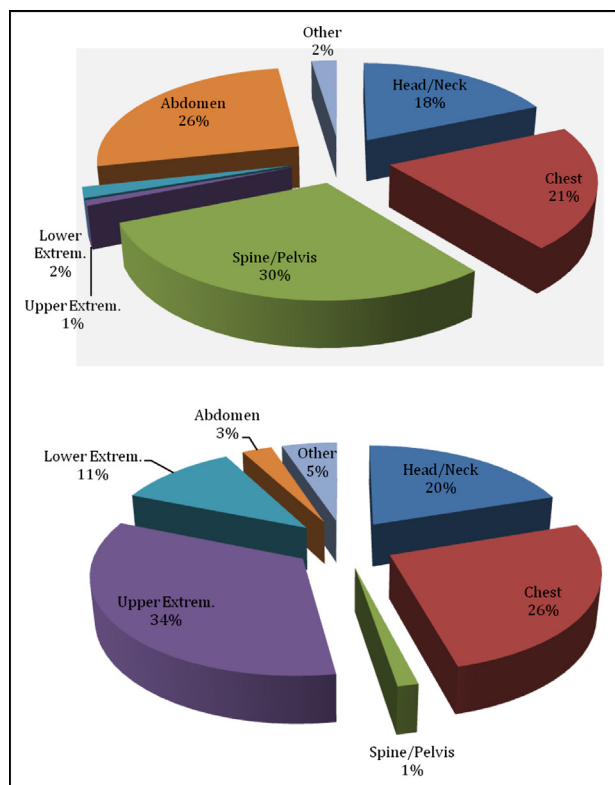
Currently, much doubt still remains in the potentials of health information technology as a cost-control strategy. In a recent observational study, McCormick et al<sup>17</sup> raised the

possibility that health information technology may actually have the opposite effect. They found that physicians who have electronic access to health data are 40% to 70% more likely to order additional imaging studies,<sup>17</sup> concluding that simply installing an off-the-shelf commercial software by itself may not produce optimal results in certain settings. Indeed, any technology is bound to fail if implemented without careful attention to personnel, workflow, and cultures that are unique to each organization. It is our experience that leadership and an organizational culture that values quality improvement are as important, if not more than, as any computer codes and functionality.

As much as technology is essential in our intervention, actionable high-quality evidence deliverable via clinical decision support is available for only a small portion of overall care. Therefore, we also included accountability tools, including targeted peer-to-peer consultation and academic detailing, as well as practice pattern variation reporting, to the radiology medical management program. Even as more complete scientific evidence becomes available, such accountability tools will likely play an important role in modifying physician test-ordering practices. Unfortunately, with the current predominant payment system that rewards healthcare transactions (ie, imaging interpretations), unpaid interactions between radiologists and referrers are financially discouraged. It is likely that any sustainable radiology medical management program will require a care delivery model that realigns rewards with the cognitive input of physicians for the coordinated provision of patient-centered, evidence-based care.

## Study Limitations

First, it was beyond our scope to assess the impact of the radiology medical management program on appropriateness of testing. However, we designed the radiology medical management program interventions to specifically target inappropriate imaging studies, using evidence that was largely based on peer-reviewed literature, particularly research using decision analytic, decision rule, or cost-effective analysis.<sup>18-23</sup> Therefore, on the basis of the intended target of the interventions, it is probable, although we could not confirm, that the observed use reduction was primarily in unnecessary studies. Of note, throughout the study period, we noted a decreasing need for peer-to-peer consultation, which suggests that orderers may have been learning from the clinical decision support over time. Further studies are needed to evaluate the impact of radiology medical management programs on appropriateness of high-cost imaging and other metrics of quality of care. Second, our observed association between radiology medical management program implementation and intensity of high-cost imaging does not confirm a cause and effect relationship. During this timeframe, other forces, such as healthcare reform and increased awareness of cancer risk associated with medical imaging, also may be at play. The increased radiation awareness may partially explain the



**Figure 6** Breakdown of CT and MRI examinations performed by body part over study period. CT = computed tomography; MRI = magnetic resonance imaging.

stability of MRI pre- and post-intervention. Randomized controlled trials of radiology medical management programs would be needed to help confirm causality. Third, because of the nature of implementation of the overall radiology medical management program, we are unable to assign a value to each individual component of the radiology medical management program for potentially enabling reductions in imaging intensity. However, it is possible and indeed likely that the components of the radiology medical management program have a reinforcing effect on imaging use.

In addition, our study was performed at a single academic medical center, and therefore generalizability of the findings in other settings is unclear. We relied on claims data from a commercial payer, which did not reflect only orders that were placed through Brigham and Women's Hospital. For example, if a patient received a CT study at a hospital outside of our network, the requesting physician would not have received the clinical decision support or other interventions, but that study would still have been included in the study analysis. However, such a confounder biases our findings toward the null hypothesis. Also, our patient population was not necessarily static, because patients often switch third-party payers over time. Therefore, the radiology medical management program was not applied to a specific set of patients over the entire study period. However, we believe that the current study is more representative of the "real world" where such programs will be applied.

## CONCLUSIONS

Our study demonstrates that a provider-led, technology-enabled radiology medical management program may result in a significant sustainable reduction in high-cost imaging use.

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