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Abbreviations:

HMO = health maintenance organization
 IPA = independent practice association

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Relative Procedure Intensity with Self-Referral and Radiologist Referral: Extremity Radiography¹

PURPOSE: To compare the relative use of bilateral versus unilateral extremity radiographic examinations when patients are referred to radiologists for imaging (radiologist referred) versus when studies are performed in the referring physician's office (self-referred).

MATERIALS AND METHODS: We reviewed 1 year of claims data for extremity radiographic examinations performed by a referring physician or referred to a radiology facility and claims data for related patient office visits. Data were analyzed for orthopedics, podiatry, and rheumatology, and data were divided by the practice pattern of the referring physician into pure self-referring, pure radiologist-referring, and mixed-referring categories. We compared the percentage of unilateral and bilateral studies and the number of unilateral and bilateral studies per 100 office visits in each setting. Statistical analysis of each comparison was performed with a one-tailed Z test.

RESULTS: A total of 13 094 (14%) self-referred studies were bilateral, while 778 (10%) radiologist-referred studies were bilateral ($P < .001$). The rate of self-referred bilateral examinations was 2.21 times higher per 100 office visits than the rate of radiologist-referred bilateral examinations. Combined bilateral and unilateral use by self-referrers was only 1.86 times higher than use by radiologist-referrers. Orthopedists had no clinically meaningful difference in the percentage of self-referred and radiologist-referred bilateral studies, but they ordered 1.98 times as many studies per 100 visits when they self-referred studies. Self-referring podiatrists and rheumatologists ordered bilateral studies up to 3.25 times more frequently than did their radiologist-referring colleagues. Mixed-referring podiatrists had 2.70-times increased use of bilateral examinations when performing imaging in their offices, whereas mixed-referring rheumatologists had 6.40-times increase in that setting.

CONCLUSION: Orthopedists, podiatrists, and rheumatologists use extremity radiography at a higher rate when they self-refer. Moreover, self-referring podiatrists and rheumatologists order radiographic examinations of increased intensity compared with radiologist-referring physicians.

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After several years of restrained growth, spending on health care in the United States has resumed its rapid rise (1–3). Radiology and imaging use and costs are reportedly growing even faster (4). This disturbing trend has renewed interest in evaluation of the necessity and appropriateness of imaging examinations and in the potential financial incentives that may prompt overuse in certain clinical settings (5–7).

Several studies over the past 30 years have demonstrated that ownership of imaging equipment, imaging facilities, or both by referring physicians may create financial interests that lead to increased use of imaging procedures (6,8–13). Physicians who refer patients to radiologist- or hospital-owned imaging facilities (radiologist-referrers) order imaging examinations less frequently than do physicians who perform imaging examina-

tions in their own offices (self-referrers). Research also shows that the imposition of imaging guidelines or “privileging” rules, which allow only certain physician specialists to perform specific imaging examinations, can lower cost and improve quality (14,15).

Previously published literature on the subject of self-referral has been largely limited to an examination of the overall number of studies performed in the ordering physician’s office versus the number of studies referred to a radiologist. The type or intensity of the service provided has received less attention. The “intensity” of the examination is a measure of the amount of resources (measured as relative value units, costs, etc) that are used in each incident of health care. For example, a magnetic resonance examination of the knee has a higher intensity than a bilateral knee radiographic study, which in turn has a higher intensity than a unilateral knee radiographic study. In general, studies with a higher intensity are reimbursed at a higher rate.

One might expect that the same financial interests that promote increased use of imaging among physicians who self-refer patients could also produce a higher level of intensity in the self-referred examinations. To test this hypothesis, our study was undertaken to compare the relative use of bilateral versus unilateral extremity radiographic examinations when studies are referred to radiologists for imaging versus when studies are performed in the referring physician’s office.

MATERIALS AND METHODS

Independent Practice Association

A large health maintenance organization, or HMO, in the Greater New York metropolitan area contracted with a radiology independent practice association, or IPA, to manage its outpatient imaging costs. The individual radiology providers (radiologists or radiology facilities) and the nonradiologist physicians were paid a global (technical and professional) fee for each imaging examination performed and interpreted. Although the radiology IPA was responsible for the overall imaging costs, the participating physicians—both radiologists and nonradiologists—had no incentive to control costs, as all physicians were paid on a fee-for-service basis; that is, the more studies they performed and interpreted, the more they were reimbursed.

As part of the IPA’s management effort,

TABLE 1
Procedure Codes and Definitions

Procedure Code	Definition
73020	Radiologic examination, shoulder; one view
73030	Radiologic examination, shoulder; complete, minimum of two views
73070	Radiologic examination, elbow; two views
73080	Radiologic examination, elbow; complete, minimum of three views
73100	Radiologic examination, wrist; two views
73110	Radiologic examination, wrist; minimum of three views
73120	Radiologic examination, hand; two views
73130	Radiologic examination, hand; minimum of three views
73560	Radiologic examination, knee; one or two views
73562	Radiologic examination, knee; three views
73564	Radiologic examination, knee; complete, four or more views
73565	Radiologic examination, both knees; standing, anteroposterior view
73600	Radiologic examination, ankle; two views
73610	Radiologic examination, ankle; complete, minimum of three views
73620	Radiologic examination, foot; two views
73630	Radiologic examination, foot; minimum of three views

guidelines were developed that prescribed which nonradiologist physicians would be compensated for the performance and interpretation of certain imaging studies in their office. For example, internists and primary care physicians were only compensated for performing chest radiographic studies and were not reimbursed for performing any other imaging studies. Only orthopedists, podiatrists, and rheumatologists were privileged to perform extremity radiography in their offices. Within those three specialties, some individual physicians elected to perform all imaging studies at their own facility, some chose to refer all imaging studies to an outpatient radiology facility or a hospital radiology department, and some performed some imaging studies at their own facility and referred other imaging studies to radiologic facilities. Billing by these privileged specialists and by the radiology facilities was performed by using the American Medical Association’s Current Procedural Terminology code (16). Reimbursement to all providers (nonradiologists and radiologists) involved a previously negotiated fee schedule that paid more for bilateral extremity examinations than for unilateral extremity examinations.

Data Collection

Data were made available to us via the HMO after removal of identifying information, so as to ensure individual patient and physician anonymity. We (A.W.L., D.B., K.N.P.) analyzed outpatient radiology procedure claims data for dates of service during the period of January 1, 2001, through December 31, 2001, and date of claims submission through June

30, 2002. The 6-month extension on claims submission after the date of service minimized any bias from late claims filed by providers. During the period analyzed, the HMO–radiology IPA contract covered an average of 1 013 186 HMO plan members. Claims for the 15 current procedural terminology codes corresponding to the extremity radiography codes were analyzed (Table 1). Bilateral examinations were distinguished from unilateral examinations by use of a “bilateral modifier –50” on the current procedural terminology code, by two current procedural terminology codes of the same type on the same day, or by the use of left and right modifiers on two of the same current procedural terminology codes on the same day. This study only included outpatient examinations; in-patient, emergency room, and ambulatory surgery facility examinations were excluded, as they were not covered in the IPA contract and data were not available for review.

On the basis of the identification of the provider who performed the study, studies were divided into two groups: “Self-referred examinations” were studies performed by the referring provider in his or her office, and “radiologist-referred examinations” were studies performed in a radiology facility. For radiologist-referred examinations, we identified the physician who referred the study on the basis of the referring physician’s identification number on the procedure billing claim or, if such documentation was lacking, with an office visit to that specialist within 60 days prior to the study. In 2594 (2.5%) studies, we could not identify the referring physician with the claims data

TABLE 2
Self-referred and Radiologist-referred Examinations by Provider Specialty

Specialty	Bilateral	Unilateral	Total
Self-referred examinations			
Orthopedics	5583 (9)	58 975 (91)	64 558
Podiatry	6263 (24)	20 036 (76)	26 299
Rheumatology	1248 (59)	874 (41)	2122
Total	13 094 (14)	79 885 (86)	92 979
Radiologist-referred examinations			
Orthopedics	538 (8)	6426 (92)	6964
Podiatry	41 (10)	368 (90)	409
Rheumatology	199 (30)	475 (70)	674
Total	778 (10)	7269 (90)	8047

Note.—Data are number of examinations. Data in parentheses are percentages.

or a recent office visit, and these claims were excluded from further analysis.

The referring specialists were then classified into three groups: those who always performed extremity radiography in their office (pure self-referrers), those who always referred the patient to either a radiology facility or a hospital imaging facility (pure radiologist-referrers), and those who performed some studies in their office and referred some studies to radiology facilities (mixed-referrers). Examination data were then classified according to these three categories, with each examination assigned to the category of the specialist who ordered it.

We also obtained HMO claims data for outpatient visits to orthopedists, podiatrists, and rheumatologists for the same time period as the imaging examination data (January 1, 2001, through December 31, 2001, with claims filed by June 30, 2002). Imaging utilization data were then correlated with visit data on the basis of the referring provider's identification number.

Statistical Analysis

Appropriate Z tests were used to determine statistical significance of an increase or decrease between specified proportions. For example, a one-tailed test was used to determine whether the proportion of bilateral examinations among self-referred cases was larger than the proportion of bilateral examinations among radiologist-referred cases. The one-tailed test was used to compare overall proportions of self-referred versus radiologist-referred cases, bilateral self-referred cases versus bilateral radiologist-referred cases, and unilateral self-referred cases versus unilateral radiologist-referred cases. The one-tailed Z test was used to compare the total percentage of self-referred office visits in which imaging was used with the

total percentage of radiologist-referred office visits in which imaging was used.

RESULTS

Among the three specialties privileged to perform in-office extremity radiography, 1784 orthopedists, 1425 podiatrists, and 103 rheumatologists self-referred and/or radiologist-referred patients for extremity imaging.

Orthopedists, podiatrists, and rheumatologists ordered a total of 101 026 extremity radiographic examinations during the 1-year period; 92 979 studies were performed in the referring provider's office (self-referred), and 8047 studies were referred to outpatient radiology centers or hospitals (radiologist-referred).

Self-referred and Radiologist-referred Studies

Of the self-referred studies, 79 885 (86%) were unilateral and 13 094 (14%) were bilateral (Table 2). Of the radiologist-referred studies, 7269 (90%) were unilateral and 778 (10%) were bilateral; thus, self-referred bilateral studies were performed more frequently than radiologist-referred bilateral studies ($P < .001$). Of the self-referred examinations performed by podiatrists, 24% were bilateral, whereas 10% of radiologist-referred examinations performed by podiatrists were bilateral ($P < .001$). The relative increase in bilateral studies in the podiatrists' self-referred situation was 140%. Rheumatologists ordered bilateral studies in 59% of extremity examinations performed in their office and 30% of examinations referred to a radiology facility. The relative increase in bilateral studies in the rheumatologists' self-referred situation was 97% ($P < .001$). There was a statistically significant difference in the

percentage of bilateral studies ordered by orthopedists (9% when self-referred and 8% when radiologist-referred) ($P = .003$); however, this difference was not clinically meaningful.

Self-Referrers and Radiologist Referrers

Two physician categories (pure self-referrers and pure radiologist-referrers) were then compared on the basis of imaging examinations per 100 visits (Table 3). The total number of extremity radiography studies ordered per 100 office visits to self-referrers (32 examinations) was almost twice as high as the number of studies ordered per 100 visits to radiologist-referrers (17 examinations) ($P < .001$). Among the specialists who only self-referred examinations, there were 28 associated unilateral radiography studies per 100 visits and five bilateral radiography studies. In the radiologist-referred situation, there were 15 unilateral and two bilateral radiography studies per 100 visits. Thus, both bilateral and unilateral studies were far more common among self-referrers than among radiologist-referrers ($P < .001$ for both types of study). Moreover, while the overall use of imaging per visit was 1.86 times greater in the self-referred situation, the rate of bilateral examinations per visit was 2.21 times greater in the self-referred situation (Table 4).

In these two categories, there was also a substantial variation according to specialty. Self-referring orthopedists had a unilateral imaging rate that was 1.98 times greater than that of radiologist-referring orthopedists and a bilateral imaging rate that was 2.00 times greater than that of radiologist-referring orthopedists (no meaningful difference between 1.98 and 2.00). Self-referring rheumatologists had a unilateral imaging rate that was 1.86 times greater than that of radiologist-referring rheumatologists and a bilateral imaging rate that was 3.25 times greater than that of radiologist-referring rheumatologists. Similarly, self-referring podiatrists had a unilateral imaging rate that was 1.58 times greater than that of radiologist-referring podiatrists and a bilateral imaging rate that was 3.00 times greater than that of radiologist-referring podiatrists.

Mixed Referrers

Review of the data from mixed-referrers (Table 5) shows a pattern according to specialty similar to that seen in each of

TABLE 3
Imaging per Visit by Provider Specialty in Self-referrers and Radiologist Referrers

Specialty	No. of Providers	No. of Office Visits	Bilateral Studies	Unilateral Studies	Imaging Studies per 100 Office Visits		
					Bilateral	Unilateral	Total
Self-referrers							
Orthopedics	1600	101 127	3694	40 360	4	40	44
Podiatry	1338	105 812	5757	18 018	5	17	22
Rheumatology	47	5735	537	539	9	9	19
Total	2985	212 674	9988	58 917	5	28	32
Radiologist referrers							
Orthopedics	180	14 467	264	2910	2	20	22
Podiatry	53	1215	22	131	2	11	13
Rheumatology	71	6245	180	315	3	5	8
Total	304	21 927	466	3356	2	15	17

Note.—Unless otherwise indicated, data are number of studies.

TABLE 4
Relative Rate of the Use of Extremity Imaging in Self-referrers and Radiologist Referrers

Specialty	Self-Referral		Radiologist Referral		Relative Rate of Office Visits in Self-referrers vs Radiologist Referrers		
	Office Visits with Bilateral Imaging	Office Visits with Unilateral Imaging	Office Visits with Bilateral Imaging	Office Visits with Unilateral Imaging	Bilateral	Unilateral	Total
	Orthopedics	4	40	2	20	2.00	1.98
Podiatry	5	17	2	11	3.00	1.58	1.78
Rheumatology	9	9	3	5	3.25	1.86	2.37
Total	5	28	2	15	2.21	1.81	1.86

Note.—Data are percentages.

TABLE 5
Mixed-Referral Physicians: Self-referred and Radiologist-referred Imaging

Specialty	No. of Providers	Office Visits	Self-referred Bilateral Studies	Self-referred Unilateral Studies	Bilateral Studies of Total Self-referred Studies (%)	Radiologist-referred Bilateral Studies	Radiologist-referred Unilateral Studies	Bilateral Studies of Total Radiologist-referred Studies (%)	Ratio of Bilateral Imaging in Self-referral Compared with Radiologist Referral
Orthopedics	257	54 307	1889	18 615	9	274	3516	7	1.27
Podiatry	78	13 773	506	2018	20	19	237	7	2.70
Rheumatology	35	5037	711	335	68	19	160	11	6.40
Total	370	73 117	3106	20 968	13	312	3913	7	1.75

the pure categories. Overall, there is no meaningful difference for orthopedists in the percentage of bilateral studies between self-referred and radiologist-referred examinations. However, mixed-referrer podiatrists ordered a much higher percentage of bilateral studies when they performed studies in their own office rather than when they referred studies to a radiologist (20% vs 7%, 2.70-times increase, $P < .001$). The mixed-referrer rheumatologists also ordered bilateral

imaging at a higher frequency when they performed examinations in their office (68% vs 11%, 6.40-times increase, $P < .001$) than when they ordered examinations to be performed by a radiologist.

DISCUSSION

Radiologists perform fewer than 40% of all outpatient imaging studies and fewer than 14%–22% of outpatient extremity

radiography studies (17,18). In fact, the proportion of imaging studies performed by radiologists compared with other specialties is declining (19). Moreover, an extensive search of the literature dating back over 3 decades documents the increased use of imaging examinations by nonradiologist physicians who own imaging equipment or have a financial interest in the provision of such imaging services (6,8–13). A 1990 report by Hillman et al (11) showed a 4.0–4.5-times

increase in the frequency of self-referred imaging compared with radiologist-referred imaging.

The report by Hillman et al (11) also documented a threefold increase in the incidence of spine radiography in the evaluation of patients with low back pain when comparing data of patients imaged in an orthopedist's office with data of patients referred to a radiologist for imaging. Other specialty differences in increased use of imaging in the self-referral situation were noted, as well (11). Additional data are available from the U.S. General Accounting Office study (13), in which complex radiography use was compared with simple radiography use in both the self-referred and the radiologist-referred settings. This study (13) found a 3.24-times greater use of complex radiography and a 1.86-times greater use of simple radiography by orthopedists. There was also a 6.04-times increased use of simple radiography by podiatrists. Complex radiography by podiatrists and imaging by rheumatologists were not studied. Moreover, the study did not elaborate on the definitions of complex and simple radiography, and all radiographic studies were included.

In response to previous reports of increased use of imaging among physicians who have investments in outside imaging facilities, both state and federal legislation have limited the ability of physicians to invest in outside facilities to which they refer patients. In general, however, such legislation has exempted imaging performed in the referring physician's office as part of his or her practice.

The current study reaffirms the findings of Hillman et al (11) and the U.S. General Accounting Office (13) by demonstrating an overall doubling in the frequency of extremity imaging per office visit among self-referring physicians compared with radiologist-referring physicians. The prior studies showed a ratio of imaging use in the self-referred environment that was even more elevated (3–4 times) than that shown in this study (2 times). This difference might result from the application of the IPA's privileging rules, which only permitted the three specialty physicians to perform certain types of radiographic examinations in their offices.

The most important contribution of our study is the examination of the intensity of imaging services provided by self-referring and radiologist-referring physicians. The overall use of bilateral imaging was 40% higher (14% vs 10%) in

the self-referred setting than in the radiologist-referred setting. Thus, while overall imaging per visit was about twice as high for self-referring physicians as for radiologist-referring physicians, the increase in bilateral imaging was substantially greater. This demonstrates a preference for more intense and, hence, more highly remunerative examinations when studies are performed in the referring physician's office.

The difference by specialty in the relative increase of bilateral examinations among self-referring physicians was particularly interesting. Among orthopedists, the increase in bilateral and unilateral examinations in the self-referred setting was the same; there was a doubling. The other specialties had a significantly different increase in the usage profile: Podiatrists had an increase in bilateral examinations of 3.00 times in the self-referred versus radiologist-referred settings and an increase in unilateral examinations of 1.58 times in the two settings. Rheumatologists demonstrated a similar trend, with an increase in bilateral examinations of 3.25 times in the self-referred versus radiologist-referred settings and an increase in unilateral examinations of 1.86 times in the two settings.

The documentation of increased intensity of imaging adds a new dimension to the previous understanding of increased use in the self-referral environment. This should be of substantial interest to regulatory and reimbursement agencies and to the employers that pay for health care in the United States. While our data do not make it possible to state definitively the underlying cause for this increased intensity, several explanations can be postulated.

Previous authors have suggested that financial incentives to health care providers are the driving force for the increased use of imaging in the self-referral setting (8,11,18,20). Financial incentives could be a motivation in the increased intensity of imaging, as well. Bilateral examinations are reimbursed at double the rate of unilateral examinations, and the marginal cost of the study of the second extremity is limited to additional film costs and additional physician time for interpretation. The fixed costs of equipment, space, and staff remain the same.

An alternative or additional explanation would be that nonradiologist physicians lack confidence in reviewing extremity radiographs and wish to compare the extremity suspected of being unhealthy with the contralateral healthy

one. A previous study examined the confidence of emergency physicians in their interpretations and found them to be confident in only 58% of their interpretations (21). While this study did not specifically address the issues of extremity radiographs or the three referring specialties we studied, similar questions regarding lack of confidence may apply. If the contralateral extremity was imaged solely for comparison with the symptomatic extremity, this would suggest that these physicians are less confident in their interpretation of such images and need the support of the comparison.

We did not obtain any data that could shed further light on the question of interpretation confidence because the reports of the imaging examinations were not reviewed. One could, however, hypothesize that this lack of confidence could arise from poor technical image quality in the self-referral situation. A quality audit by another insurer demonstrated unacceptable quality of foot and ankle images in 82% of studies performed by podiatrists, 7% of studies performed by orthopedists, and 1% of studies performed by radiologists. Another study also demonstrated 82% of examinations performed by podiatrists to be unacceptable, although the rate of poor-quality examinations performed by orthopedists and radiologists was not significantly different (13% and 12%, respectively) (20). Finally, another insurer performed inspections of radiographic facilities in multiple specialists' offices and found that only 47% of podiatrists were able to meet established technical criteria. A total of 81% of orthopedists offices and 96% of radiologic facilities passed the inspection (15).

Another possible explanation for the difference in bilateral use is that physicians who have their own imaging equipment see more complicated patient conditions involving both extremities at a higher rate than those who refer their patients to a radiologist. We have controlled for possible differences in patient complexity across specialties, however, by directly comparing physicians within each specialty. Also militating against this explanation is the large number of academic medical centers in the covered region. Physicians practicing in academic medical centers tend to care for patients with more complex conditions and typically refer their patients to the radiology department of those centers. Thus, in the geographic area studied, the conditions of the self-referred patients are likely, if

anything, to be simpler than those of the radiologist-referred patients.

Some might argue that because arthritic conditions are systemic diseases that often affect multiple joints, rheumatologists may reasonably be ordering bilateral examinations more often than orthopedists. While this may be true, it would not explain why rheumatologists who self-refer such examinations order bilateral studies 3.25–6.40 times more frequently than those who refer such examinations to a radiology facility.

Advocates of self-referral often claim the inconvenience of sending a patient to a radiologist discourages necessary imaging. Thus, they claim usage levels seen with in-office self-referral are appropriate, while those seen with referral to a radiologist represent underuse (6). No such explanation involving patient and physician convenience can rationalize the finding that the percentage of bilateral examinations is higher among self-referred studies than among radiologist-referred studies. Once the patient is referred to a radiology facility to undergo imaging, it is no more or less convenient to perform a bilateral examination than a unilateral one. Strictly from a convenience perspective, the proportion of bilateral and unilateral examinations should be the same in both the self-referred and radiologist-referred settings.

There has been little previous specific evaluation of the differences in imaging intensity between the self-referred and radiologist-referred environments. A study by Levin et al (22) examined the rapid increase in the use of myocardial perfusion imaging performed by both cardiologists and radiologists. They found a tenfold higher rate of growth in the cardiologist's office than in either the hospital setting or the radiologist's office. Of note was a difference in the use of add-on codes (wall motion analysis and ejection fraction analysis codes) in myocardial perfusion imaging. The cardiologists added on higher intensity codes 1.8–2.0 times more frequently than did radiologists. This supports the conclusion of the current study that physicians who perform self-referred imaging are likely to perform higher-intensity, more complex examinations.

Like all studies, ours has limitations. The data are all from one geographic location, the greater New York metropolitan area; thus, the findings may not be

applicable to the entire United States. Similarly, our information deals only with extremity radiography; thus, it may not be applicable to all types of imaging.

Because of limitations in the data, we did not identify the physicians responsible for referring 2.5% of the examinations. This made no difference in the analysis of self-referred versus radiologist-referred examinations because all examinations are identified in this respect.

Finally, because we only reviewed insurance claims data, we could analyze neither the indication for nor the results of each examination. Further studies to evaluate the indications for an examination and review the imaging reports may be useful.

In conclusion, this report reconfirms the data of previous studies regarding the increased use of imaging studies in the self-referred situation and presents new evidence that such increased imaging is of a higher intensity and greater cost. Further research into the cause or causes of this differential is warranted.

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References

1. Aaron HJ. The unsurprising surprise of renewed health care cost inflation. *Health Aff (Millwood)* 2002; Jul-Dec(suppl Web exclusives):W85–W87.
2. Altman SH, Tompkins CP, Eilat E, Glavin MP. Escalating health care spending: is it desirable or inevitable? *Health Aff (Millwood)* 2003; Jan-Jun(suppl Web exclusives):W3–W14.
3. Strunk BC, Ginsburg PB, Gabel JR. Tracking health care costs: growth accelerates again in 2001. *Health Aff (Millwood)* 2002; Jul-Dec(suppl Web exclusives):W299–W310.
4. Blue Cross and Blue Shield Association. Medical technology as a driver of health-care costs: diagnostic imaging. Chicago, Ill: Blue Cross and Blue Shield Association, 2003.
5. Wiley G. Self-referral: the new gold rush. *Decis Imaging Econ* 2003; April:23–28.
6. Kouri BE, Parsons RG, Alpert HR. Physician self-referral for diagnostic imaging: review of the empiric literature. *AJR Am J Roentgenol* 2002; 179:843–850.
7. Maitino AJ, Levin DC, Parker L, Rao VM, Sunshine JH. Nationwide trends in rates of utilization of noninvasive diagnostic imaging among the Medicare population between 1993 and 1999. *Radiology* 2003; 227:113–117.
8. Childs AW, Hunter ED. Non-medical factors influencing use of diagnostic x-ray by physicians. *Med Care* 1972; 10:323–335.
9. Radecki SE, Steele JP. Effect of on-site facilities on use of diagnostic radiology by non-radiologists. *Invest Radiol* 1990; 25: 190–193.
10. Strasser RP, Bass MJ, Brennan M. The effect of an on-site radiology facility on radiologic utilization in family practice. *J Fam Pract* 1987; 24:619–623.
11. Hillman BJ, Joseph CA, Mabry MR, Sunshine JH, Kennedy SD, Noether M. Frequency and costs of diagnostic imaging in office practice—a comparison of self-referring and radiologist-referring physicians. *N Engl J Med* 1990; 323:1604–1608.
12. Hillman BJ, Olson GT, Griffith PE, et al. Physicians' utilization and charges for outpatient diagnostic imaging in a Medicare population. *JAMA* 1992; 268:2050–2054.
13. Aronovitz L. Referrals to physician-owned imaging facilities warrant HCFA's scrutiny: General Accounting Office (GAO) report to the U.S. House of Representatives. Washington, DC: GAO, 1994.
14. Moskowitz H, Sunshine J, Grossman D, Adams L, Gelinas L. The effect of imaging guidelines on the number and quality of outpatient radiographic examinations. *AJR Am J Roentgenol* 2000; 175:9–15.
15. Verrilli DK, Bloch SM, Rousseau J, Crozier ME, Yecies SB. Design of a privileging program for diagnostic imaging: costs and implications for a large insurer in Massachusetts. *Radiology* 1998; 208:385–392.
16. American Medical Association. Physicians' Current Procedural Terminology (CPT 2001). Chicago, Ill: American Medical Association, 2001.
17. Sunshine JH, Bansal S, Evens RG. Radiology performed by nonradiologists in the United States: who does what? *AJR Am J Roentgenol* 1993; 161:419–429.
18. Spettell CM, Levin DC, Rao VM, Sunshine JH, Bansal S. Practice patterns of radiologists and nonradiologists: nationwide Medicare data on the performance of chest and skeletal radiography and abdominal and pelvic sonography. *AJR Am J Roentgenol* 1998; 171:3–5.
19. Maitino AJ, Levin DC, Parker L, Rao VM, Sunshine JH. Practice patterns of radiologists and nonradiologists in utilization of noninvasive diagnostic imaging among the Medicare population 1993–1999. *Radiology* 2003; 228:795–801.
20. Levin DC, Merrill C. Sosman Lecture. The practice of radiology by nonradiologists: cost, quality, and utilization issues. *AJR Am J Roentgenol* 1994; 162:513–518.
21. Lufkin KC, Smith SW, Matticks CA, Brunette DD. Radiologists' review of radiographs interpreted confidently by emergency physicians infrequently leads to changes in patient management. *Ann Emerg Med* 1998; 31:202–207.
22. Levin DC, Parker L, Intenzo CM, Sunshine JH. Recent rapid increase in utilization of radionuclide myocardial perfusion imaging and related procedures: 1996–1998 practice patterns. *Radiology* 2002; 222:144–148.