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Are Small Reimbursement Changes Enough to Change Cancer Care? Reimbursement Variation in Prostate Cancer Treatment

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QUESTION ASKED: Centers for Medicare and Medicaid Services (CMS) is making small adjustments to physician reimbursement to improve the value of care delivered to Medicare beneficiaries under fee-for-service. Using localized prostate cancer as a model, we examined whether these small reimbursement changes were enough to increase the value of cancer care.

SUMMARY ANSWER: Small variations in fee-for-service reimbursement for costly physician-administered prostate cancer drugs in the early 2000s did not reduce low-value care, suggesting that small payment changes may not be enough to motivate improvements in care quality. Moreover, patient clinical characteristics and practice organization were associated with low-value care (Table 3).

METHODS: We conducted a natural experiment exploiting unintended differences in regional Medicare carriers' payment of Part B drug claims. Using data from SEER registries that are linked to Medicare claims, we conducted multilevel analysis to assess whether the reimbursement variation affected urologists' inappropriate use of gonadotropin-releasing hormone (GnRH) agonists. These drugs are often used, and misused, in prostate cancer treatment.

BIAS, CONFOUNDING FACTOR(S), DRAWBACKS: We conducted our study among urologists. Much of cancer care is delivered by medical and radiation oncologists and our results may not be generalizable to these providers. Future studies should address these groups specifically to compare how reimbursement changes, both small and large, affect prescribing of GnRH agonists to complete our understanding of the clinical and practice contexts in which reimbursement does or does not change clinical decision making.

REAL-LIFE IMPLICATIONS: CMS' efforts to align reimbursement with high quality care should continue. However, our findings suggest that small adjustments to reimbursement on the order of 2% to 3% may be insufficient to improve the value of care delivered by urologists treating localized prostate cancer. Other efforts may also be needed to change physicians' behavior, such as CMS' identification of low-performing practices through publication of quality ratings and targeted, physician-centered interventions to support health care providers who are not adherent to guidelines. JOP

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Table 3. Multilevel Regression Predicting Primary GnRH Agonist Use

Factor	Odds Ratio	95% CI
Reimbursement generosity index	1.00	1.00 to 1.00
Practice type		
Group practice	Reference	
Solo practice	1.27	1.07 to 1.52
Missing	0.86	0.58 to 1.26
Physician prostate panel size, prostate patients per year		
< 20	Reference	
21-37	0.75	0.65 to 0.86
≥ 38	0.81	0.68 to 0.96
T stage		
T1	Reference	
T2	1.91	1.72 to 2.13
Grade		
Well differentiated, 2-4	Reference	
Moderately differentiated, 5-7	2.26	1.78 to 2.88
Missing	3.50	2.50 to 4.91
No. of comorbidities		
0	Reference	
1	1.40	1.24 to 1.57
2	1.43	1.18 to 1.72
≥ 3	2.07	1.65 to 2.60
Age, years	1.78	1.38 to 2.30
Age, squared	1.00	1.00 to 1.00
Race/ethnicity		
Non-Hispanic white	Reference	
Non-Hispanic black	1.42	1.17 to 1.73
Hispanic	1.25	1.00 to 1.56
Other	1.30	0.94 to 1.79
Missing	1.95	1.50 to 2.53
Radiation oncology consultation		
No	Reference	
Yes	0.26	0.23 to 0.31
Medical oncology consultation		
No	Reference	
Yes	0.88	0.65 to 1.19
Urology consultation		
No	Reference	
Yes	5.62	3.19 to 9.90
Primary care consultation		
No	Reference	
Yes	0.41	0.36 to 0.46
Constant	0.95	0.87 to 1.04

NOTE. Sample includes only patients (n = 15,128) of urologists who prescribed GnRH agonists. The model also adjusts for urologists' length of time in practice, sex, training location, board certification status, medical school affiliation, proportion of minority patients in practice, patients' marital status, rural residence, community educational attainment, community income, prior primary care use, year treated, and SEER region.

Abbreviation: GnRH, gonadotropin-releasing hormone.

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Abstract

Purpose

The Centers for Medicare and Medicaid Services recently initiated small reimbursement adjustments to improve the value of care delivered under fee-for-service. To estimate the degree to which reimbursement influences physician decision making, we examined utilization of gonadotropin-releasing hormone (GnRH) agonists among urologists as Part B drug reimbursement varied in a fee-for-service environment.

Methods

We analyzed treatment patterns of urologists treating 15,128 men included in SEER-linked Medicare claims who were diagnosed with localized prostate cancer between January 1, 2000, and December 31, 2003. We calculated a reimbursement generosity index to measure differences in GnRH agonist reimbursement among regional Medicare carriers and over time. We used multilevel analysis to control for patient and provider characteristics.

Results

Among urologists treating early-stage and lower grade prostate cancer, variation in reimbursement was not associated with overuse of GnRH agonists from 2000 to 2003, a period of guideline stability (odds ratio, 1.00; 95% CI, 0.99 to 1.00).

Conclusion

Small differences in androgen-deprivation therapy reimbursement generosity were not associated with differential use. Fee-for-service reimbursement changes currently being implemented to improve quality in fee-for-service Medicare may not affect patterns of cancer care.

ASSOCIATED CONTENT

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INTRODUCTION

Numerous payment policies and incentives have been implemented to increase the value of cancer services in the United States.[1,2] Although recent attention has focused on alternative payment models,[3] the majority of oncology care continues to be delivered under fee-for-service arrangements.[4,5] Accordingly, the Centers for Medicare and Medicaid Services (CMS) recently announced plans to link value or quality to 90% of Medicare fee-for-service payments by 2018.[5] Beginning this year, CMS will adjust

reimbursement to disincentivize poor-quality and high-cost care.[3,5]

These plans were likely informed by prior evidence of the impact of reimbursement reductions on prostate cancer care delivery in the past decade. Before 2005, when Medicare had a generous reimbursement policy for gonadotropin-releasing hormone (GnRH) agonists and other physician-administered drugs reimbursed through the Part B medical benefit, this form of androgen-deprivation therapy (ADT) was widely used as primary treatment of localized prostate cancer,[6-10] despite the lack of recommendation by published guidelines for patients with early prostate cancer.[11,12] A sharp decline in GnRH use occurred after 2005, when the Medicare Modernization Act (MMA) of 2003 changed the pricing benchmark used in the reimbursement formula from an average wholesale price set by the manufacturers to average sales price on the basis of national sales, reducing reimbursement for GnRH agonists by 65%.[7,8,13,14] These studies suggest quality may be improved by limiting reimbursement of inappropriate treatment options. However, no prior study has evaluated the effect of more modest reimbursement variation on clinical decision making, similar to the 0.5% to 1% reductions in payments currently in place to transform fee-for-service.[15]

Between January 2000 and December 2003, there were unintentional differences in physician reimbursement for GnRH agonists delivered through the Medicare Part B drug benefit,[16] which resulted in reimbursement variations of up to 10.5%, or $59 per administration, across providers. Taking advantage of this natural experiment, we examine the association between modest reimbursement variation and GnRH agonist use during a period in which there was stability in guidelines (primary ADT recommended for high-risk, but not low- or intermediate-risk, patients) and the potential harms of ADT were largely unknown. We hypothesize that practicing under more generous drug reimbursement conditions is associated with greater use of ADT.

METHODS

We conducted a retrospective analysis to examine the association of reimbursement and primary GnRH agonist use among patients with clinically localized prostate cancer. The study was approved by the University of North Carolina at Chapel Hill Institutional Review Board.

Data Sources

We linked SEER-Medicare data to the American Medical Association (AMA) Masterfile. SEER records patient demographics, tumor morphology, and stage at diagnosis for a population-based sample of US residents diagnosed with cancer.[17] Medicare administrative claims include hospital services, physician services, and physician-administered drug therapy. We used Medicare Provider Analysis and Review, Outpatient, Durable Medical Equipment, and Carrier files for sample selection, initial treatment ascertainment, and treating provider identification; we used carrier files alone to evaluate response to reimbursement because other files do not identify physicians and/or reimbursement.[18] AMA Masterfile data include individual and practice characteristics from approximately 800,000 US physicians. Data originate from training records collected annually (96% to 98% response rates) and are supplemented by physician survey.[19]

Cohort Definitions

Patients

We identified patients with an incident diagnosis of prostate adenocarcinoma as their first and only cancer. Of men receiving initial treatment between January 1, 2000, and December 31, 2003, we excluded those $\leq$ 66 years old at diagnosis because we could not ascertain their comorbidities. We also excluded patients whose initial treatment could not be fully ascertained because they were diagnosed at autopsy, by death certificate, or at a nursing/convalescent facility; died within 12 months of diagnosis; were not continuously enrolled in fee-for-service Medicare for 12 months before and after diagnosis; or had no treatment claims. This study focused on patients with early prostate cancer, so we restricted the cohort to men who lacked evidence of nodal or metastatic involvement and who had no greater than stage T2 tumors and WHO grade 1 or 2 disease.[8] We also excluded men with an actuarial life expectancy of less than 5 years because national guidelines permitted primary ADT use for these patients.[6,11]

Urologists

We included only urologists because they prescribe 95% of the GnRH agonists used among patients with localized prostate cancer.[20] We used patients' medical claims to identify the treating provider, defined as the physician responsible for the most treatment claims.[21] Providers were matched by encrypted Unique Physician Identifier Number or National Provider Identifier to the AMA Masterfile data. We excluded

urologists who did not prescribe GnRH agonists because we could not compute their reimbursement generosity index (RGI; see Measures).

Measures

Dependent variable

Primary GnRH agonist use is defined as any claim for goserelin acetate (GA) implants, leuprolide acetate (LA) injections, LA implants, or triptorelin pamoate injections administered within 1 year after diagnosis, unless orchiectomy, radical prostatectomy, brachytherapy, chemotherapy, or cryotherapy was also administered within that time (codes used listed in Appendix Table A1, online only).

Explanatory variables

Part B claims are paid by local carriers, which lack uniform reimbursement policies.[22] From 1997 to 2002, carriers were responsible for translating Part B drug Healthcare Common Procedure Coding System (HCPCS) claims into National Drug Code (NDC) indices.[18] Although some HCPCS codes had only one equivalent NDC, others had $\geq$ 10 matches, resulting in substantial reimbursement variation.[16] In addition to variability among carriers, reimbursements changed at different rates over time as a result of changes in average wholesale prices for specific NDCs.[18]

Thus, for each urologist, we created an RGI, a weighted average difference in reimbursement indicating reimbursement above or below the national average.[18] First, we calculated the difference between the reimbursement the physician received for each ADT modality and the average national reimbursement amount for that same product during that time period. Next, we weighted these differences by the proportion of spending on that drug among spending on all GnRH agonists used by each urologist in that year (Appendix, online only). Differences in RGI reflect reimbursement variation specific to each carrier and over time, as well as changes in the mix of drugs prescribed by each physician in any year. An RGI greater than 0 indicates excess reimbursement (greater than the national average).

The following example demonstrates our calculation of RGI. A physician started five patients on ADT in 2001, using LA injections one time and GA implants four times. During that year, he was reimbursed for LA at \$592.60 per monthly dose. He was reimbursed for GA at \$446.49 per monthly dose all four times. Thus, in 2001, his average reimbursement for LA was \$592.60 and his average reimbursement for GA was \$446.49. However, across all SEER regions, the average reimbursement in 2001 for LA was \$487.92 and the average reimbursement for GA was \$434.70. Thus, he was reimbursed \$104.68 more than the SEER national average for LA and \$11.79 more than the SEER national average for GA. In 2001, LA spending was 43% of spending on all initial use of primary ADT and GA was 55% of all spending on initial use of primary ADT. This doctor's reimbursement generosity was proportional to only the two drugs he used. Over 2001, this physician's RGI is equal to:

$$\frac{(592.60 - 487.92) + (446.49 - 434.70)0.545}{0.434 + 0.545} = 52.9$$

Thus, for this physician in 2001, his reimbursement per monthly dose was \$53 more generous than the national average for the mix of GnRH agonists he used.

Control variables

We controlled for patient, urologist, and practice variables (see Appendix, online only) known to be associated with prostate treatment decisions, quality of care, or responsiveness to incentives.

Statistical and Sensitivity Analyses

As a result of high intraclass correlation among patients treated by the same urologist[23] and to exploit both increases and decreases in reimbursement as well as reimbursement variation both within physicians and between physicians, we used multilevel mixed effects logistic regression models to control for clustering. Statistical significance was evaluated at $\alpha = .05$ using Stata/SE 12.1 (StataCorp, College Station, TX).[24]

We varied definitions of the primary dependent (GnRH agonist use) and independent variables (treating provider) to assess robustness of our findings. Because reimbursement may affect adjuvant GnRH agonist use, we created a second dependent variable that captured both primary GnRH agonist use (potentially inappropriate) and adjuvant GnRH agonist use (potentially appropriate). Further sensitivity analysis used the SEER average reimbursement for urologists who did not prescribe any GnRH agonists to assess the effect of excluding nonprescribing urologists.

RESULTS

The final sample (Appendix Fig A1) included 15,128 men with T1 or T2 well-differentiated or moderately differentiated prostate cancer treated by 1,800 urologists between 2000 and

2003. Twenty four percent of patients (3,653 of 15,128 patients) received primary ADT.

GA implants (3.6 mg) and LA injections (7.5 mg) composed more than 94% of ADT use. Monthly median reimbursement for GA implants (3.6 mg), which had one equivalent NDC, fluctuated little from 2000 to 2003, increasing from $193 to $199. Reimbursement for LA injections (7.5 mg), which had multiple NDCs, had greater variation; the median reimbursement per monthly dose was $207 in 2000, $214 in 2001, $190 in 2002, and $223 in 2003.

The average RGI over the study period was 2.93 (standard deviation [SD], 69.63), indicating that, on average, urologists treating patients with primary GnRH agonists were reimbursed $2.93 more generously for the drugs they used relative to the national average reimbursement. However, RGI fluctuated by treatment year; the average RGI decreased from 2.92 in 2000 to 1.88 in 2001, increased to 3.89 in 2002, and decreased to 2.87 in 2003, with the average RGI ranging from $18.89 less than the average reimbursement at the 25th percentile to $15.03 more than average at the 75th percentile. However, variation between urologists (SD, $73.63) was greater than variation among individual urologists over time (SD, $43.54).

Primary GnRH agonist use grew from 21.9% of patients in 2000 to 29.2% in 2002 and then decreased to 23.1% in 2003 (Table 1). Patients of physicians who were reimbursed for GnRH agonists at levels above the national average differed from those of physicians who were reimbursed at or below the national average on most clinical, demographic, care-seeking, and geographic indicators (Table 1). However, at the physician level, 30% of patients treated by physicians practicing in areas where GnRH agonist reimbursement is at or below national average received primary ADT; this proportion is identical for physicians reimbursed above the national average (30%; $P = .56$; Table 2).

After controlling for patient, urologist, and practice characteristics, excess GnRH agonist reimbursement was not associated with primary GnRH agonist use among patients with T1 and T2 well-differentiated or moderately differentiated prostate cancer (odds ratio [OR], 1.00; 95% CI, 1.00 to 1.00; Table 3). Solo practitioners were more likely to use primary ADT than urologists in group practice or with missing practice status, all else being equal (OR, 1.27; 95% CI, 1.07 to 1.52). Larger panel sizes and seeing a primary care provider between diagnosis and treatment were protective against primary GnRH agonist use.

Sensitivity Analyses

Results for all models were substantively similar when we also included adjuvant GnRH agonist use in the outcome (data not shown). When considering all urologists (2,213 urologists and 16,789 patients) and assuming nonprescribers were reimbursed at the SEER national average, excessive reimbursement had a small negative effect on GnRH agonist overuse, although the upper CI rounded to 1 (OR, 0.99; 95% CI, 0.99 to 1.00).

DISCUSSION

We evaluated the potential association between small reimbursement variation and use of primary ADT for patients with early prostate cancer during a period when there was widespread variation in reimbursement across different regions of the United States. Contrary to our hypothesis, we found no association between variation in reimbursement and primary GnRH agonist use, suggesting that small incentives or disincentives may have little impact on urologists' prescribing practices.

Our findings were consistent with other studies exploiting variation in carrier reimbursement. For example, small carrier reimbursement differences were not associated with use of chemotherapy among fee-for-service Medicare beneficiaries with metastatic cancer during the 1990s.[18] However, our findings differ from prior studies that demonstrated a sharp decline in GnRH agonist use after the 2005 MMA reimbursement changes.[7,8] One possibility for the divergent findings is confounding in studies conducted in the mid-2000s.[25-27] Coincident with MMA reimbursement changes, many other events occurred that could have contributed to the decline in GnRH agonist use; for example, emerging evidence about harms, guideline changes, prosecution of illegal marketing practices, and practice reorganization.[11,12,26,28-34] In fact, further analyses related to large changes in ADT use coincident with MMA reimbursement cuts suggest that factors other than financial incentives may have played a role[35]; urologists may not have responded uniformly to reimbursement cuts[6]; and, in some clinical indications, physicians were responsive to changes in evidence to omit GnRH agonists despite high reimbursement.[36] Thus, the relationship between reimbursement and physician decision making may be less well understood than previously thought. Future research should attempt to isolate the independent impact of multiple changes on GnRH agonist use, in particular the effect of widespread practice reorganization occurring in response to new technologies. We purposely designed this

Table 1. Patient Characteristics According to Reimbursement Generosity Index of Urologists Prescribing GnRH Agonists

Characteristic	Overall (N = 15,128)	GnRH Agonist Reimbursement Less Than or Equal to National Average (n = 5,932)	GnRH Agonist Reimbursement Greater Than National Average (n = 9,196)	*P*
GnRH agonist overuse	3,653 (24.1)	1,356 (22.9)	2,297 (25.0)	.003
Reimbursement generosity index, mean (SD)	2.9 (69.6)	−48.0 (65.6)	35.8 (49.5)	< .001
Year treated				< .001
2000	3,317 (21.9)	1,332 (22.5)	1.985 (21.6)	
2001	3,894 (25.7)	1,618 (27.3)	2,276 (24.7)	
2002	4,421 (29.2)	1,890 (31.9)	2,531 (27.5)	
2003	3,496 (23.1)	1,092 (18.4)	2,404 (26.1)	
T stage				.08
T1	6,296 (41.6)	2,417 (40.7)	3,879 (42.2)	
T2	8,832 (58.4)	3,515 (59.3)	5,317 (57.8)	
Grade				< .001
Well differentiated, 2-4	759 (5.0)	333 (5.6)	426 (4.6)	
Moderately differentiated, 5-7	13,867 (91.7)	5,439 (91.7)	8,428 (91.6)	
Missing	502 (3.3)	160 (2.7)	342 (3.7)	
No. of comorbidities				< .001
0	10,245 (67.7)	4,129 (69.6)	6,116 (66.5)	
1	3,298 (21.8)	1,240 (20.9)	2,058 (22.4)	
2	998 (6.6)	354 (6.0)	644 (7.0)	
≥ 3	587 (3.9)	209 (3.5)	378 (4.1)	
Age, years, mean (SD)	73.9 (5.5)	73.7 (5.5)	73.9 (5.5)	.03
Race/ethnicity				< .001
Non-Hispanic white	12,008 (79.4)	4,878 (82.2)	7,130 (77.5)	
Non-Hispanic black	1,175 (7.8)	303 (5.1)	872 (9.5)	
Hispanic	925 (6.1)	352 (5.9)	573 (6.2)	
Other	550 (3.6)	249 (4.2)	301 (3.3)	
Missing	470 (3.1)	150 (2.5)	320 (3.5)	
Marital status				.01
Not married	2,767 (18.3)	1,022 (17.2)	1,745 (19.0)	
Married	10,231 (67.6)	4,086 (68.9)	6,145 (66.8)	
Missing	824 (14.1)	5,923 (13.9)	9,196 (14.2)	
Pretreatment primary care use				.19
0-2 visits in prior year	2,991 (19.8)	1,135 (19.1)	1,856 (20.2)	
3-5 visits in prior year	6,753 (44.6)	2,693 (45.4)	4.060 (44.1)	
≥ 6 visits in prior year	5,384 (35.6)	2,104 (35.5)	3,280 (35.7)	
Primary care consultation				.21
No	7,104 (47.0)	2,823 (47.6)	4,281 (46.6)	
Yes	8,024 (53.0)	3,109 (52.4)	4,915 (53.4)	
Radiation oncology consultation				.008
No	10,805 (71.4)	4,309 (72.6)	6,496 (70.6)	
Yes	4,323 (28.6)	1,623 (27.4)	2,700 (29.4)	

(continued on following page)

Table 1. Patient Characteristics According to Reimbursement Generosity Index of Urologists Prescribing GnRH Agonists (continued)

Characteristic	Overall (N = 15,128)	GnRH Agonist Reimbursement Less Than or Equal to National Average (n = 5,932)	GnRH Agonist Reimbursement Greater Than National Average (n = 9,196)	*P*
Medical oncology consultation				.04
No	14,603 (96.5)	5,703 (96.1)	8,900 (96.8)	
Yes	525 (3.5)	229 (3.9)	296 (3.2)	
Urology consultation				.008
No	156 (1.0)	45 (0.8)	111 (1.2)	
Yes	14,972 (99)	5,887 (99.2)	9,085 (98.8)	
Rural residence				< .001
No	14,835 (98.1)	5,768 (97.2)	9,067 (98.6)	
Yes	293 (1.9)	164 (2.8)	129 (1.4)	
SEER region				< .001
Seattle	751 (5.0)	644 (10.9)	107 (1.2)	
Connecticut	1,037 (6.9)	477 (8.0)	560 (6.1)	
Detroit	1,270 (8.4)	108 (1.8)	1,162 (12.6)	
Hawaii	163 (1.1)	105 (1.8)	58 (0.6)	
Iowa	1,133 (7.5)	439 (7.4)	694 (7.5)	
New Mexico	368 (2.4)	51 (0.9)	317 (3.4)	
California	4,498 (29.7)	1,982 (33.4)	2,516 (27.4)	
Utah	678 (4.5)	631 (10.6)	47 (0.5)	
Georgia	332 (2.2)	27 (0.5)	305 (3.3)	
Kentucky	1,212 (8.0)	670 (11.3)	542 (5.9)	
Louisiana	1,233 (8.2)	340 (5.7)	893 (9.7)	
New Jersey	2,453 (16.2)	458 (7.7)	1,995 (21.7)	
Median income of patients' communities, dollars				< .001
2,506-35,031	3,574 (23.6)	1,495 (25.2)	2,079 (22.6)	
35,051-46,079	3,817 (25.2)	1,660 (28.0)	2,157 (23.5)	
46,084-60,668	3,563 (23.6)	1,351 (22.8)	2,212 (24.1)	
60,669-200,008	3,596 (23.8)	1,205 (20.3)	2,391 (26.0)	
Missing	578 (3.8)	221 (3.7)	357 (3.9)	
Proportion of patient's community without high school education, %				.002
0-9.7	3,615 (23.9)	1,499 (25.3)	2,116 (23.0)	
9.7-15.5	3,720 (24.6)	1,469 (24.8)	2,251 (24.5)	
15.5-25.2	3,569 (23.6)	1,313 (22.1)	2,256 (24.5)	
25.2-100	3,653 (24.1)	1,431 (24.1)	2,222 (24.2)	
Missing	571 (3.8)	220 (3.7)	351 (3.8)	

NOTE. Data are presented as No. (%) unless otherwise indicated. Reimbursement generosity index indicates GnRH agonist reimbursement relative to the national average. *P* values calculated with *t* test for continuous variables and χ^2 test for binary/categorical variables.
Abbreviations: GnRH, gonadotropin-releasing hormone; SD, standard deviation.

study to minimize the contribution from these potentially confounding factors and exploited a natural variation in reimbursement that occurred both within and between urologists as a result of the inconsistent Medicare reimbursement policy.

A second reason our findings may differ from earlier studies is because the size and consistency of the reimbursement change differed between the study periods. Studies noting large changes in treatment patterns examined a consistent treatment-level reimbursement decrease of 65% over a 2-year

Table 2. Characteristics of Urologists Prescribing Primary GnRH Agonists

Characteristic	Overall (N = 1,800)	GnRH Agonist Reimbursement Less than or Equal to National Average (n = 701)	GnRH Agonist Reimbursement Greater Than National Average (n = 1,099)	*P*
Proportion of patients in practice receiving unnecessary GnRH agonist, mean (SD)	0.3 (0.3)	0.3 (0.3)	0.3 (0.3)	.56
Reimbursement generosity index, mean (SD)	2.9 (73.6)	−37.0 (62.2)	28.4 (68.9)	< .001
Years in practice				.42
< 20	686 (38.1)	259 (36.9)	427 (38.9)	
≥ 20	1,114 (61.9)	442 (63.1)	672 (61.1)	
Sex				.41
Male	1,763 (97.9)	689 (98.3)	1,074 (97.7)	
Female	37 (2.1)	12 (1.7)	25 (2.3)	
US trained				.29
No	298 (16.6)	108 (15.4)	190 (17.3)	
Yes	593 (83.4)	593 (84.6)	909 (82.7)	
Board certified				.55
No	113 (6.3)	41 (5.8)	72 (6.6)	
Yes	1,687 (93.7)	660 (94.2)	1,027 (93.4)	
Medical school affiliation				< .001
None	903 (50.2)	391 (55.8)	512 (46.6)	
Some	854 (47.4)	294 (41.9)	560 (51.0)	
Missing	43 (2.4)	16 (2.3)	27 (2.5)	
Physician prostate panel size, prostate patients per year				.45
0-20	1,195 (66.4)	474 (67.6)	721 (65.6)	
21-37	454 (25.2)	175 (25.0)	279 (25.4)	
≥ 38	151 (8.4)	52 (7.4)	99 (9.0)	
Practice type				.03
Group practice	1,274 (70.8)	471 (67.2)	803 (73.1)	
Solo practice	442 (24.6)	193 (27.5)	249 (22.7)	
Missing	84 (4.7)	37 (5.3)	47 (4.3)	
Proportion of minority patients, %				< .001
< 6.1	668 (37.1)	295 (42.1)	373 (33.9)	
6.2-19.5	522 (29.0)	211 (30.1)	311 (28.3)	
≥ 20	610 (33.9)	195 (27.8)	415 (37.8)	

NOTE. Data are presented as No. (%) unless otherwise indicated. *P* values determined by *t* test for continuous variables and χ^2 test for binary/categorical variables.

Abbreviations: GnRH, gonadotropin-releasing hormone; SD, standard deviation.

period. In our study, although average annual SEER-wide drug reimbursements fluctuated as much as 17% for one of the drugs, at the individual physician level, reimbursement changes were more modest. Most physicians experienced little change in their reimbursement on an annual basis. Of the urologists who used the therapy consistently, 75% experienced RGI changes—positive or negative—of less than 2.6% in any given year. Still, we did not have access to the cost of GnRH agonists used by the urologists. Because physicians would have been responding to marginal costs (difference between cost and reimbursement) rather than reimbursement alone, we assumed that physicians with similar practice characteristics and size might receive similar kinds of discounts and rebates from pharmaceutical manufacturers or have similar access to

Table 3. Multilevel Regression Predicting Primary GnRH Agonist Use

Factor	Odds Ratio	95% CI
Reimbursement generosity index	1.00	1.00 to 1.00
Practice type		
Group practice	Reference	
Solo practice	1.27	1.07 to 1.52
Missing	0.86	0.58 to 1.26
Physician prostate panel size, prostate patients per year		
< 20	Reference	
21-37	0.75	0.65 to 0.86
≥ 38	0.81	0.68 to 0.96
T stage		
T1	Reference	
T2	1.91	1.72 to 2.13
Grade		
Well differentiated, 2-4	Reference	
Moderately differentiated, 5-7	2.26	1.78 to 2.88
Missing	3.50	2.50 to 4.91
No. of comorbidities		
0	Reference	
1	1.40	1.24 to 1.57
2	1.43	1.18 to 1.72
≥ 3	2.07	1.65 to 2.60
Age, years	1.78	1.38 to 2.30
Age, squared	1.00	1.00 to 1.00
Race/ethnicity		
Non-Hispanic white	Reference	
Non-Hispanic black	1.42	1.17 to 1.73
Hispanic	1.25	1.00 to 1.56
Other	1.30	0.94 to 1.79
Missing	1.95	1.50 to 2.53
Radiation oncology consultation		
No	Reference	
Yes	0.26	0.23 to 0.31
Medical oncology consultation		
No	Reference	
Yes	0.88	0.65 to 1.19
Urology consultation		
No	Reference	
Yes	5.62	3.19 to 9.90
Primary care consultation		
No	Reference	
Yes	0.41	0.36 to 0.46
Constant	0.95	0.87 to 1.04

NOTE. Sample includes only patients (n = 15,128) of urologists who prescribed GnRH agonists. The model also adjusts for urologists' length of time in practice, sex, training location, board certification status, medical school affiliation, proportion of minority patients in practice, patients' marital status, rural residence, community educational attainment, community income, prior primary care use, year treated, and SEER region.
Abbreviation: GnRH, gonadotropin-releasing hormone.

third-party suppliers who could negotiate lower drug costs[29,37] and controlled our model accordingly. Nonetheless, whether reimbursement shifted significantly enough to affect marginal costs during our study period is unknown, although none of the prior observational studies suggesting a strong effect of reimbursement on GnRH agonist use measured marginal costs either.[7,8] Better efforts to capture marginal costs are needed in future studies. To place our findings in the context of the unfolding Medicare value initiatives, the global payment changes incurred by the CMS initiative to align fee-for-service payments with higher quality and greater value (the Physician Feedback Program/Value-Based Payment Modifier) resulted in payment cuts of 0.5% to 1% and bonuses of up to 2%.[38] Our study demonstrates that reimbursement variation more than twice the current CMS penalties did not seem to deter potentially inappropriate prescribing. Thus, if small physician-level reimbursement changes have little effect on shaping desired patterns of care, it may be more efficient for CMS to expand alternative payment models (eg, episode-based payments) than to further tweak the current fee-for-service schedule.

However, there are differences in the way reimbursement cuts were experienced in our study compared with the CMS Physician Feedback Program. In localized prostate cancer, any decrease in reimbursement was coupled with the individual administration of the drug. CMS penalties are global, accrue to the practice, and have been widely publicized. Whether and how quickly a physician receives negative feedback for a specific behavior—an important component of effective behavior change—would be mediated by practice management's ability to link the behavior to the consequence and to

implement effective remediation. We cannot assess the mediating effect of practice management, and this should be the subject of future studies that seek to understand how global payment adjustments work effectively. Future research should also isolate the effects of the timing of the reimbursement penalties. CMS penalties lag performance by 2 years. We presume reimbursement cuts were realized more quickly in our study, but time to payment can vary on the basis of practice and carrier factors that were not measured in our administrative claims. Finally, we do not know the degree to which social influences facilitate behavior change in a global payment cut. Although 2015 CMS penalties were equivalent to less than $345 per physician,[38] they accrued to the practice, and the ways practices identify and manage outliers are unknown.

Our study has limitations. First, we were unable to control for the proportion of a physician's patients who were in fee-for service Medicare. However, few urology practices treat high proportions of Medicare patients, and urologists maintained stable portions of Medicare patients during this time.[32-34] Second, we conducted our study among urologists. Much of cancer care is delivered by medical and radiation oncologists, and our results may not be generalizable to these providers. Future studies should address these groups specifically to compare how reimbursement changes, both small and large, affected their prescribing of GnRH agonists to complete our understanding of the clinical and practice contexts in which reimbursement does or does not change clinical decision making. Last, although rates of GnRH agonist use in our study mirror trends reported elsewhere,[7,8] our study is limited to Medicare patients older than 66 years who were treated by urologists.

Although policymakers and payers may view reimbursement change as a promising strategy to reduce overuse,[39] this was not necessarily the case for urologists experiencing average treatment-level variations in GnRH agonist reimbursement of 2.6% in our large, national sample of men with localized prostate cancer. Multiple sensitivity analyses supported our finding that reimbursement changes were not associated with practice patterns. Policy changes being implemented in 2015 also result in small reimbursement cuts to physicians.[40] Our findings suggest these changes may not influence patterns of care; however, additional research to identify the potentially nuanced way in which physicians respond to reimbursement changes is needed to further inform policy decisions. JOP

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AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Are Small Reimbursement Changes Enough to Change Cancer Care? Reimbursement Variation in Prostate Cancer Treatment

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Appendix

Reimbursement Generosity Calculation

The reimbursement generosity index was calculated as follows:

$$R_{it} = \frac{\sum_{g \in g(i,t)} \left(P_{itg} - P_{tg}\right) W_{tg}}{\sum_{g \in g(i,t)} W_{tg}}$$

where P_{itg} is the average reimbursement for patients receiving GnRH agonist g prescribed by provider i in year t, and P_{tg} is the SEER average reimbursement of GnRH agonist g in year t. W_{tg}, the weight for GnRH agonist g, is the ratio of SEER-wide spending on that regimen to total spending on all GnRH agonists. Each GnRH agonist regimen was dose standardized by converting each instance of GnRH agonist in use on separate days to a monthly dosing regimen. Intended duration was determined from the unit designation of the "carrier miles/time/units/serv count" field in carrier claims or the "revenue center unit count" field in outpatient claims. Claims for 12-month implant were assumed to represent 12 months of therapy regardless of unit designation. The alternate RGIs considered in the sensitivity analyses treated all prostate cancer treatments combined (surgery, radiation, and surveillance) as a single treatment modality. In analyses including urologists who did not prescribe GnRH agonists, we considered the RGI to be equal to 0.

Control Variables

Patient-level factors

Disease severity included tumor stage and grade, categorized as low (Gleason score 2 to 4) or intermediate (Gleason score 5 to 7). Comorbidities were measured by the National Cancer Institute Comorbidity Index (Klabunde CN, et al: Ann Epidemiol 17:584-590, 2007).[8] Patient demographics included age, race/ethnicity, and marital status (married/living with partner *v* single, widowed, or divorced, or missing). Health care use included prior primary care use (any claim in the 12 months before diagnosis), (Feldstein PJ: Health Policy Issues: An Economic Perspective [4th ed], 2007) specialist consultation (three binary variables indicating more than one prostate-related claim filed by a radiation oncologist, urologist, or medical oncologist between diagnosis and the earliest of first treatment date or 12 months, Jang TL, et al: Arch Intern Med 170:440-450, 2010), and primary care consultation (more than one visit to the same primary care physician occurring in both the 12 months before diagnosis and the window between diagnosis and treatment, Jang TL, et al: Arch Intern Med 170:440-450, 2010). We also controlled for SEER region, collapsed by state, rurality of patient's residence (urban *v* rural), and community deprivation (quartiles of median income and proportion of adults with $<$ 12 years of education in the patients' ZIP code of residence, Fiscella K, et al: Med Care 39:8-14, 2001).

Provider-level factors

Using data from the American Medical Association and SEER Hospital files, we measured the following: physician sex; time in practice; medical professionalization (Reid RO, et al: Arch Intern Med 170:1442-1449, 2010; Wright JD, et al: J Clin Oncol 29:3408-3418, 2011)[3] defined as board certification (yes or no) and degree of affiliation with an academic institution (categorical); training location (US versus foreign); panel size (number of patients with prostate cancer per year per urologist); practice type (solo, group practice, or missing); and proportion of minority Medicare patients within a practice (quartiles, Shahinian VB, et al: J Clin Oncol 25:5359-5365, 2007). We controlled for national trends by including variables for each year of the study.

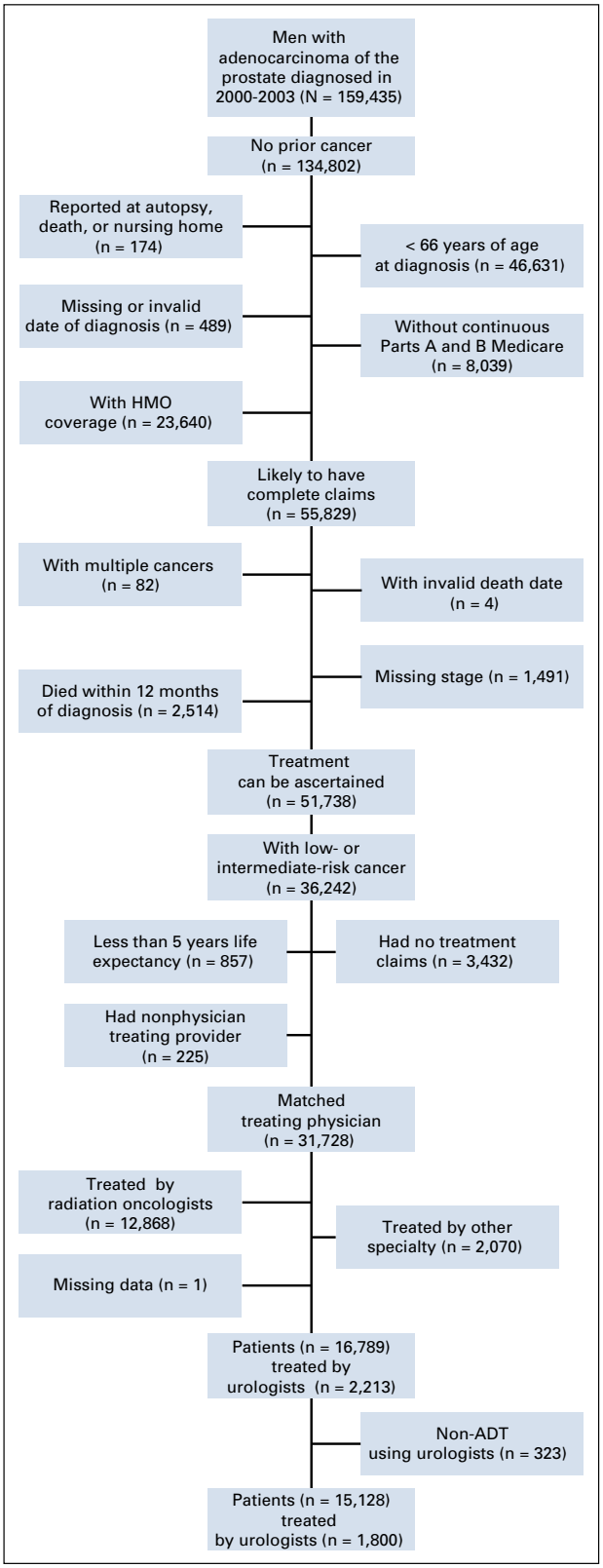

FIG A1. Cohort exclusions. ADT, androgen-deprivation therapy; HMO, health maintenance organization.

Table A1. Treatment Claims

Treatment	ICD-9 Codes	CPT/HCPCS Codes
Androgen deprivation therapy (GnRH agonist)		J0128, J1950, J9202, J9217, J9218, J9219, J9225, J9226, J3315, C9216, C9430, or S0165
Nonsurveillance prostate treatment	60, 60.1, 60.21, 60.29, 60.3, 60.4, 60.5, 60.61-60.69, 62.3, 62.4, 62.41, 62.42, 92.2, 92.21, 92.22, 92.23, 92.24, 92.25, 92.26, 92.27, 92.28, 92.29, 99.25, V58.0, V58.1x, V66.1, V66.2, V67.1, V67.2	00865, 54520, 54522, 54530, 54535, 54690, 55801, 55810, 55812, 55815, 55821, 55831, 55840, 55842, 55845, 55860, 55866, 55873, 55875, 55876, 76873, 77301, 77305, 77310, 77315, 77321, 77326, 77327, 77328, 77338, 77371, 77372, 77373, 77380, 77381, 77402, 77403, 77404, 77406, 77407, 77408, 77409, 77411, 77412, 77413, 77414, 77416, 77418, 77423, 77432, 77435, 77520, 77522, 77523, 77525, 77750-77760, 77761, 77762, 77763, 77774, 77775, 77776, 77777, 77778, 77779, 77780, 77781, 77782, 77783, 77784, 77785, 77786, 77787, 77789, 77790, 77791-77798, 77799, G0356, J1675, J9000-J9164, 0073T, 0082T, 0083T, 0182T, 4164F, A9527, C1715, C1716, C1717, C1719, C1728, C2634, C2635, C2636, C2637, C2638, C2639, C2640, C2641, C2642, C2643, C2698, C2699, C9725, G0174, G0178, G0251, G0339, G0340, J1050, J1051, J9165, J9166-J9201, J9203-J9216, J9220-J9224, J9227- J9998, J9999, Q0083-Q0085, Q3001, S0175, S9560, C2616

Abbreviations: CPT, current procedural terminology; GnRH, gonadotropin-releasing hormone; HCPCS, Healthcare Common Procedure Coding System; ICD-9: International Classification of Diseases, 9th Revision.