Magnetic Resonance Imaging And Low Back Pain Care For Medicare Patients

More MRI scanners appear to translate into more scans and more surgeries for enrollees.

by Jacqueline D. Baras and Laurence C. Baker

ABSTRACT: Magnetic resonance imaging (MRI) is a technology frequently used to evaluate low back pain, despite evidence that challenges the usefulness of routine MRI and the surgical interventions it may trigger. We analyze the relationship between MRI supply and care for fee-for-service Medicare patients with low back pain. We find that increases in MRI supply are related to higher use of both low back MRI and surgery. This is worrisome, and careful attention should be paid to assessing the outcomes for patients. [Health Aff (Millwood). 2009;28(6):w1133–40 (published online 14 October 2009; 10.1377/hlthaff.28.6.w1133)]

The number of magnetic resonance imaging (MRI) scanners in the United States more than tripled during 2000–2005, from 7.6 to 26.6 per million people.\(^1\,^2\) This rapid expansion has undoubtedly enabled more patients to receive advanced imaging that can produce valuable diagnostic information. However, it is not clear that all new MRI use is beneficial. MRI can be quite costly—state-of-the-art MRI units can cost $2 million or more. This raises questions about whether the benefits of expanding availability are sufficient to justify the costs.\(^3\,^4\)

This paper provides new information about the relationship between expanding MRI availability and the diagnosis and treatment of low back pain. Low back pain is the fifth most common reason for all physician visits in the United States.\(^5\) MRI is frequently used in the diagnosis of low back pain but is controversial.\(^6\) In particular, the value of using MRI early in the course of diagnosis and treatment of patients with new onset of low back pain is not clear.\(^7\) In these instances, MRI frequently detects low back abnormalities, and sometimes this information is valuable, but often the abnormalities detected are not the cause of the symptoms.\(^8\,^9\) Accordingly, low back MRI is sometimes implicated in treatment “cascades,” in which the use of advanced imaging produces findings that call for follow-up and set the stage for treatments, particularly back surgery, that are of uncertain efficacy for many patients.\(^10\,^11\)

In this paper we examine the relationship between MRI availability and the use of MRI and surgery in patients with low back pain. Specifically, we examine how changes over time in MRI availability in different geographic areas are associated with changes in the use of MRI and back surgery by Medicare patients with new episodes of care for low back pain in those areas.

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Study Data And Methods

- **Patient data.** We developed cohorts of traditional (fee-for-service) Medicare patients with low back pain using Medicare claims data from 1998–2005 for a 20 percent sample of these Medicare beneficiaries. We focused on patients who received care for nonspecific low back pain, which accounts for more than 80 percent of low back pain complaints and includes back pain associated with lumbar strains and sprains, degenerative disk disease, and spinal instability. MRI and surgery for patients with nonspecific low back pain are controversial and generally not recommended. We excluded other types of back pain, such as herniated disk and spinal stenosis, for which MRI and surgery may be beneficial.

- **Episodes of care.** To identify episodes of care for study, we searched the claims data for instances in which a patient had an evaluation with a primary diagnosis of nonspecific low back pain, following a one-year period without any visits for low back pain. We treated each such instance as an “index visit,” indicating the beginning of an episode of low back pain care. We then recorded whether or not each patient had any claims for a low back MRI scan or surgery within 30, 90, 180, and 365 days of the index visit.

- **MRI availability.** Data on MRI availability for each of 318 Metropolitan Statistical Areas (MSAs) were obtained from IMV Ltd., a private health care consulting firm that conducts regular surveys of facilities providing MRI. These data are widely used in the industry and have been used in previous publications. Based on three surveys conducted between November 1998 and early 1999, April 2002 and April 2003, and December 2003 and December 2004 (which we refer to as the 1999, 2002, and 2004 surveys), we computed the number of MRI units per one million population in each MSA each year.

- **Matching patients to MRI availability.** To match patient data to MRI availability data, we selected episodes that began in 1999, 2002, or 2004 and linked each episode to an MRI availability measure according to index-visit year and the MSA of the patient’s permanent residence. For analysis, we assigned each episode an MRI availability “quartile” based on the distribution across the three index-visit years of MRI availability per MSA.

- **Study methods.** To examine the relationship between the availability of MRI equipment and low back care, we used logistic regression analyses in which the dependent variable was an indicator of low back MRI or surgery receipt, and the key independent variable was the MRI availability quartile. These models controlled for a range of potential confounders including the patient’s age at the time of the index visit; sex, race, and ethnicity; diagnosis at index visit (degenerative disk changes, possible instability, strain/sprain, other); specialty of the index-visit physician (general/family medicine, internal medicine, neurology, orthopedic surgery, neurosurgery, chiropractic, anesthesia, physical medicine and rehabilitation, rheumatology, other); and type of index visit (outpatient, chiropractic, osteopathic, hospital inpatient, emergency department, other). The models also controlled for thirty comorbid conditions using the Elixhauser risk-adjustment approach, as well as the number of specialty surgeons, ambulatory surgery centers, and acute care hospital beds in each MSA each year, as identified from the 2005 Area Resource File.

The models also included dummy variables for index-visit year and MSA. The year dummies captured trends over time in MRI and surgery use that were common to all areas. The MSA dummies controlled for the underlying characteristics of MSAs, their health care providers, and their patients that were fixed over time. In essence, with the MSA and year fixed effects included, the results of our analysis were based on the effects of changes over time within each MSA.

We present regression results as odds ratios and, to aid in interpretation, as predicted probabilities. We constructed probabilities from the regression coefficients using sample mean values for the covariates and varying the indicator for MRI availability. The predicted probabilities thus provide comparisons of
MRI or surgery receipt for an average patient living in the first (lowest), second, third, and fourth (highest) quartiles of MRI availability.

**Study Findings**

Our final sample included 666,455 low back pain episodes, of which 15.6 percent resulted in low back MRI and 2.7 percent resulted in low back surgery within one year of the index visit.\(^{14}\)

MRI availability increased steadily over time. Across MSAs, the median number of MRI units per million population in 1999 was 13.3 (range 0–89.7). By 2004 the median had grown to 22.4 (range 0–157.5). Across the three years of analysis (n = 954), the median number of MRI units per million population per MSA was 17.4.

**MRI availability and use.** We found a clear relationship between MRI availability and MRI use for low back pain patients. The MSAs that had the largest growth in MRI units also had the largest growth in low back MRI procedures billed to Medicare. In Exhibit 1, each additional MRI added between 1999 and 2004 is associated with about eight additional MRI scans. Because our data derive from a 20 percent sample of Medicare beneficiaries, this implies about forty additional low-back MRI procedures per additional scanner among all traditional Medicare beneficiaries with nonspecific low back pain.

We also found that higher levels of MRI availability are statistically significantly associated with higher odds, as well as predicted probabilities, of receiving an MRI scan (Exhibit 2). The difference in probability between the highest and lowest quartiles of MRI availability is 1.1 percentage points at thirty days and grows only to 1.4 percentage points at 365 days, which suggests that most of the effect of MRI availability on low back MRI use becomes evident early in the course of treatment.

When we extrapolated our results to the entire population of traditional Medicare beneficiaries, we found that in 2004, 456,250 Medicare patients (91,250 patients in our 20 percent sample) with nonspecific low back pain lived in the highest MRI-availability areas. We estimate that these patients had a 17.2 percent chance of receiving an MRI within one year of their index visit. If, instead, these patients had lived in the lowest MRI-availability areas, this likelihood would have been only 15.1 percent.

**EXHIBIT 1**

Unadjusted Relationship Between Change In The Number Of Magnetic Resonance Imaging (MRI) Units And In The Number Of Low Back MRI Procedures Among Fee-For-Service Medicare Beneficiaries With Nonspecific Low Back Pain, 1999–2004

<table>
<thead>
<tr>
<th>Change in low back MRIs</th>
<th>800</th>
<th>600</th>
<th>400</th>
<th>200</th>
<th>0</th>
<th>-200</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in MRI units</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**SOURCE:** Authors’ calculations based on data from IMV Ltd. MRI site census data and the study sample derived from Medicare claims data; see text.

**NOTES:** Based on data from 318 Metropolitan Statistical Areas (MSAs). Low back MRI procedures per MSA include scans received by the study sample within 365 days of an index visit in 1999 and 2004. Correlation: 0.74.
EXHIBIT 2
Adjusted Odds And Probability Of Receiving Low Back Magnetic Resonance Imaging (MRI) According To MRI Availability, Among Fee-For-Service Medicare Beneficiaries

<table>
<thead>
<tr>
<th>Quartile of MRI availability at MSA level</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>At 30 days</td>
<td>Reference</td>
<td>1.06 (1.02–1.10)a</td>
<td>1.14 (1.09–1.19)a</td>
<td>1.17 (1.11–1.24)a</td>
</tr>
<tr>
<td>At 90 days</td>
<td>Reference</td>
<td>1.05 (1.01–1.08)a</td>
<td>1.11 (1.07–1.16)a</td>
<td>1.12 (1.07–1.18)a</td>
</tr>
<tr>
<td>At 180 days</td>
<td>Reference</td>
<td>1.04 (1.01–1.07)a</td>
<td>1.09 (1.06–1.13)a</td>
<td>1.10 (1.05–1.15)a</td>
</tr>
<tr>
<td>At 365 days</td>
<td>Reference</td>
<td>1.03 (1.01–1.06)a</td>
<td>1.08 (1.05–1.12)a</td>
<td>1.09 (1.04–1.13)a</td>
</tr>
</tbody>
</table>

**Predicted probability**

| At 30 days | 6.2% | 6.6% | 7.1% | 7.3% |
| At 90 days | 9.7  | 10.2 | 10.8 | 10.9 |
| At 180 days| 12.2 | 12.7 | 13.3 | 13.5 |
| At 365 days| 15.8 | 16.2 | 17.1 | 17.2 |

**SOURCE:** Authors’ estimations based on statistical models fit to IMV Ltd. MRI site census data, Medicare claims data, and the 2005 Area Resource File.

**NOTES:** MRI availability is calculated as the number of MRI units per one million population in each Metropolitan Statistical Area (MSA) per index-visit year. Results are based on logistic regression analyses relating changes in MRI availability to changes in low back MRI use. All models control for patient sex, age, race, and comorbidities at time of index visit; type of index visit; physician specialty and primary diagnosis at index visit; number of specialty surgeons, ambulatory surgery centers, and acute care hospital beds per MSA per year; and MSA and year fixed effects. All models had 666,455 observations. 95 percent confidence intervals are in parentheses.

1 Denotes p < 0.01 in a chi-square test of the hypothesis that the odds ratio is equal to 1.
2 Denotes p < 0.05 in a chi-square test of the hypothesis that the odds ratio is equal to 1.

areas, we estimate that they would have had a 15.8 percent chance, which translates to a difference of 6,388 low back MRI scans. If all Medicare low back pain patients in 2004 living in the second, third, and fourth MRI availability quartiles (n = 1,125,795) had instead lived in the lowest quartile, then 12,277 fewer low back MRI scans would have been performed.

MRI availability and use of surgery.

Exhibit 3 shows the unadjusted relationship between increases in MRI availability between 1999 and 2004 and increases in low back surgeries provided to our study sample within one year of an index visit in 1999 and 2004. It suggests a moderately strong correlation between MRI availability and the receipt of low back surgery. Adding an additional MRI scanner is associated with about one additional surgery in our sample, which suggests about five additional surgeries in the whole population of traditional Medicare patients with nonspecific low back pain.

Increases in MRI availability within an MSA are significantly associated with higher odds as well as higher predicted probabilities of surgery receipt (Exhibit 4). About 2.4 percent of patients in the highest MRI-availability areas received surgery within 365 days, compared to 2.0 percent in the lowest MRI-availability areas.

Extrapolating these results to the entire population of traditional Medicare beneficiaries, we estimate that 1,825 fewer back surgeries would have taken place if all low back pain patients living in the highest MRI-availability areas in 2004 had instead lived in the lowest MRI-availability areas. Similarly, 3,521 fewer surgeries would have occurred if all low back pain patients living in the second, third, and fourth MRI-availability quartiles in 2004 had instead lived in the first quartile.

Discussion

We found that increases in MRI unit supply are associated with increases in MRI use for nonspecific low back pain. Even after we
controlled for a wide range of patient characteristics and overall trends in MRI receipt, the areas that had the largest increases in MRI availability also had the largest increases in MRI use. Previous research has demonstrated a strong association between the supply of MRI facilities and high overall use and spending at the population level. Our study provides additional evidence for this relationship by linking MRI availability to increased use in a specific patient population.

The convenience factor. This study was not designed to address the reasons why expanding MRI availability is associated with higher MRI use. However, it is not difficult to believe that changes in MRI availability drive changes in the convenience with which MRI can be obtained. Easily available MRI may also, over time, lead physicians to adapt their practice patterns to more routinely incorporate MRI for a wider range of patients and thus lead to increases in use. Indeed, previous studies have associated increases in physician and hospital bed availability in an area with increases in medical services use, giving rise to the possibility that expanding supply can give rise to circumstances that generate demand for the new services.

Possible noncausal factors. At the same time, as in most retrospective claims studies of this type, unobserved confounders may be leading to observed relationships that are not causal. For example, if the populations of some areas have stronger preferences for using health care than others have, then this general demand could drive both the availability of MRI and its use. Although we cannot rule this out entirely, we believe that it is unlikely to be a major source of bias in our estimates. Our estimates are based on changes over time within MSAs, and thus they implicitly control for a wide range of factors such as preferences for care that tend to remain stable over time within areas.

Another possibility is that the unmeasured characteristics of the population, such as their health status, change more over time in some areas than in others. Although this may be pos-

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**EXHIBIT 3**

Unadjusted Relationship Between Change In The Number Of Magnetic Resonance Imaging (MRI) Units And In The Number Of Low Back Surgery Procedures Among Fee-For-Service Medicare Beneficiaries With Nonspecific Low Back Pain, 1999–2004

<table>
<thead>
<tr>
<th>Change in low back surgeries</th>
<th>Change in MRI units</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>100</td>
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<tr>
<td>80</td>
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<td>60</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>-20</td>
<td>-20</td>
</tr>
</tbody>
</table>

**SOURCE:** Authors’ calculations based on data from IMV Ltd. MRI site census data and the study sample derived from Medicare claims data; see text.  
**NOTES:** Based on data from 318 Metropolitan Statistical Areas (MSAs). Low back MRI procedures per MSA include surgeries received by the study sample within 365 days of an index visit in 1999 and 2004. Correlation: 0.48.
sible, the chance that there are strongly divergent trends in patient characteristics across areas in our study period seems small.

Connection to surgery. We also found that expanding MRI availability is associated with increased use of low back surgery. A natural interpretation of our results, consistent with other studies of low back pain treatment patterns, is that expanding MRI availability leads to increased use of MRI for low back pain, and the high frequency of incidental findings on MRI scans may induce a cascade of subsequent use of low back pain care, including surgery.19

As in the case of MRI use itself, other characteristics of areas, such as a preference of patients or doctors for back surgery requiring preoperative MRI, could lead some areas to have both higher surgery rates and more MRI availability than others. Because we studied changes over time within areas, implicitly controlling for underlying fixed characteristics of areas such as preferences, we believe that this is not likely to be a major source of bias.

Cost and value issues. Expanding the availability and use of MRI for low back pain patients, let alone increased use of surgery, is costly. High costs may, however, be worth it if the associated MRI scans or surgeries provide sufficient benefits, such as earlier diagnosis and reduced disability. In other fields of medicine, the effectiveness of new and expensive technologies has been used to argue that the overall gains from increased spending can often be worth the costs.20 On the other hand, there is concern that increased spending might not necessarily improve quality of care or outcomes.21, 22

In this light, findings that expanded MRI availability is associated with increased early use of low back MRI as well as surgery are worrisome. Since 1994, low back pain guidelines have recommended delaying MRI use for most patients for at least one month, because the natural history of more than 90 percent of
low back pain is spontaneous improvement within four weeks. Specifically, a large body of evidence challenges the usefulness of low back MRI and surgery for patients with new-onset, nonspecific low back pain. Certainly, patients’ and physicians’ preferences play a major role in the decision for early imaging or surgery, and it is therefore difficult to draw concrete conclusions about the motivation for these procedures in any given circumstance. However, the associations we observe should reinforce the need for careful attention to the pressures that expanding MRI availability can place on care for patients with low back pain.

Limitations. This analysis is subject to some limitations. This study used claims data, which do not contain information about patients’ and physicians’ preferences that could influence the delivery of care. Because we studied changes over time within MSAs, the effect of this limitation should be mitigated. The claims also lacked data on patients’ health and functional outcomes, so we were unable to directly ascertain the relationship between MRI availability and quality of care. Third, our data are limited to three years, and associations may vary over time. Finally, the relationships observed in the study are applicable to the traditional Medicare population and not necessarily to patients with private health plans that use different pricing and utilization management approaches to MRI.

Between 2000 and 2006 MRI was one of the fastest-growing sets of services paid for under the Medicare Part B physician fee schedule. If increased MRI availability is associated with increased early use of low back MRI as well as with subsequent use of low back surgery, both of which have questionable clinical benefit, then widespread MRI diffusion may put patients at risk for a decrease in the quality of care they receive. We hope that this study will contribute to the debate over how to restrain the growth of health care spending without reducing access to high-quality care. We believe that these results should give further impetus to policy efforts that would attempt to encourage more efficient MRI availability and use.

An earlier version of this paper was presented at the AcademyHealth Annual Research Meeting in Chicago, Illinois, June 2009. This work was funded by the Stanford University School of Medicine and the California HealthCare Foundation.

NOTES
14. Further information about cohort selection, the regression analysis, and patient demographic and clinical characteristics can be found in the online appendix at http://content.healthaffairs.org/cgi/content/full/healthaff.28.6.w1133/DC2.