

SPECIAL ARTICLE

Urologists' Use of Intensity-Modulated Radiation Therapy for Prostate Cancer

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ABSTRACT

BACKGROUND

Some urology groups have integrated intensity-modulated radiation therapy (IMRT), a radiation treatment with a high reimbursement rate, into their practice. This is permitted by the exception for in-office ancillary services in the federal prohibition against self-referral. I examined the association between ownership of IMRT services and use of IMRT to treat prostate cancer.

METHODS

Using Medicare claims from 2005 through 2010, I constructed two samples: one comprising 35 self-referring urology groups in private practice and a matched control group comprising 35 non-self-referring urology groups in private practice, and the other comprising non-self-referring urologists employed at 11 National Comprehensive Cancer Network centers matched with 11 self-referring urology groups in private practice. I compared the use of IMRT in the periods before and during ownership and used a difference-in-differences analysis to evaluate changes in IMRT use according to self-referral status.

RESULTS

The rate of IMRT use by self-referring urologists in private practice increased from 13.1 to 32.3%, an increase of 19.2 percentage points ($P<0.001$). Among non-self-referring urologists, the rate of IMRT use increased from 14.3 to 15.6%, an increase of 1.3 percentage points ($P=0.05$). The unadjusted difference-in-differences effect was 17.9 percentage points ($P<0.001$). The regression-adjusted increase in IMRT use associated with self-referral was 16.4 percentage points ($P<0.001$). The rate of IMRT use by urologists working at National Comprehensive Cancer Network centers remained stable at 8.0% but increased by 33.0 percentage points among the 11 matched self-referring urology groups. The regression-adjusted difference-in-differences effect was 29.3 percentage points ($P<0.001$).

CONCLUSIONS

Urologists who acquired ownership of IMRT services increased their use of IMRT substantially more than urologists who did not own such services. Allowing urologists to self-refer for IMRT may contribute to increased use of this expensive therapy. (Funded by the American Society for Radiation Oncology.)

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IN 2011, NEARLY 240,900 MEN IN THE UNITED States received a new diagnosis of prostate cancer.¹ Approximately 90% of these men had clinically localized disease, which was indolent in most cases. The relative 10-year survival rate among all men with prostate cancer is 98%.^{1,2} Primary definitive treatments include prostatectomy, external-beam radiation therapy, and brachytherapy. Alternatively, the patient may opt for a less aggressive (monitoring) approach that includes active surveillance or hormone therapy. Table 1 describes each treatment option.

Despite substantial variation in reimbursement, evidence suggests that for low-risk disease, the three primary definitive treatments are clinically equivalent when measured in terms of survival.^{2,6} Moreover, clinical studies indicate that no single treatment approach is preferable with respect to the risk of adverse events and implications for quality of life.^{7,8} When selecting a treatment option, the patient will consider the recommendations of his physicians, the tumor attributes, whether monitoring is preferable to definitive treatment, the costs of and time required for treatment, potential side effects (urinary, bowel, and sexual dysfunction), and individual characteristics (e.g., age, race or ethnic group, and highest educational level attained). Lacking clinical expertise, the patient must rely on his treating physician to act as his agent in the health care decision-making process. Given this asymmetrical information problem, the physician's recommendation has considerable influence on the patient's decision.^{9,10}

Since 2005, an increasing number of urologists (physicians who diagnose and sometimes treat prostate cancer) have expanded their scope of practice to incorporate intensity-modulated radiation therapy (IMRT), a radiation treatment with a high rate of reimbursement.^{11,12} Because urologists are not trained in radiation oncology, the group typically hires a radiation oncologist to develop and monitor IMRT for patients with prostate cancer who are treated by urologists in the group. IMRT revenues represent additional income for the urology group; therefore, each urologist has financial incentives to refer patients for IMRT. Such arrangements enable urologists to partially replace the income losses they incurred after Medicare substantially cut payments for androgen-deprivation therapies in the mid-2000s.^{4,12}

The practice whereby a physician refers patients to facilities in which the physician has an investment interest is known as self-referral.^{13,14}

This practice is controversial because it poses a conflict of interest for referring physician-investors. Although self-referral is generally illegal, the federal prohibition has exceptions that permit physicians to self-refer under certain conditions. The most notable exception concerns in-office ancillary services; this provision enables individual physicians and physician groups to integrate designated health services, including radiation therapy, into their practices without violating the law.¹³⁻¹⁵ Before the adoption of the self-referral model, urologists sent patients with prostate cancer to radiation oncologists who worked at either hospital-based or independent radiation centers.

Considerable research has shown that self-referral is linked to the increased use of services and escalating health care spending, with no clear benefit to patients.¹⁵⁻²² Most prior studies have focused on advanced imaging techniques and specialty hospitals.¹⁷⁻²⁵ Little research during the past few years has examined the effects of self-referral on other services that fall under the umbrella of the exception for in-office ancillary services.^{26,27} To address this knowledge gap, I compared the frequency of use of IMRT for patients with prostate cancer by self-referring urologists, before and after they acquired IMRT services, with the use rates among non-self-referring urologists, who referred their patients to either hospital-based or independent radiation centers.

METHODS

DATA SOURCES

The analysis relied on five data sources with information about Medicare fee-for-service beneficiaries: the carrier file, the hospital outpatient file, the beneficiary summary file, the Medicare Physician Identification and Eligibility Registry file, and the National Provider Identifier file. The carrier file contains claims submitted by physicians, laboratories, diagnostic centers, and radiation centers, and the hospital outpatient file contains information submitted by hospital outpatient departments. The Centers for Medicare and Medicaid Services (CMS) has developed algorithms to identify beneficiaries with chronic conditions (including prostate cancer) from Medicare claims data.

Relying on anecdotal information, I selected states in which at least one IMRT self-referral arrangement had been established and neighboring states in which such arrangements did not exist.

Table 1. Treatment Options for Clinically Localized Prostate Cancer.*

Treatment	Description	Claim Code†	Mean Cost Estimate‡
Radical prostatectomy§	Complete removal of the prostate gland is performed with the use of one of three surgical approaches: radical retropubic prostatectomy, laparoscopic radical prostatectomy, or robot-assisted prostatectomy; the latter two are less invasive.	55801, 55810, 55812, 55815, 55821, 55831, 55840, 55842, 55845, 55866, and 55899	\$16,762¶
Brachytherapy§	Brachytherapy with the use of low-dose-rate isotopes involves permanent implantation of seeds that emit a low dose of radiation over a period of several months. Some patients also receive a boost of external-beam radiation therapy or androgen-deprivation therapy.	55875, 55862, 55865, 77778, 77784, and 77787	\$17,076¶
IMRT	This advanced form of three-dimensional radiation therapy involves the use of a computer-driven machine that revolves around the patient as it delivers radiation. Radiation beams are aimed at the prostate from multiple angles. Intensity can be adjusted to maximize the dose targeted at the cancerous tissue and minimize the dose to surrounding healthy tissue.	77418	\$31,574¶
Androgen-deprivation therapy	This hormone treatment reduces the effects of testosterone, thereby slowing the growth of prostate cancer. Medications are administered orally or injected to reduce or block circulating androgens.	54520, J1950, J9217, J9218, J9219, and J9202	\$2,112
Active surveillance	This active plan to postpone intervention typically involves monitoring with office visits every 6 months, prostate-specific antigen testing, digital rectal examination, and prostate biopsy.	NA	\$4,228**
Less common procedures			
Cryosurgery	Liquid nitrogen or liquid carbon dioxide is used to freeze tissue in order to destroy abnormal cells.	55873	—
Stereotactic body radiation therapy	This type of external-beam radiation therapy involves the use of special equipment to position a patient and precisely deliver radiation to tumors in the body (except the brain). The total dose of radiation is divided into smaller doses given over a period of several days. This type of radiation therapy helps spare normal tissue.	G0339 and G0340 during 2005–2006 and 77435 during 2007–2010	—
External-beam radiation therapy as a three-dimensional conformal treatment	Also called three-dimensional radiation therapy and three-dimensional conformal radiation therapy, this procedure uses a computer to create a three-dimensional picture of the tumor, allowing doctors to give the highest possible dose of radiation to the tumor, while sparing as much of the normal tissue as possible.	77401–77404, 77406–77409, 77411–77413, and 77416	\$20,588¶

* IMRT denotes intensity-modulated radiation therapy, and NA not applicable.

† The codes used to identify alternative treatment options are based on the Healthcare Common Procedure Coding System.

‡ The mean cost for each treatment is provided in 2005 dollars. Reliable cost-estimate data are not available for cryosurgery and stereotactic body radiation therapy because these procedures are much less common than the other procedures listed.

§ Some patients who undergo brachytherapy or prostatectomy also receive radiation (external-beam radiation therapy or IMRT) as adjuvant therapy but not as the primary treatment.

¶ Cost-estimate data are from Nguyen et al.³

|| Cost-estimate data are from Shahinian et al.⁴

** Cost-estimate data are from the Institute for Clinical and Economic Review.⁵

I obtained hospital-outpatient and carrier claims for services received by men with prostate cancer according to the CMS algorithm during the period from January 1, 2005, through December 31, 2010. The beneficiaries were continuously enrolled in the Medicare fee-for-service program and resided in 26 geographically dispersed states (see the Supplementary Appendix, available with the full text of this article at NEJM.org).

With clinical guidance from a urologist in private practice who specializes in treating prostate cancer, I developed an algorithm to identify men with newly diagnosed, nonmetastatic prostate cancer from the initial data extract (see the Supplementary Appendix). The inclusion criteria stipulated that a beneficiary had to have undergone a biopsy performed by a member of a participating urology group because of possible

prostate cancer (Healthcare Common Procedure Coding System code 55700), without a diagnosis of prostate cancer on the biopsy claim, followed by a diagnosis of prostate cancer within 30 days after the biopsy.

The urologist–consultant recommended a 6-month observation period after the date of the initial diagnosis of prostate cancer. I assessed the treatments received by each beneficiary during this period. After 6 months, the beneficiary was no longer considered to have a new diagnosis, so any treatment received after this time window was excluded. Patients who received a diagnosis within 6 months before the end of either the period before IMRT services were acquired (the preownership period) or the period of IMRT ownership were excluded from the analysis. The rationale for their exclusion was that these patients did not have the full 6 months of follow-up during the period in which they received the diagnosis.

CONSTRUCTION OF THE SAMPLE

I identified 50 urology practices that established a self-referral arrangement involving IMRT for the treatment of prostate cancer between January 1, 2005, and January 15, 2010. The initial list included 37 groups identified by the *Wall Street Journal* as acquiring ownership of IMRT services.¹² During the search for control groups to match these 37 groups, I identified an additional 13 self-referring groups. The initial data request to CMS was for data from the 17 states that had 1 or more of the self-referring urology groups identified by the *Wall Street Journal*. I also requested data for 9 states in which there were no known self-referring groups.

A total of 8 of the 50 practices were located in states not included in the data request to CMS. A total of 7 of the remaining 42 self-referring groups were excluded from the primary sample for one of the following reasons: the group had fewer than 20 cases during the preownership period (3 groups), the group had fewer than 20 cases during the ownership period (1), or the group could not be matched with a suitable control in a nearby market area (3). The third situation was the consequence of several smaller groups in one metropolitan area merging to form 3 large self-referring practices. Thus, the analysis focused on 35 of the original 50 self-referring urology practices that had been identified. Considerable literature has documented the existence of substantial geographic variation in

physician practice patterns, use of services, and health care spending.^{28,29} To account for such geographic variation in practice patterns, each self-referring urology group was matched with a non-self-referring group in private practice that was located in the same or a nearby market area.

A second control group comprised men treated by non-self-referring urologists who were employed by National Comprehensive Cancer Network (NCCN) centers. Physicians working at these centers are likely to practice on the basis of clinical evidence and are unlikely to derive financial benefits from recommending specific services. There are 21 NCCN centers in the United States. Of these centers, 4 were excluded because they were located in Ohio, Missouri, Nebraska, or North Carolina — states that were not included in the data request to CMS. It was also necessary to exclude 5 centers because they could not be matched to a self-referring urology practice in a nearby market area. Another center was excluded because it had a financial relationship with a self-referring urology practice. Thus, the analysis focused on urologists working at 11 cancer centers and 11 matched self-referring private practices within close proximity.

Using information reported on the website of each self-referring and non-self-referring practice, I identified the names of the urologists. Next, I searched the Medicare Physician Identification and Eligibility Registry and the National Provider Identifier files to match each physician's name with his or her unique identification number. Using the physician identification numbers, I searched the claims to identify the tax identification numbers associated with each urologist. Finally, I extracted all claims for cases of prostate cancer with the earmarked physician and tax identification numbers and then sequentially ordered the claims to create a medical profile of services received by each beneficiary.

Relying on clinical guidance from a urologist and a radiation oncologist, I constructed variables to earmark the receipt of the alternative cancer treatments, using Healthcare Common Procedure Coding System codes (Table 1). Because the self-referring urology practices began billing Medicare for IMRT at different points in time, it was critical to assign the same preownership and ownership periods to each matched pair. I determined the preownership and ownership periods for each matched pair on the basis of the date on which each self-referring practice began bill-

ing Medicare for IMRT. The individually matched treatment and control groups were then concatenated (linked) to construct a sample of men with newly diagnosed, nonmetastatic prostate cancer. The primary sample comprised 35 self-referring and 35 matched non-self-referring urology practices located in eight of the nine regions of the United States as defined by the Census Bureau. The study was approved by the institutional review board at Georgetown University.

STATISTICAL ANALYSIS

Changes over time in IMRT use according to self-referral status were evaluated with the use of a difference-in-differences analysis. This approach controls for initial differences in practice patterns during the preownership period and secular trends that affect the use of IMRT and are unrelated to ownership status. The empirical specification, shown below, was estimated by means of a linear probability model and logistic regression. If the difference-in-differences estimator is positive, this implies that the frequency of use of IMRT increased more (or decreased less) among self-referring urologists than among their non-self-referring counterparts. The regression models included controls for patient age, status with respect to coexisting conditions, year of diagnosis, and indicator variables identifying the urology group that treated each beneficiary.³⁰ The rationale for the inclusion of each of these variables is provided in the Supplementary Appendix.

The model was specified as follows:

$$\text{IMRT}_{ijt} = \beta_0 + \beta_1 \text{Selfref}_{ijt} + \delta_j \text{Urology Group}_j + \alpha_t \text{Cancer Year}_t + \beta_2 \text{Age}_{ijt} + \beta_3 \text{Coexisting Condition}_{ijt} + u_{ijt},$$

where i is the beneficiary, j the urology group, t the time period, and u_{ijt} the error term.

IMRT_{ijt} was equal to 1 if one of the following applied: the beneficiary was seen by a non-self-referring urologist during either the preownership or ownership period and received IMRT, the beneficiary was seen by a self-referring urologist during the preownership period and received IMRT, or the beneficiary was seen by a self-referring urologist during the ownership period and received IMRT that was performed and billed by the self-referring urology group. The dependent variable equals 0 for all other observations, including beneficiaries seen by a self-referring urologist

during the ownership period who underwent IMRT that was performed and billed by a non-self-referring provider. Although these beneficiaries received IMRT, assigning a value of 1 to these observations would bias upward the coefficient for the self-referral variable. Selfref_{ijt} was equal to 1 if the beneficiary was treated by a self-referring urologist after the physician's practice began billing Medicare for IMRT. I also evaluated the time from the date of the cancer diagnosis to the initiation of definitive treatment in order to assess whether the time to the initiation of treatment was shorter among patients treated by integrated urology–radiation oncology practices.

RESULTS

USE OF IMRT AND OTHER TREATMENTS

Table 2 shows the rates of IMRT use by urologists in private practice, with adjustment for self-referral status and ownership period. Among beneficiaries treated by self-referring urologists in private practice, the rate of IMRT referral increased from 13.1 to 32.3%, an increase of 19.2 percentage points ($P < 0.001$). Approximately 6.0% of the men treated by self-referring urologists underwent IMRT performed by non-self-referring providers. Rates of brachytherapy and hormone use fell by 13.0 and 8.1 percentage points, respectively ($P < 0.001$). Changes in use rates for prostatectomy and active surveillance were inconsequential. By contrast, the rate of IMRT referral among patients treated by non-self-referring urologists was virtually unchanged between the preownership and ownership periods, from 14.3 to 15.6%, which was an increase of 1.3 percentage points ($P = 0.05$). Use rates for the remaining treatment options by non-self-referring urologists remained stable.

The unadjusted difference-in-differences analysis comparing the frequency of use of IMRT among men treated by urologists in private practice is shown in Figure 1A. Self-referral was associated with an unadjusted increase in IMRT use of 17.9 percentage points ($P < 0.001$). Results stratified according to age were similar (Fig. S1 and S2 in the Supplementary Appendix).

Table 3 shows the changes in use rates from the preownership period to the ownership period among men treated by urologists working at 11 NCCN centers and their counterparts at 11 matched self-referring urology practices. The

Table 2. Treatment Provided for Men with Newly Diagnosed, Nonmetastatic Prostate Cancer in the 35 Matched Groups of Self-Referring and Non-Self-Referring Urologists in Private Practice, According to Self-Referral Status and Ownership Period.*

Treatment	Self-Referring Urologists in Private Practice				Non-Self-Referring Urologists in Private Practice			
	Preownership Period (N=13,929)	Ownership Period (N=14,319)	Change	P Value	Preownership Period (N=5404)	Ownership Period (N=5113)	Change	P Value
IMRT delivery by self-referring group (%)	13.1	32.3	19.2	<0.001	—	—	—	—
IMRT delivery by other provider (%)	—	6.3	—	—	14.3	15.6	1.3	0.05
Brachytherapy (%)	18.6	5.6	−13.0	<0.001	18.9	17.9	−1.0	0.19
Prostatectomy (%)	17.7	16.6	−1.1	0.01	21.9	23.8	1.9	0.02
Androgen-deprivation therapy (%)	16.5	8.4	−8.1	<0.001	15.6	11.4	−4.2	<0.001
Active surveillance (%)	26.7	27.0	0.3	0.65	26.1	27.4	1.3	0.12
Other procedure (%)	7.3	3.9	−3.4	<0.001	3.2	3.9	0.7	0.05
Time from diagnosis to treatment (days)	79.8±37.9	76.0±32.6	−3.8	<0.001	78.8±38.1	78.0±36.2	−0.8	0.50

* Plus-minus values are means ±SD. For percentage data, change is shown in percentage points. Beneficiaries who underwent prostatectomy or brachytherapy may also have received adjuvant radiation therapy (external-beam radiation therapy or IMRT), but the definitive treatment was either brachytherapy or prostatectomy.

rate of IMRT use by self-referring urologists rose from 9.0 to 42.0%, an increase of 33.0 percentage points ($P<0.001$). Another 4.5% of men seen by self-referring urologists obtained IMRT from another provider. Rates of brachytherapy and hormone use fell by 14.9 percentage points and 10.0 percentage points, respectively ($P<0.001$ for both comparisons). The percentage of men monitored with active-surveillance protocols fell by 6.3 percentage points, and the use of prostatectomy and other procedures declined by less than 4.0 percentage points ($P<0.001$ for all comparisons). By contrast, there was virtually no change in the practice patterns of urologists employed by NCCN centers. During both periods, approximately 8.0% of the men seen by urologists at cancer centers underwent IMRT.

Figure 1B shows the unadjusted difference-in-differences results for men treated by urologists employed by NCCN centers and those treated by self-referring urologists in private practice. The unadjusted difference-in-differences estimator (self-referral effect) was 32.6 percentage points ($P<0.001$). Analyses stratified according to age yielded similar findings (Fig. S3 and S4 in the Supplementary Appendix).

Regression analyses that were adjusted for age, status with respect to coexisting conditions, year of cancer diagnosis, and urology-group

fixed effects had similar results. The analysis that was based on urologists in private practice indicated that self-referral was associated with an increase in IMRT use of 16.4 percentage points ($P<0.001$) (Table 4, and Table S1 in the Supplementary Appendix). Results of regression analyses with urologists employed by cancer centers as matched controls were similar to the unadjusted findings; self-referral was associated with an increase in IMRT use of 29.3 percentage points ($P<0.001$) (Table S1 in the Supplementary Appendix). Sensitivity analyses that used alternative modeling approaches had similar results (Table S1 in the Supplementary Appendix).

TIME TO INITIATION OF TREATMENT

The unadjusted difference-in-differences analysis in which urologists in private practice were used as controls suggested that self-referral was associated with a 3.0-day decline in the time to the initiation of treatment ($P<0.001$). Similar unadjusted analyses in which urologists employed by cancer centers were used as controls suggested that self-referral was associated with a reduction of 6.4 days in the time to the initiation of treatment ($P<0.001$). These significant, although modest, reductions in the time to treatment initiation with self-referral became increases, albeit insignificant, in regression-adjusted analyses that

controlled for urology group, type of definitive treatment, age, year of cancer diagnosis, and status with respect to coexisting conditions. In analyses with urologists in private practice as controls, self-referral was associated with an increase in the time to the initiation of treatment of 1.3 days ($P=0.12$); in analyses with urologists employed at cancer centers as controls, the increase was 1.9 days ($P=0.39$) (Table S2 in the Supplementary Appendix).

DISCUSSION

The results of this study indicate that referral by urologists to IMRT services in which they have a financial interest is associated with large increases in the rate of IMRT use for Medicare beneficiaries who have newly diagnosed, nonmetastatic prostate cancer. There was increased use of IMRT among private-practice urology groups that acquired ownership of IMRT services both in analyses that used other urology groups in private practice as controls and in analyses that used urologists employed by NCCN centers as controls. In adjusted analyses, self-referral was not associated with a shorter time to receipt of definitive treatment. These findings are consistent with the results of other studies showing substantial increases in the frequency of use of advanced imaging techniques, clinical laboratory testing, and anatomical-pathology services by self-referring physicians,^{17-22,26,27} and also corroborate the significant increases in the use of surgery that characterize physician-owners of specialty hospitals.²³⁻²⁵

Financial incentives may have contributed to the increased use of IMRT among self-referring urologists; financial pressures induced by substantial start-up costs may likewise have prompted physician-owners to recommend IMRT in lieu of alternative treatments.^{11,12} To establish an IMRT center requires a capital investment of \$2 million and the hiring of advanced support staff. However, explanations other than financial incentives and pressures must be considered. For example, urologists may integrate IMRT into their practice because they believe this treatment will reduce the risk of adverse events and improve quality of life. However, evidence from clinical studies indicates that each primary treatment for prostate cancer has pros and cons in terms of side effects and their implications for quality of life.^{7,8}

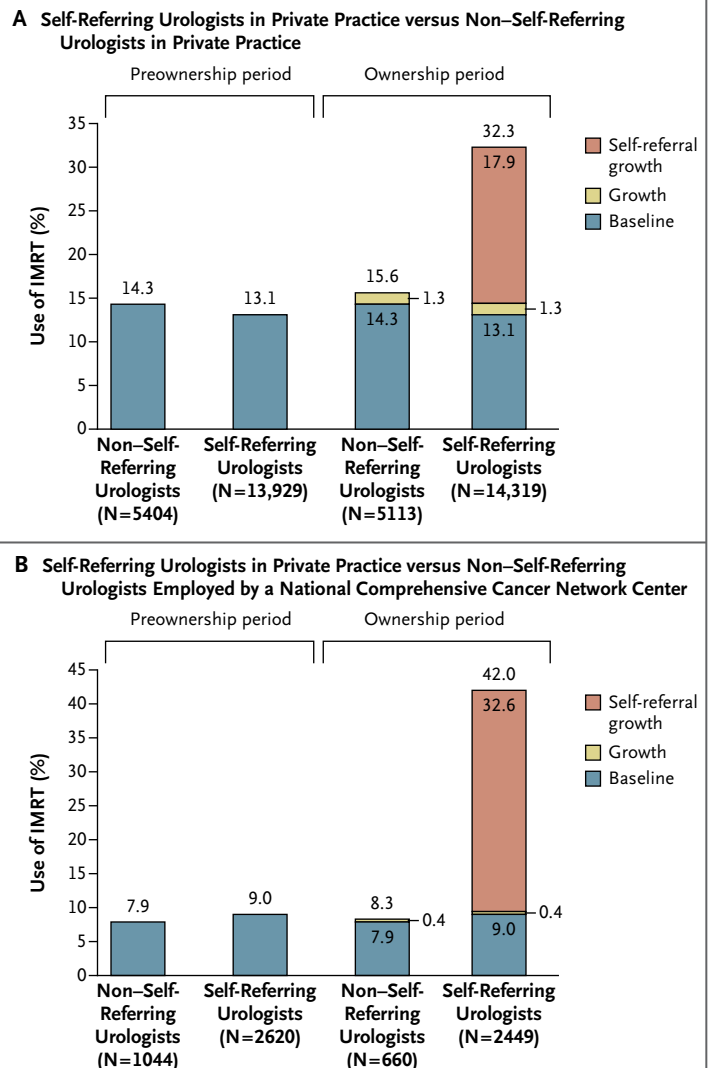


Figure 1. Use of Intensity-Modulated Radiation Therapy (IMRT) among Men 65 Years of Age or Older with Newly Diagnosed Prostate Cancer.

Panel A shows the results of the unadjusted difference-in-differences analysis comparing the frequency of use of IMRT among men treated by urologists in private practice. The difference in use between the period before acquiring IMRT services (the preownership period) and the ownership period for the self-referring urologists was 19.2 percentage points ($P<0.001$); the corresponding difference for non-self-referring urologists was 1.3 percentage points ($P=0.05$). Self-referral was associated with an unadjusted increase in IMRT use of 17.9 percentage points ($P<0.001$). Panel B shows the unadjusted difference-in-differences results for men treated by urologists employed by a National Comprehensive Cancer Network center and self-referring urologists in private practice. The difference in use between the preownership and ownership periods for the self-referring urologists was 33.0 percentage points ($P<0.001$); the corresponding difference for urologists employed at the cancer centers was 0.4 percentage points ($P=0.78$). The unadjusted difference-in-differences estimator (self-referral effect) was 32.6 percentage points ($P<0.001$).

Table 3. Treatment Provided in the 11 Matched Groups of Self-Referring Urologists in Private Practice and Non-Self-Referring Urologists Employed by a National Comprehensive Cancer Network Center, According to Self-Referral Status and Ownership Period.*

Treatment	Self-Referring Urologists in Private Practice				Non-Self-Referring Urologists Employed by the National Comprehensive Cancer Network			
	Preworship Period (N=2620)	Ownership Period (N=2449)	Change	P Value	Preworship Period (N=1044)	Ownership Period (N=600)	Change	P Value
IMRT delivery by self-referring group (%)	9.0	42.0	33.0	<0.001	—	—	—	—
IMRT delivery by other provider (%)	—	4.5	—	—	7.9	8.3	0.4	0.78
Brachytherapy (%)	17.6	2.7	-14.9	<0.001	6.3	8.5	2.2	0.09
Prostatectomy (%)	16.4	12.8	-3.6	<0.001	28.5	27.0	-1.5	0.50
Androgen-deprivation therapy (%)	17.4	7.4	-10.0	<0.001	12.0	9.7	-2.3	0.14
Active surveillance (%)	33.9	27.6	-6.3	<0.001	44.3	45.0	0.7	0.79
Other procedure (%)	5.7	3.0	-2.7	<0.001	1.0	1.5	0.5	0.30
Time from diagnosis to treatment (days)	80.0±35.9	71.2±31.1	-8.8	<0.001	84.4±38.9	82.0±36.7	-2.4	0.39

* Plus-minus values are means ±SD. For percentage data, change is shown in percentage points. Beneficiaries who underwent either prostatectomy or brachytherapy may also have received adjuvant radiation therapy (either external-beam radiation therapy or IMRT), but the definitive treatment was either brachytherapy or prostatectomy.

Table 4. Linear Probability and Logistic-Regression Difference-in-Differences Estimates Predicting Receipt of IMRT for the Comparison of Self-Referring Urologists in Private Practice with Non-Self-Referring Urologists in Private Practice.*

Estimate	Beneficiary Treated by Self-Referring Urologist during Ownership Period	P Value
Linear probability marginal effect	16.4 percentage points	<0.001
Logistic-regression marginal effect	16.9 percentage points	<0.001
Logistic-regression odds ratio (95% CI)	2.79 (2.53–3.08)	<0.001

* The sample of 38,765 patients included all beneficiaries treated by physicians in private practice from 35 self-referring urology groups that began billing Medicare for IMRT at some point during the period from January 1, 2005, through January 15, 2010, and those treated by physicians in private practice from 35 matched non-self-referring urology groups that did not bill Medicare for IMRT. All regression models included the age of the beneficiary at the time of the cancer diagnosis, indicator variables to distinguish year of diagnosis, indicator variables to identify the presence or absence of specific coexisting conditions, and indicator variables to control for the urology group that treated each beneficiary. CI denotes confidence interval.

In addition, the self-referring urologists in this study may have been early adopters of IMRT. However, the data do not support this explanation, because 60% of the self-referring practices established their IMRT center during the period from January 1, 2008, through January 15, 2010. Moreover, self-referring and non-self-referring urologists had similar rates of IMRT referral during the preownership period. Another possible explanation is patient preference. Some beneficiaries may prefer the latest technology even if the efficacy is speculative. Patients who were interested in IMRT may have sought care from integrated urology–radiation oncology practices.

The study has limitations that stem from deficiencies inherent in claims data. First, the analysis did not evaluate the appropriateness of IMRT use because information on tumor characteristics and radiation dose was unavailable. Second, claims data lack information on physician characteristics. Third, data on physicians' perceptions of profitability are not available. In particular, the costs of administering IMRT, including amortization and payments for radiation oncologists, are unknown. Nevertheless, Jacobs et al.¹¹ cited marketing materials from UroRad Healthcare, a company that sells complete packages of IMRT technology and services to urolo-

gists. The Urorad brochure claims that treating 1.5 new patients monthly with IMRT could generate more than \$425,000 in additional revenue per urologist annually.

In conclusion, this study shows that men treated by self-referring urologists, as compared with men treated by non-self-referring urologists, are much more likely to undergo IMRT, a treatment with a high reimbursement rate, rather than less expensive options, despite evidence that all treatments yield similar outcomes.² The findings raise concerns regarding the appropriate use of IMRT, especially among older Medicare beneficiaries, for whom the risks of undergoing intensive irradiation probably exceed the benefits. Recent evidence suggests that the IMRT self-referral arrangement is

becoming more common; by the end of 2011, approximately 19% of urology practices had incorporated IMRT services into their practice.³¹ Permitting urologists to self-refer for IMRT may contribute to increased use of this expensive therapy.

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