Original Investigation

Physician Variation in Management of Low-Risk Prostate Cancer
A Population-Based Cohort Study

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IMPORTANCE Up-front treatment of older men with low-risk prostate cancer can cause morbidity without clear survival benefit; however, most such patients receive treatment instead of observation. The impact of physicians on the management approach is uncertain.

OBJECTIVE To determine the impact of physicians on the management of low-risk prostate cancer with up-front treatment vs observation.

DESIGN, SETTING, AND PARTICIPANTS Retrospective cohort of men 66 years and older with low-risk prostate cancer diagnosed from 2006 through 2009. Patient and tumor characteristics were obtained from the Surveillance, Epidemiology, and End Results cancer registries. The diagnosing urologist, consulting radiation oncologist, cancer-directed therapy, and comorbid medical conditions were determined from linked Medicare claims. Physician characteristics were obtained from the American Medical Association Physician Masterfile. Mixed-effects models were used to evaluate management variation and factors associated with observation.

MAIN OUTCOMES AND MEASURES No cancer-directed therapy within 12 months of diagnosis (observation).

RESULTS A total of 2145 urologists diagnosed low-risk prostate cancer in 12 068 men, of whom 80.1% received treatment and 19.9% were observed. The case-adjusted rate of observation varied widely across urologists, ranging from 4.5% to 64.2% of patients. The diagnosing urologist accounted for 16.1% of the variation in up-front treatment vs observation, whereas patient and tumor characteristics accounted for 7.9% of this variation. After adjustment for patient and tumor characteristics, urologists who treat non–low-risk prostate cancer (adjusted odds ratio [aOR], 0.71 [95% CI, 0.55-0.92]; $P = .01$) and graduated in earlier decades ($P = .004$) were less likely to manage low-risk disease with observation. Treated patients were more likely to undergo prostatectomy (aOR, 1.71 [95% CI, 1.45-2.01]; $P < .001$), cryotherapy (aOR, 28.2 [95% CI, 19.5-40.9]; $P < .001$), brachytherapy (aOR, 3.41 [95% CI, 2.96-3.93]; $P < .001$), or external-beam radiotherapy (aOR, 1.31 [95% CI, 1.08-1.58]; $P = .005$) if their urologist billed for that treatment. Case-adjusted rates of observation also varied across consulting radiation oncologists, ranging from 2.2% to 46.8% of patients.

CONCLUSIONS AND RELEVANCE Rates of management of low-risk prostate cancer with observation varied widely across urologists and radiation oncologists. Patients whose diagnosis was made by urologists who treated prostate cancer were more likely to receive up-front treatment and, when treated, more likely to receive a treatment that their urologist performed. Public reporting of physicians' cancer management profiles would enable informed selection of physicians to diagnose and manage prostate cancer.

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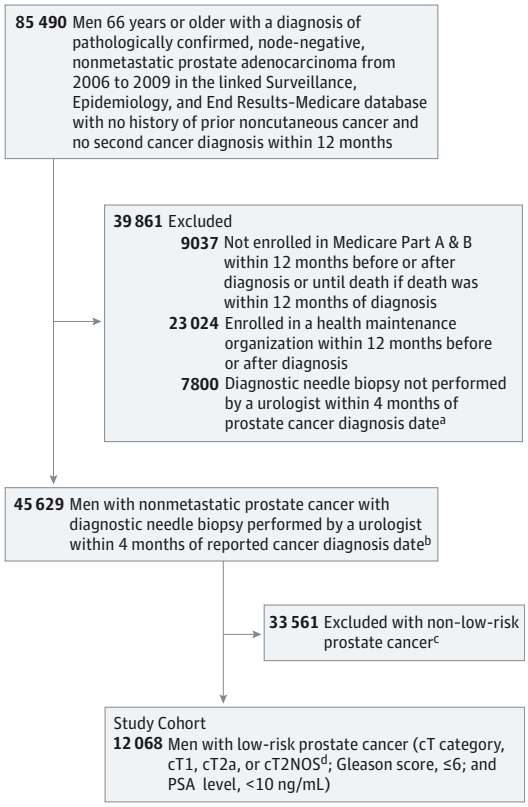
Low-risk prostate cancer (clinical tumor [cT] category, T1-T2a; Gleason score, ≤6; and serum prostate-specific antigen [PSA] level, <10 ng/mL [to convert to micrograms per liter, multiply by 1.0]) is unlikely to cause symptoms or affect survival if left untreated. However, most men with a diagnosis of low-risk prostate cancer in the United States receive up-front treatment with prostatectomy or radiotherapy and are thus exposed to the risk of treatment-induced urinary dysfunction, rectal bleeding, and impotence.[1-3] Observation is an alternative to up-front treatment for low-risk prostate cancer and is endorsed by numerous professional societies.[4-6] Randomized trials demonstrate that in older men with low-risk prostate cancer, observation yields similar survival and decreased morbidity compared with up-front treatment.[7,8] Nevertheless, few eligible men opt for observation.[1]

Prior studies suggest that the choice of up-front treatment vs observation for early-stage prostate cancer is influenced by patient factors, including age and severity of comorbid conditions.[2,9] It is not known, however, whether management approach is influenced by physician factors, including characteristics of the diagnosing urologist, who conveys the diagnosis and discusses disease severity and management. Primary care physicians who refer patients to urologists for prostate biopsy may assume that patients will receive similar management recommendations regardless of the urologist they see. We sought to determine whether this is indeed the case. In a population-based cohort of older men with low-risk prostate cancer, we sought to (1) determine the relative impact of the diagnosing urologist and patient factors on choice of observation vs up-front treatment, (2) quantify the rate of observation vs up-front treatment for individual urologists, and (3) identify urologist and patient factors associated with selection of observation. Because many older men with prostate cancer also meet with a radiation oncologist, we similarly evaluated the impact of the consulting radiation oncologist on the management approach.

Figure 1. Cohort Selection Criteria



cT Indicates clinical tumor, and PSA, prostate-specific antigen.
[a]This step excluded patients whose diagnosis was made by transurethral resection of the prostate alone; patients who received a diagnosis in the Veterans Affairs or military medical system, in which claims are not submitted; and patients whose diagnostic biopsy was performed by a nonurologist. There were no clinically meaningful differences between men who were and were not matched to a diagnosing urologist.
[b]These men were used to determine urologist diagnosis volume and radiation oncologist treatment volume.
[c]These men who did not have low-risk prostate cancer were used to determine whether or not the urologist treated non–low-risk prostate cancer.
[d]Because men with cT2NOS disease could have higher-volume disease, men with cT2 disease were excluded from sensitivity analyses.

Methods

Study Participants

Study participants were selected from the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) database. Under the supervision of the National Cancer Institute, records from the SEER database have been linked to Medicare claims. The study was granted exemption by our institution's institutional review board, and informed consent was waived because the medical records were part of a publicly available, anonymized database.

The study cohort comprised men 66 years and older with low-risk prostate adenocarcinoma diagnosed during 2006 through 2009 (**Figure 1**). Men with cT2NOS disease likely had low-risk disease because categorization into a non-low-risk group is usually driven by Gleason score of greater than 6 or PSA level of at least 10 ng/mL. However, men with cT2NOS disease were excluded in sensitivity analyses. We chose the period 2006 through 2009 because this was after publication of the Scandinavian Prostate Cancer Group Study Number 4 (SPCG-4), which showed that among men 65 years and older with clinically localized prostate cancer, watchful waiting and up-front prostatectomy produced similar survival outcomes.[10] Throughout the period covered by our study, National Comprehensive Cancer Network (NCCN) guidelines recommended observation as a treatment option for men with low-risk prostate cancer.[11,12] Men without continuous fee-for-service Medicare coverage during the 12 months before and after diagnosis were excluded because their claims would not be sufficient to determine comorbidity and treatment.

Outcome

The primary outcome was receipt of prostate cancer treatment within 12 months of diagnosis. Patients were considered to have received up-front treatment if codes for prostatectomy, radiotherapy, cryotherapy, or androgen deprivation

therapy were present in either registry or claims data within 12 months of the registry date of diagnosis (eTable 1 in the Supplement). Patients not receiving treatment were classified as undergoing observation.

Covariates

Patient-level covariates were age, race and ethnicity, comorbidity, Medicaid coverage, cT category, diagnosis year, and registry. Comorbidity score was calculated from claims submitted during the period from 12 months to 1 month before diagnosis using the adaptation of the Charlson comorbidity index by Klabunde and colleagues.[13]

The diagnosing urologist was identified from Medicare claims (eTable 1 in the Supplement) as the urologist who performed the first diagnostic prostate biopsy within 4 months of diagnosis. The consulting radiation oncologist was identified from Medicare claims as the radiation oncologist who delivered radiotherapy or, if the patient did not receive radiotherapy, the first radiation oncologist whom the patient saw. Physician-level covariates, determined via linkage to the American Medical Association Physician Masterfile, included sex, decade of medical school graduation, medical degree, training location, and board certification. Urologist diagnosis volume and radiation oncologist treatment volume were defined in men with node-negative, nonmetastatic cancer and divided into tertiles. A urologist was classified as treating non–low-risk prostate cancer if he or she submitted claims for prostatectomy, cryotherapy, brachytherapy, external-beam radiotherapy, or androgen deprivation therapy for patients with non–low-risk disease (Figure 1).

Statistical Analyses

Descriptive statistics were used to summarize characteristics of urologists, radiation oncologists, and patients. Hierarchical mixed-effects models were used to evaluate the odds of observation with patients nested within physicians and to estimate the proportion of variation in the rate of observation attributable to physician-level and patient-level covariates.[14,15] The unit of analysis in the logistic regression was the patient. This multilevel logistic regression model assumes a physician-level random effect, which explicitly considers the interdependencies among patients treated by the same physician. Variance of the random intercept describes heterogeneity in observation rate among physicians after patient-level covariates are accounted for. To measure the impacts of the physician-level and patient-level effects on use of observation, we used the threshold method to estimate the proportion of outcome variance attributable to physician-level or patient-level effects in accordance with published methods.[16,17(pp302-307)] Given prior literature,[2,9] we included patient age, race and ethnicity, comorbidity, cT category, and PSA level as fixed patient-level covariates in the mixed-effects models. Backward selection with a *P* value cutoff of .10 was used to identify additional patient and physician factors for inclusion in the regression model. Physicians who diagnosed prostate cancer in at least 1 patient in the study cohort were included in the main analyses, and patients and physicians with unknown covariate values were excluded from the final model.

Using the hierarchical model adjusted for patient-level covariates, we calculated the case-adjusted rate of observation and 95% confidence intervals (CIs) for each physician who diagnosed prostate cancer in or consulted with 10 or more patients (patients with unknown covariate values were excluded). Physicians were ranked from lowest to highest rate of observation, and predicted observation rates were graphed relative to the adjusted mean rate.[16] All analyses were conducted using SAS for Windows, version 9.2 (SAS Institute Inc).

Results

A total of 12 068 patients with low-risk prostate cancer met the selection criteria (**Table 1**). Most patients were non-Hispanic white (79.7%), had cT1 disease (73.4%), and were seen by a radiation oncologist (67.8%). The median age was 72 years. These patients' cancers were diagnosed by 2145 urologists. Most urologists (88.2%) treated non–low-risk prostate cancer (**Table 2**).

Urologist and Patient Factors Associated With Observation

Most patients (80.1%) received up-front treatment; 19.9% were observed (Table 1). In multivariable analysis adjusted for patient-level and urologist-level characteristics, urologists who graduated from medical school more recently were more likely to manage low-risk disease with observation ($P = .004$), whereas urologists with a DO degree ($P = .04$) and urologists who treated non–low-risk prostate cancer ($P = .01$) were less likely to manage low-risk disease with observation (**Table 3**). Management with observation was not associated with urologist diagnosis volume ($P > .10$, not selected for inclusion in the multivariable model). Older men ($P < .001$) and men who received diagnoses more recently ($P < .001$) were more likely to undergo observation. However, 55.1% of men older than 80 years received up-front treatment (eTable 2 in the Supplement).

Men seen by urologists only were more likely to undergo observation (1703 of 3890 [43.8%]) than men seen by a radiation oncologist and a urologist (700 of 8178 [8.6%]) ($P < .001$). Overall, 70.8% (1703 of 2403) of men who underwent observation saw only a urologist.

In sensitivity analyses, the frequency of observation changed by less than 2% when the definition of up-front treatment was changed to treatment within 6 months of diagnosis or within 18 months of diagnosis. Most (86.6%) men with observation underwent subsequent PSA evaluation or prostate biopsy, indicating that their disease was managed with surveillance.

Multilevel analyses estimating the relative contributions of the diagnosing urologist and patient-level fixed effects to the variance in the rate of observation are summarized in eTable 3 in the Supplement. The diagnosing urologist was the most influential measured factor, responsible for 16.1% of the variance in management choice; just 7.9% of the variance was attributable to measured patient characteristics. The diagnosing urologist remained the most influential factor in sensitiv-

Table 1. Characteristics of Patients With Low-Risk Prostate Cancer

Characteristic	No. (%) of Patients[a] (N = 12 068)
Age, y	
66-70	5068 (42.0)
71-75	4131 (34.2)
76-80	2158 (17.9)
>80	711 (5.9)
Race and ethnicity	
Non-Hispanic white	9612 (79.7)
Hispanic	691 (5.7)
Non-Hispanic black	969 (8.0)
Non-Hispanic other	796 (6.6)
Comorbidity score	
0	8337 (69.1)
1	2613 (21.7)
≥2	1118 (9.3)
Medicaid coverage	
No	11 113 (92.1)
Yes	955 (7.9)
cT category	
cT1	8853 (73.4)
cT2	3215 (26.6)
PSA level, ng/mL	
<4	2052 (17.0)
4-10	10 016 (83.0)
Diagnosis year	
2006	3274 (27.1)
2007	3293 (27.3)
2008	2900 (24.0)
2009	2601 (21.6)
Registry	
California[b]	3368 (27.9)
Connecticut	583 (4.8)
Detroit	661 (5.5)
Georgia[c]	1748 (14.5)
Hawaii	115 (1.0)
Iowa	559 (4.6)
Kentucky	770 (6.4)
Louisiana	934 (7.7)
New Jersey	2088 (17.3)
New Mexico	218 (1.8)
Seattle	673 (5.6)
Utah	351 (2.9)
Seen by radiation oncologist	
Yes	8178 (67.8)
No	3890 (32.2)
Primary management	
Observation	2403 (19.9)
Prostatectomy	1855 (15.4)
Brachytherapy	2774 (23.0)
EBRT	3513 (29.1)
EBRT and brachytherapy	749 (6.2)
Cryotherapy	340 (2.8)
Androgen deprivation therapy	434 (3.6)

Abbreviations: cT, clinical tumor; EBRT, external-bean radiotherapy; PSA, prostate-specific antigen.

SI conversion factor: To convert PSA level to micrograms per liter, multiply by 1.0.

[a] Percentages may not total 100% because of rounding.

[b] Greater California, Los Angeles, San Francisco–Oakland, and San Jose–Monterey.

[c] Atlanta and rural Georgia.

ity analyses limited to patients with cT1 disease or patients who did not undergo prostatectomy.

Urologist Case-Adjusted Frequency of Observation

Because patient factors affect the likelihood of observation, case-adjusted frequency of observation was estimated for urologists with the characteristics of their patients taken into account. The analysis was limited to 391 physicians who diagnosed low-risk prostate cancer in at least 10 study participants to enable calculation of CIs. The mean case-adjusted rate of observation was 19.7%. The case-adjusted rate of observation varied widely across urologists, from 4.5% to 64.2% (**Figure 2**A). Forty urologists (10.2%) had rates significantly different from the mean ($P < .05$). Similar variation was seen in sensitivity analysis of 955 physicians who diagnosed low-risk prostate cancer in at least 5 study participants.

Impact of Type of Treatment Performed by Diagnosing Urologist

For the patients who received up-front treatment, we evaluated whether the type of treatment performed by the diagnosing urologist affected the type of treatment that the patient received. Men were more likely to undergo prostatectomy (23.8% vs 12.4%; $P < .001$), cryotherapy (22.0% vs 1.0%; $P < .001$), and brachytherapy (47.5% vs 21.0%; $P < .001$) if their urologist performed that treatment for non-low-risk disease (**Table 4**). Similarly, men whose cancers were diagnosed by urologists who billed for external-beam radiotherapy were more likely to receive external-beam radiotherapy (52.7% vs 42.9%; $P = .005$). Most patients who underwent prostatectomy (1449 of 1855 [78.1%]) had prostatectomy performed by the diagnosing urologist.

Impact of Radiation Oncologist Factors

Characteristics of the 870 radiation oncologists who met with study participants and the 7554 study participants who met with radiation oncologists are summarized in eTable 4 in the Supplement. Of the men who met with a radiation oncologist, 91.5% received up-front treatment and 8.5% were observed (eTable 4 in the Supplement). In multivariable analysis, radiation oncologists with a DO degree were less likely to manage disease with observation ($P = .02$)

Table 2. Characteristics of the Diagnosing Urologists

Characteristic	No. (%) of Urologists (N = 2145)[a]
Sex	
Female	61 (2.8)
Male	2047 (95.4)
Unknown	37 (1.7)
Decade of graduation	
Prior to 1980	906 (42.2)
1980-1989	572 (26.7)
After 1989	630 (29.4)
Unknown	37 (1.7)
US training	
Yes	1827 (85.2)
No	281 (13.1)
Unknown	37 (1.7)
Degree	
MD	2050 (95.6)
DO	58 (2.7)
Unknown	37 (1.7)
Board certified	
Yes	1979 (92.3)
No	129 (6.0)
Unknown	37 (1.7)
Patient volume	
Lowest tertile	729 (34.0)
Middle tertile	703 (32.8)
Highest tertile	713 (33.2)
Prostate cancer treatments performed[b]	
None	253 (11.8)
Prostatectomy	1128 (52.6)
Brachytherapy	894 (41.7)
External-beam radiotherapy	156 (7.3)
Cryotherapy	216 (10.1)
Androgen deprivation therapy	1760 (82.1)

[a] Percentages may not total 100% because of rounding.

[b] Total exceeds 100% because some urologists perform more than 1 type of treatment.

(eTable 5 in the Supplement). There was no association between observation and physician treatment volume or decade of graduation ($P > .10$, not selected for inclusion in the multivariable model).

In multilevel analyses (eTable 6 in the Supplement), 19.0% of the variance in management choice was attributable to the radiation oncologist and just 3.2% to measured patient characteristics. For radiation oncologists who treated at least 10 men with low-risk prostate cancer, case-adjusted rates of observation varied widely, from 2.2% to 46.8% (Figure 2B).

Discussion

In this group of older Medicare patients eligible for observation because they had low-risk prostate cancer, 80.1% received up-front treatment. Case-adjusted rates of observation varied widely across both urologists (from 4.5% to 64.2%) and radiation oncologists (from 2.2% to 46.8%). The variance in treatment selection attributable to physicians was at least double the variance attributable to measured patient-level characteristics such as age, comorbidity, cT category, and PSA level. Patients who received their diagnoses from urologists who treated non–low-risk prostate cancer were more likely to receive up-front treatment and, when treated, more likely to receive a treatment that their diagnosing urologist used for men with non–low-risk disease. These findings strongly suggest that physicians substantially influence not only decision making regarding up-front treatment vs observation but also the type of up-front treatment when treatment is selected.

Our findings have implications for policymakers, primary care physicians, and patients. At least two-thirds of men in this cohort had cancer detected by PSA screening (cT1c disease). The US Preventive Services Task Force has recommended against PSA screening, stating that "the balance of benefits and harms of prostate cancer screening is heavily influenced by . . . overtreatment"[18(p126)] and its associated morbidity. Our finding of meaningful physician-level variation in management of low-risk prostate cancer implies that the risk of overtreatment varies by physician. Public reporting of physicians' rates of observation would empower primary care physicians and patients to seek out urologists and radiation oncologists who choose observation for suitable patients (see eAppendix in the Supplement).[19,20]

We postulate that the diagnosing urologist plays an important role in treatment selection because he or she is the first to convey the diagnosis to the patient and discuss disease severity and management options. Physician description of prostate cancer is known to affect patient perception of the seriousness of the condition and to affect treatment choice.[21] In addition, patients report that physician recommendation is the most important reason that they select a prostate cancer treatment.[21-24] We could not determine which management options were offered to patients or the tone of the recommendations, but other studies have demonstrated that some men with low-risk prostate cancer are not offered observation.[23,25] Diagnosing urologists also refer patients to other physicians for second opinions and radiotherapy. Prostate cancer physician referral networks are relatively stable.[26] Because diagnosing urologists refer patients to other physicians, the management selected may also reflect discussions between the patient and the physicians to whom the patient was referred. However, prior literature indicates that fewer management options are discussed at second consultations than at the primary consultation and that most men who seek a second opinion accept the first management recommendation.[24,27] In addition, more than two-thirds of the men in our study who underwent observation saw only a urologist and did not meet with a radiation oncologist, suggesting that urologists play a key role in the selection of observation.

Urologists who treated men with non–low-risk prostate cancer were more likely to manage low-risk disease with up-front treatment rather than observation. A possible explanation is that urologists have witnessed the morbidity of late-stage, aggressive prostate cancer. Financial incentives may also

Table 3. Diagnosing Urologist and Patient Characteristics Associated With Observation[a]

Characteristic	No. of Urologists	No. of Patients	Urologists' Patients With Disease Managed With Observation, %	Patients With Disease Managed With Observation, %	Adjusted Odds Ratio	*P* Value
Physician Characteristics						
Decade of graduation						
Prior to 1980	906	...	19.1	...	1 [Reference]	
1980-1989	572	...	20.1	...	1.17 (1.01-1.36)	.04
After 1989	630	...	21.3	...	1.26 (1.08-1.48)	.004
Degree						
MD	2050	...	20.1	...	1 [Reference]	
DO	58	...	13.4	...	0.66 (0.44-0.97)	.04
Treats non-low-risk prostate cancer						
No	246	...	25.0	...	1 [Reference]	
Yes	1862	...	19.8	...	0.71 (0.55-0.92)	.01
Patient Characteristics						
Age, y						
66-70	...	5002	...	13.8	1 [Reference]	
71-75	...	4089	...	18.0	1.44 (1.28-1.61)	<.001
76-80	...	2135	...	30.0	2.95 (2.59-3.36)	<.001
>80	...	701	...	45.1	5.63 (4.70-6.74)	<.001
Race and ethnicity						
Non-Hispanic white	...	9502	...	18.9	1 [Reference]	
Hispanic	...	684	...	18.0	0.94 (0.75-1.17)	.57
Non-Hispanic black	...	957	...	18.2	1.14 (0.94-1.37)	.19
Non-Hispanic other	...	784	...	37.1	2.43 (1.99-2.96)	<.001
Comorbidity score						
0	...	8239	...	19.5	1 [Reference]	
1	...	2580	...	20.3	1.01 (0.91-1.13)	.83
≥2	...	1108	...	22.9	1.12 (0.95-1.30)	.17
cT category						
cT1	...	8753	...	18.4	1 [Reference]	
cT2	...	3174	...	24.4	1.23 (1.10-1.39)	<.001
PSA level, ng/mL						
<4	...	2032	...	22.3	1 [Reference]	
4-10	...	9895	...	19.5	0.88 (0.77-1.00)	.06

(continued)

influence management because up-front treatment generates more revenue than observation.[28] Concern has been raised that urologists' financial interest in radiation equipment may increase the use of external-beam radiotherapy.[29] We could not determine whether individual urologists had ownership interest in radiation equipment. However, patients whose cancers were diagnosed by urologists who billed for external-beam radiotherapy were more likely to receive external-beam radiotherapy, a finding consistent with the recent Government Accountability Office[30] report that urologists with financial interest in radiation services are more likely to treat men with intensity-modulated external-beam radiotherapy.

As seen in other studies, we found that most older men who received up-front treatment underwent radiotherapy. Patients referred for radiation oncology consultation are presumably preselected on the basis of perceived need, interest in radiotherapy, or operative risk. However, case-adjusted rates of observation varied across radiation oncologists, indicating that individual radiation oncologists can influence treatment selection. These findings underscore the importance of the American Society for Radiation Oncology's recently published recommendations that radiation oncologists and patients not "initiate management of low-risk prostate cancer without discussing active surveillance."[31] Future research will be needed to evaluate whether these recommendations increase rates of observation and lessen interphysician variation.

Although up-front treatment of older men with low-risk prostate cancer can cause morbidity[32,33] without clear survival benefit, only 19.9% of the men in our cohort underwent observation. Prospective observational studies of men with low-risk prostate cancer managed with observation with active surveillance (serial PSA testing, digital rectal examina-

Table 3. Diagnosing Urologist and Patient Characteristics Associated With Observation (continued)[a]

Characteristic	No. of Urologists	No. of Patients	Urologists' Patients With Disease Managed With Observation, %	Patients With Disease Managed With Observation, %	Adjusted Odds Ratio	*P* Value
Diagnosis year						
2006	...	3236	...	17.5	1 [Reference]	
2007	...	3246	...	17.3	1.01 (0.88-1.15)	.90
2008	...	2863	...	21.1	1.36 (1.18-1.56)	<.001
2009	...	2582	...	25.1	1.76 (1.53-2.02)	<.001
Registry						
California[b]	...	3341	...	24.2	1 [Reference]	
Connecticut	...	581	...	21.7	1.14 (0.86-1.51)	.36
Detroit	...	659	...	21.9	0.93 (0.69-1.25)	.63
Georgia[c]	...	1709	...	15.1	0.69 (0.55-0.87)	.001
Hawaii	...	115	...	17.4	0.28 (0.15-0.52)	<.001
Iowa	...	542	...	14.0	0.61 (0.45-0.84)	.002
Kentucky	...	757	...	18.9	0.94 (0.69-1.27)	.68
Louisiana	...	930	...	21.5	0.91 (0.71-1.17)	.47
New Jersey	...	2062	...	14.6	0.59 (0.48-0.71)	<.001
New Mexico	...	215	...	22.3	1.03 (0.68-1.57)	.89
Seattle	...	673	...	22.7	1.11 (0.84-1.45)	.47
Utah	...	343	...	30.6	1.64 (1.15-2.34)	.006

Abbreviations: cT, clinical tumor; ellipses, not applicable; PSA, prostate-specific antigen.

SI conversion factor: To convert PSA level to micrograms per liter, multiply by 1.0.

[a] Hierarchical (patients nested within urologists) mixed-effects multivariable model evaluating 2108 urologists and 11 927 of their patients. Patients and physicians with unknown covariates were excluded. Age, race and ethnicity, comorbidity, clinical tumor category, and PSA level were included on the basis of prior studies in the literature. Inclusion of additional patient characteristics (Medicaid coverage, registry) and urologist characteristics (decade of graduation, training location, degree, board certification, diagnosis volume, treatment of prostate cancer) were considered using backward selection with *P* value cutoff of .10.

[b] Greater California, Los Angeles, San Francisco–Oakland, and San Jose–Monterey.

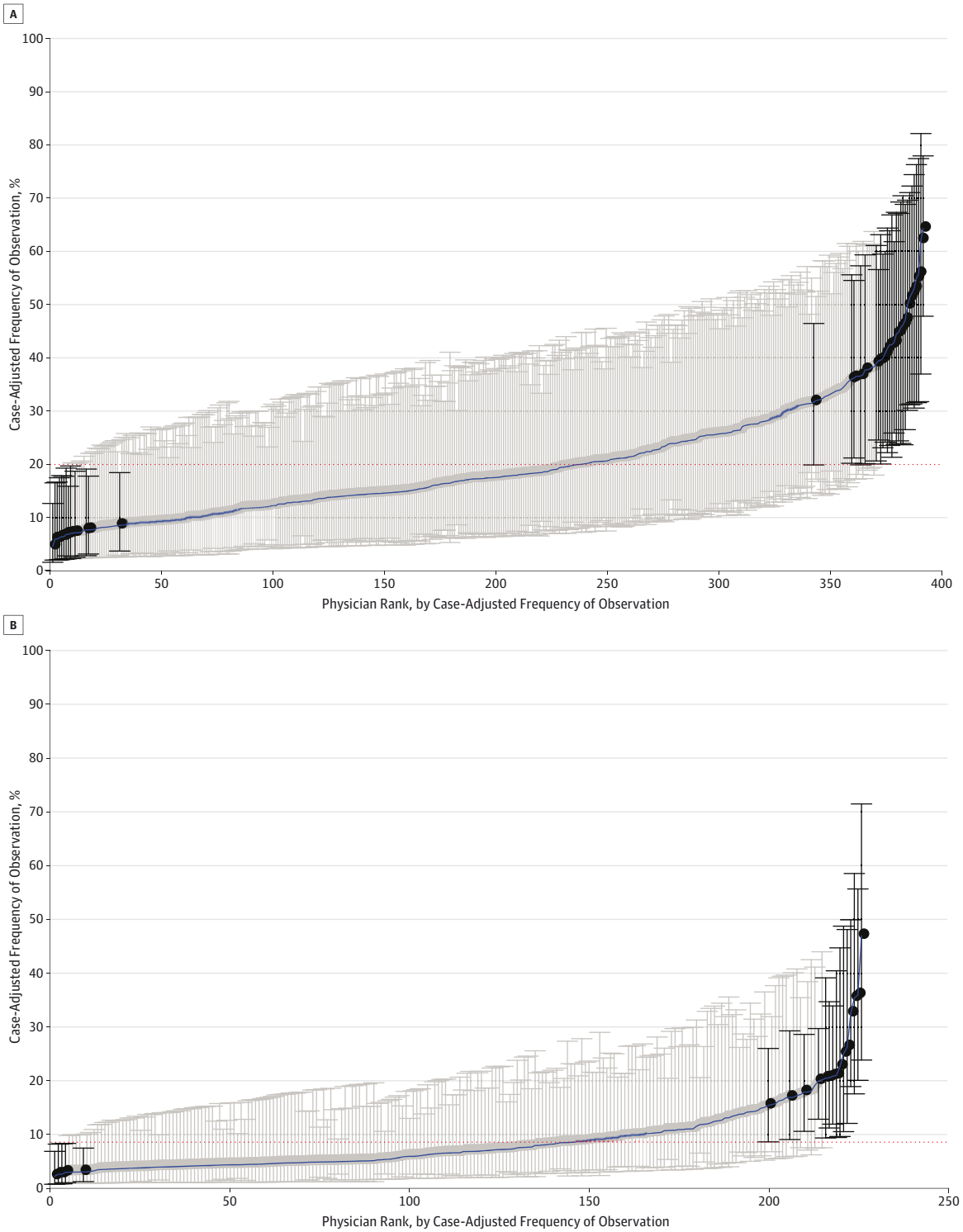
[c] Atlanta and rural Georgia.

tion, and repeated biopsy with selective delayed intervention for histologic or PSA progression) report low rates of prostate cancer mortality.[3,4] Furthermore, randomized trials demonstrate that observation does not compromise survival in appropriately selected older men. Men 65 years and older with clinically localized prostate cancer managed with watchful waiting in the SPCG-4 had prostate cancer metastasis and survival outcomes similar to those in men who underwent prostatectomy.[7,10] Likewise, in the Prostate Cancer Intervention vs Observation Randomized Trial (PIVOT), observation did not increase prostate cancer or all-cause mortality compared with prostatectomy for men with clinically localized prostate cancer in the PSA-screening era.[8]

Our study and others demonstrate that older men with low-risk prostate cancer are more likely to undergo observation than are younger men.[2,9,35] However, in our cohort, 70.0% of men aged 76 to 80 years and 55.1% of men older than 80 years still received up-front treatment. The high treatment rate in the oldest men is striking because average life expectancy for men 77 years and older in the United States is less than 10 years.[36] Older men, especially those with multiple medical conditions, are not thought to gain a survival benefit from treatment of low-risk prostate cancer. Because potential harms outweigh benefits for men with limited life expectancy, current NCCN guidelines recommend observation as the only management option for men with low-risk prostate cancer and a life expectancy of less than 10 years.[4]

Because the catchment for this cohort encompassed 26% of the US population, the findings are likely representative of national care patterns and physician variation in the treatment of older men enrolled in fee-for-service Medicare during the study era. Nevertheless, our study has certain limitations. First, we used the most recent available data, but practice patterns may have shifted in subsequent years. Results from the SPCG-4 trial and from expectant-management studies supporting observation were available during the study period, but additional prospective expectant-management studies and the PIVOT trial were published after the study period.[8,34,37-39] Second, although all men were candidates for observation according to NCCN guidelines, we could not measure certain factors that may affect treatment choice, such as number and extent of biopsy cores involved with cancer, family history of prostate cancer, and patient anxiety. These factors may account for some of the residual patient-level variance. Third, the Gleason score for patients who underwent prostatectomy was based on pathologic examination of the prostatectomy specimen. Therefore, we may have inappropriately excluded men who had biopsy Gleason score upgraded at prostatectomy (thereby overestimating the frequency of observation) or included men who had Gleason

Figure 2. Case-Adjusted Frequency of Management of Low-Risk Prostate Cancer With Observation for Individual Urologists and Radiation Oncologists



Frequency of observation is adjusted for patient age, race and ethnicity, comorbidity, Medicaid coverage, clinical tumor category, and serum prostate-specific antigen level. Red dotted line indicates mean case-adjusted frequency of observation, and black bars, physicians who had rates significantly different from the mean ($P < .05$). The 95% confidence interval bars take into account variability of the calculated rate based on the size of the patient panel. A, Frequency by rank, from lowest (4.5%) to highest (64.2%), for 391 urologists who diagnosed low-risk prostate cancer in at least 10 men in the study cohort (blue line). Mean case-adjusted frequency was 19.7%; 40 urologists had rates significantly different from the mean. B, Frequency by rank, from lowest (2.2%) to highest (46.8%), for 226 radiation oncologists who saw at least 10 men with low-risk prostate cancer in the study cohort (blue line). Mean case-adjusted frequency of observation was 8.5%; 20 radiation oncologists had rates significantly different from the mean.

Table 4. Association Between Type of Prostate Cancer Treatment Performed or Billed by Diagnosing Urologist and Type of Treatment Received by Patients Who Underwent Up-Front Treatment

Type of Treatment Performed or Billed by Diagnosing Urologist	Adjusted Odds Ratio (95% CI) of Receiving Specific Type of Treatment for Low-Risk Prostate Cancer[a]							
	Prostatectomy	*P* Value	Cryotherapy	*P* Value	Brachytherapy	*P* Value	External-Beam Radiotherapy	*P* Value
Prostatectomy	1.71 (1.45-2.01)	<.001	1.05 (0.70-1.58)	.80	0.81 (0.70-0.94)	.004	0.84 (0.73-0.96)	.01
Cryotherapy	0.90 (0.72-1.13)	.38	28.2 (19.5-40.9)	<.001	0.65 (0.53-0.79)	<.001	0.50 (0.40-0.61)	<.001
Brachytherapy	0.69 (0.58-0.81)	<.001	0.45 (0.31-0.65)	<.001	3.41 (2.96-3.93)	<.001	0.62 (0.54-0.70)	<.001
External-beam radiotherapy	0.94 (0.73-1.22)	.66	0.57 (0.32-1.01)	.06	0.78 (0.62-0.98)	.03	1.31 (1.08-1.58)	.005

[a] Hierarchical (patients nested within urologists) mixed-effects multivariable models evaluating 1984 urologists and 9546 of their patients who received up-front treatment. Patients and physicians with unknown covariates were excluded. Models were adjusted for patient characteristics (age, race and ethnicity, comorbidity, Medicaid coverage, registry, clinical tumor category, prostate-specific antigen level) and urologist characteristics (decade of graduation, training location, degree, board certification, prostate cancer treatment type). Sequential models evaluated the outcome of treatment with prostatectomy, cryotherapy, brachytherapy, and external-beam radiotherapy.

score downgraded at prostatectomy (estimated to be <1% of the cohort[40]). However, findings were stable in sensitivity analyses limited to men who did not undergo prostatectomy. Finally, we evaluated frequency of observation but did not distinguish between watchful waiting, active surveillance, and loss to follow-up. However, most men whom we classified in the observation group had subsequent PSA evaluation or prostate biopsy, suggesting that their disease was managed with surveillance.

Conclusions

There is meaningful physician-level variation in the management of low-risk prostate cancer. Public reporting of physicians' cancer management profiles would enable primary care physicians and patients to make more informed decisions when selecting a physician to diagnose and manage prostate cancer.

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