
Magnetic Resonance Imaging Use by Primary Care Physicians

Robert A. Baldor, MD; Mark E. Quirk, EdD; and David Dohan

Worcester, Massachusetts

Background. Magnetic resonance imaging (MRI) has recently been introduced in the United States as an imaging technique for clinical use. Initially used by neurologists to view the brain stem, its indications have rapidly expanded to include spine, pelvis, bone marrow, and joints. This has raised concerns over the appropriate, cost-effective use of such an expensive technology. This paper examines MRI scanning patterns that have developed over time in central Massachusetts and surveys primary care knowledge, attitudes, and patterns of utilization.

Methods. The two MRI centers in central Massachusetts were surveyed for information about the number and types of scans ordered and the specialties of the physicians who ordered the scans. Questionnaires were sent to primary care physicians in Worcester County to assess knowledge and attitudes about MRI and utilization.

Results. The data demonstrate changing patterns of MRI utilization over time. Orthopedics has been the specialty with the greatest increase in use, now slightly surpassing neurology in the total number of scans ordered. Primary care physician use has doubled over this same period. Not all primary care physicians utilize MRI, but those who have used the technology have familiarized themselves with its indications and problems and have a better knowledge about its costs.

Conclusions. Utilization patterns of MRI have changed considerably in a short time, with primary care physicians requesting use of this new technology much more frequently than when it was first introduced.

Key words. Magnetic resonance imaging; referral and consultation; physicians' practice patterns; primary care.

J Fam Pract 1993; 36:281-285.

Magnetic resonance imaging (MRI) was introduced in the United States as an imaging technique for clinical use in 1980.¹ At that time it was primarily used by neurologists for scanning the brain stem. Within a short time, its use was expanded to studying the spine. By 1987, 82% of all MRI studies were of the head and spine.² Increasingly, MRI has been used to study other parts of the body outside the realm of neurology, such as the pelvis, bone marrow, and joints.³ Motion artifacts have precluded MRI from being useful in scanning other body sections (abdomen and chest), but this may change in the future.

Analysts have noted increasing use of technology, especially newer instruments, to be the most important factor in escalating health care expense.⁴ The latest exam-

ple of such new technology, MRI has one of the highest capital costs: the cost of a scanner installation approaches \$2 million, with annual operating costs of another \$1 million.^{5,6} Despite the cost, MRI has been hailed as the most exciting event in medical imaging since the introduction of radiographs, and called the diagnostic indicator par excellence for stationary, soft tissue.^{7,8}

When a new medical technology is first introduced into the health care system, it is difficult to predict the impact it will have as physician patterns of use and additional purposes for its use develop.⁴ The relatively recent introduction of MRI offers an opportunity to study the evolution of this new technology's use over time. In addition to broadening indications for scanning, recent evidence suggests that primary care physicians are making greater use of MRI. The adoption of MRI by primary care physicians may have a significant impact on the health care system.

With widespread use of this expensive technology, concerns over the appropriate, cost-effective use of MRI have been raised. In response to such concerns, some

Submitted, revised, September 28, 1992.

From the Department of Family and Community Medicine, University of Massachusetts Medical Center, Worcester. Requests for reprints should be sent to Robert A. Baldor, MD, Department of Family and Community Medicine, UMass Medical Center, 55 Lake Ave N, Worcester, MA 01655.

have argued that radiologists should play a gatekeeper role by carefully selecting only those patients who will most benefit from MRI.⁷ No evidence has been offered, however, that patients are not currently being carefully selected for scanning. Additionally, we have found no studies that assess primary care physicians' knowledge and utilization of MRI.

The purpose of this study was to determine how utilization of MRI by different specialists has changed during the first 3 years of its use in a central Massachusetts catchment area, and specifically to look at MRI use by primary care physicians. This was achieved by examining longitudinal data from the imaging centers. Specific questions to be answered concerned which specialties requested scans and what types of scans were ordered.

Information about primary care physicians' knowledge and attitudes toward MRI was also collected and was correlated with the utilization patterns. This information was obtained using a cross-sectional survey of primary care physicians in the same geographic catchment area as the MRI center.

Methods

Imaging Center Survey

The two imaging centers located in Worcester, in central Massachusetts, were surveyed. One began operation in early 1987 and has two 1.5 Tesla magnets. It is an independent outpatient center that is affiliated with three local hospitals. The other is a nonaffiliated, independent imaging center that has been open since July 1988. That center has a single 0.3 Tesla magnet. The survey considered the number and type of scans (head, spine, body, extremity) ordered and the specialty of the physician ordering the scan. All data have been expressed in percentages for the purpose of comparison.

Primary Care Physician Survey

Our sample included 124 primary care physicians defined as family practitioners, general practitioners, general internists, and pediatricians from Worcester County. Worcester County encompasses a population of approximately 800,000 people and is served primarily by the two outpatient MRI facilities in the city of Worcester.

To obtain the sample, a questionnaire was mailed to all 198 physicians from these disciplines who were listed in the Worcester County Yellow Pages telephone directory. Each physician's office was contacted by phone before the distribution of the survey to help ensure a high response rate. After the initial response, a second request to complete the questionnaire was mailed.

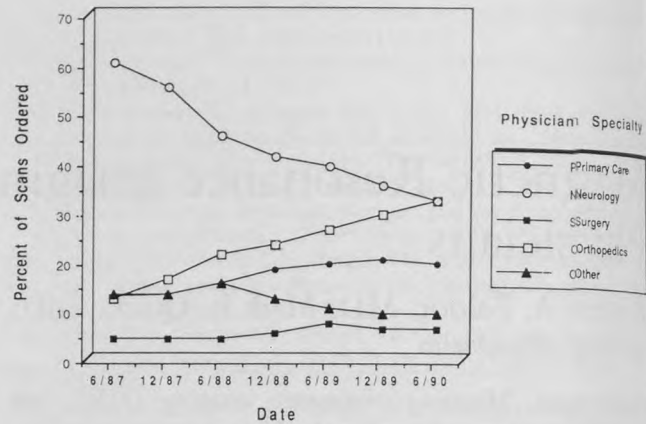


Figure 1. Percentage of total MRI scans ordered by physicians over a 3-year period.

The questionnaire was designed using a 5-point Likert-type scale (strongly agree to strongly disagree) to measure attitudinal responses to 14 items. These included familiarity with and perceived usefulness of MRI, as well as perceived "pressure" from patients to use this technology. The remaining questions assessed patterns of utilization and knowledge. Specifically, physicians were asked: (1) how often they ordered MRI scans or referred patients for scans; (2) what their estimate of the cost of a scan was; and (3) what considerations kept them from ordering a scan (eg, patient discomfort).

Responses to these questions are presented in percentages. In addition, Pearson r correlations have been used to examine the relationships between utilization behavior, knowledge about MRI, and attitudes toward MRI; t tests have been used to assess differences in attitudes and behaviors of physicians who accurately estimated the cost of an MRI scan (\$600 to \$1000) as compared with those who underestimated the cost (\$200 to \$500).

Results

Imaging Center Survey

The number of MRI scans ordered by physicians at the two MRI centers surveyed has increased steadily, from approximately 1300 during the last 6 months of 1987, when only one MRI facility was operating, to approximately 4500 during the first 6 months of 1990 at both centers. Neurologists originally ordered the majority of scans, but that percentage has decreased over time; orthopedics is the specialty that had the greatest increase in MRI use (Figure 1). Additionally, during this same period, the number of scans obtained by the primary care

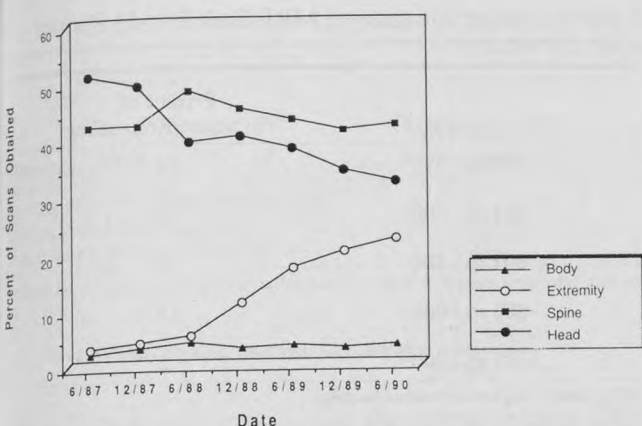


Figure 2. Percentage of each type of scan ordered by physicians over a 3-year period.

physicians surveyed increased more than fivefold (from 169 to 941 scans); and the proportion of scans obtained by primary care physicians in relation to the total number of scans obtained by all physicians in the study almost doubled (12% to 21%).

Changes in types of scans completed are shown in Figure 2. Over the period reviewed, the overall percentage of head scans decreased by about 20%, even though the total number of head scans almost doubled. Concurrent with the decreasing proportion of scans of the head, the number of scans of the extremities increased fivefold. The proportion of spinal scans remained constant, and the percentage of body scans, ie, chest and abdomen, remained very small.

As might be expected, neurologists ordered most of the head scans (59%) and orthopedists ordered most of the extremity scans (78%). Orthopedists' use of MRI changed from primarily obtaining spinal scans in 1987 to ordering slightly more extremity than spinal scans. Spinal scans were ordered by neurologists, orthopedists, and primary care physicians, in decreasing order. Body scans were ordered chiefly by primary care physicians, but these were ordered infrequently and accounted for only 4% of all scans.

The data showed that among family physicians and

internists, most scans ordered are of the spine, with head scans the second most commonly ordered and extremities the third. Pediatricians differ from the other two primary care groups in that they use MRI primarily for head scans.

Physician Questionnaire

Of the 198 primary care physicians included in the first mailing, 83 responded. A second mailing raised the total number of responses to 124 for a response rate of 63%.

Physicians were asked to indicate the number of their patients who had had MRI scans; the number of times they had personally ordered an MRI; and the number of times they had made a referral with the expectation that the specialist would order an MRI for the patient. The findings from our survey questionnaire on utilization of MRI by primary care physicians are presented in Table 1.

Nearly one third of the primary care physicians responding to our survey had not personally ordered an MRI scan in the past year. All physicians noted, however, that one or more of their patients had received an MRI scan. Twenty-one of the 124 physicians (17%) reported that more than 25 of their patients had had an MRI scan, but only 1% reported that they had personally ordered more than 25 scans. Only 17% of the respondents had not referred at least one of their patients to a specialist with the expectation that an MRI scan would be performed.

Physicians were asked about their attitudes toward ordering an MRI scan for their patients. Specific questions addressed their familiarity with MRI; their concerns about cost and patient discomfort; and whether patients had pressured them to have an MRI scan. Findings regarding the physicians' attitudes toward ordering MRI scans are presented in Table 2. Nearly one half of all physicians indicated that cost inhibits them from ordering an MRI scan; only a minority were influenced by concerns about patient discomfort. Nearly 40% acknowledged that unfamiliarity with the technology affected

Table 1. Responses of 124 Primary Care Physicians Concerning the Number of Patients in Their Practice Who Had Received an MRI Scan in the Past Year

Physician Response	Number of Patients Scanned				
	0	1 to 5	5 to 15	15 to 25	>25
Have patients in practice who have had an MRI scan, %	0	28	39	17	17
Have personally ordered MRI scans for patients, %	29	43	20	7	1
Have referred patients with the expectation of an MRI scan being ordered, %	17	54	21	6	2

MRI denotes magnetic resonance imaging.

Table 2. Attitudes of 124 Primary Care Physicians Regarding the Ordering of MRI in Response to Survey Questions

Physician Response	Agree*	Unsure	Disagree
Cost inhibits my ordering MRI, %	45	7	48
Patient discomfort makes me less likely to order, %	16	16	67
My unfamiliarity affects ordering of MRI, %	38	12	50
Patients have pressured me for an MRI, %	24	2	74

*Three-point scale is based on the 5-point Likert-type scale used in the physician questionnaire.

MRI denotes magnetic resonance imaging.

their use of MRI. One quarter of those surveyed indicated that patients had pressured them to order an MRI scan. These physicians tended to refer patients to a specialist with the understanding that they would receive an MRI rather than order MRI scans themselves ($P = .07$).

Physicians were asked to indicate whether they believed that MRI was useful for their practices; how they thought it compared with other imaging techniques; and whether they would use it in place of other imaging modalities. Data on the perceived usefulness of MRI to primary care physicians are presented in Table 3.

As indicated in the table, although nearly two thirds of the physicians agreed that MRI is useful to their practices, almost one half believed that computed tomography (CT) or other imaging techniques are as useful as MRI. One third of our primary care sample, however, believed that they would be using MRI in the future in place of other imaging techniques.

Physicians were also asked to estimate the costs of MRI. Cost estimates in five categories are presented in Table 4. The mean response was \$669. The responses ranged from \$200 to \$1500. Four physicians estimated the cost of an MRI scan at \$200, whereas two estimated it at \$1500.

Correlational data revealed relationships between

Table 3. Opinions of 124 Primary Care Physicians Regarding Usefulness of MRI

Physician Opinion	Agree*	Unsure	Disagree
MRI is useful for my practice, %	65	13	22
CT scan or other imaging techniques are as useful, %	45	19	36
I will replace other imaging techniques with MRI, %	37	28	35

*Three-point scale is based on the 5-point Likert-type scale used in the physician questionnaire.

MRI denotes magnetic resonance imaging; CT, computed tomography.

Table 4. Cost of Estimates of MRI Made by 124 Primary Care Physicians

Cost estimate (\$)	Percent of Physicians Responding
200 to 400	24
401 to 600	26
601 to 800	36
801 to 1000	12
1001 to 1500	2

MRI denotes magnetic resonance imaging.

utilization patterns and attitudes (Table 5). Physicians with more patients who had had MRI scans, as well as those who personally ordered or referred patients for MRI, felt that MRI was more useful than physicians who had ordered fewer scans believed it to be. They were also more likely to agree that the results of the scan made a difference in patient care. Further, those who personally ordered more scans disagreed that unfamiliarity with MRI affected their ordering and with the statement that CT is as useful as MRI. Interestingly, those who were more familiar with MRI or more likely to refer patients for MRI were also more likely to agree that cost inhibited their ordering. Only physicians who were more familiar with MRI indicated that patient discomfort inhibited their ordering. In this regard, those physicians who were more familiar with MRI were more likely to agree that cost and patient discomfort inhibited their ordering of MRI scans ($r^2 = .31$, $P < .01$; and $r^2 = .28$, $P < .01$, respectively). Physicians who acknowledge unfamiliarity with MRI order fewer scans than those who are familiar with its use.

In addition, physicians were divided into two groups, those who accurately assessed cost and those who did not. Those physicians who accurately assessed cost had more patients who received an MRI scan ($t^2 = 3.46$; $P = .001$); however, they were also more likely to agree that cost inhibited them from ordering an MRI ($t^2 = 2.15$; $P = .03$).

Discussion

The present findings from the MRI facility survey support the assumption that utilization patterns of new technologies develop over time. Initially used as a neurologist's imaging technique for scanning the head, MRI is now used more by orthopedic specialists to examine the spine and extremities. Although neurology is a close second behind orthopedics, primary care physicians' use

Table 5. Correlations Between Physician Utilization of MRI and Physician Attitudes and Knowledge About MRI*

Utilization of MRI	Attitude				Knowledge
	Is Useful in Making Diagnosis	Makes a Difference in Patient Care	Is More Useful Than CT	Cost Inhibits Ordering	Greater Familiarity with MRI
Has patients who have received MRI	.32†	.26†	—	—	—
Has ordered MRI in past year	.24‡	.21‡	.26†	—	.21‡
Has referred patients for MRI	.21‡	.23‡	—	.23†	—

*Correlations indicate that greater utilization is related to greater knowledge and more positive attitudes.

†P < .01.

‡P < .05.

MRI denotes magnetic resonance imaging; CT, computed tomography.

of MRI has steadily grown over the period studied. This increase in use by primary care physicians has affected overall utilization patterns and ultimately will affect the cost of health care. In this regard, the majority of primary care physicians surveyed felt that MRI was useful to their practice, and half of this group indicated that they would use MRI to replace other imaging techniques. These feelings were strongest among those who already exhibited greater use of MRI, suggesting increasing use of MRI by primary care physicians in the future. However, given that all responding physicians had at least one patient who received an MRI scan, we may not be able to generalize these findings to the entire population.

The findings also suggest that increasing use by primary care physicians may be accelerated by patient pressure to order an MRI scan. This is supported by a trend observed in the present study that showed that those physicians who were pressured by patients tended to refer more patients with the understanding that they would receive an MRI. Patient demands for the latest technology will certainly have an impact on future health care costs and utilization.

MRI represents the latest in expensive health care technology, and is one of the most important factors of escalating health care costs.⁴ Previous surveys have shown that many physicians have minimal awareness about the costs for other, more commonly used imaging modalities, such as CT scans.⁹ Our data support this observation, with a wide range of MRI cost estimates given by our physician respondents. Despite this general lack of knowledge about MRI costs, those primary care physicians who ordered more MRI scans were more accurate in their estimations of cost than those who made less use of this new technology. In addition, physicians who made greater use of MRI were more likely to agree that cost inhibited them from ordering even more scans.

The findings indicate that primary care physicians who utilize MRI scanning most are those who have

familiarized themselves with its indications and problems. One might infer from these findings that primary care physicians can play an important gatekeeper role in assuring prudent use of MRI. Future studies should directly address this issue by examining knowledge about indications and costs benefits of MRI in relation to patient outcomes in primary care settings. The data also suggest that strategies for educating primary care physicians who are less familiar with MRI need to be developed and implemented. This will ensure responsible utilization of MRI by primary care physicians in the future.

Acknowledgment

The authors are grateful to Linda Hollis for her assistance in preparing the manuscript.

References

1. Steinberg EP, Sisk JE, Locke KE. X-ray CT and magnetic resonance imagers: diffusion patterns and policy issues. *N Engl J Med* 1985; 313:859-64.
2. Evens RG, Evens RG Jr. Economic and utilization analysis of MR imaging units in the United States in 1987. *Radiology* 1988; 166:27-30.
3. Hinshaw DB Jr. Magnetic resonant imaging vs x-ray computer tomography: which is the appropriate first imaging examination? *West J Med* 1989; 151:569-70.
4. Hillman BJ. Government health policy and the diffusion of new medical devices. *Health Serv Res* 1986; 21:681-707.
5. Steinberg EP, Anderson GF, Steinwachs DM. Changes in CT utilization between 1981 and 1984: implications for Medicare payment for MR imaging under the prospective payment system. *Radiology* 1987; 165:279-81.
6. Evens RG, Jost GR, Evens RG Jr. Economic and utilization analysis of magnetic resonance imaging units in the United States in 1985. *Am J Radiol* 1985; 145:393-8.
7. Bradley WG Jr. Comparing costs and efficacy of MRI. *Am J Radiol* 1986; 146:1307-10.
8. Allen PS. Symposium on magnetic resonance imaging and spectroscopy honoring Andrei Sakharov. *J Can Assoc Radiol* 1990; 41:1.
9. Wilkinson R. Physicians shed light on marketing MR. *Hospitals* 1987; Nov 5:72-4.