HSR Health Services Research

DOI: 10.1111/1475-6773.12148
RESEARCH ARTICLE

Surgical Quality Is More Than Volume: The Association between Changing Urologists and Complications for Patients with Localized Prostate Cancer

Eva H. DuGoff, Justin E. Bekelman, Elizabeth A. Stuart, Katrina Armstrong, and Craig Evan Pollack

Objectives. To examine the association of changing urologists on surgical complications in men with prostate cancer.

Data Sources/Study Setting. Registry and administrative claims data from the Surveillance, Epidemiology, and End Results-Medicare database from 1995 to 2005.

Study Design. A cross-sectional observational study of men with prostate cancer who underwent radical prostatectomy.

Methods. Subjects were classified as having "changed urologists" if they had a different urologist who diagnosed their cancer from the one who performed their surgery. "Doubly robust" propensity score weighted multivariable logistic regression models were used to investigate the effect of changing urologists on 30-day surgical complications, late urinary complications, and long-term incontinence.

Principal Findings. Men who changed urologists between diagnosis and treatment had significantly lower odds of 30-day surgical complications compared with men who did not change urologists (odds ratio: 0.82; 95 percent confidence interval: 0.76–0.89), after adjustment. Changing urologists was associated with lower risks of 30-day complications for both black and white men compared with staying with the same urologist for their diagnosis and surgical treatment.

Conclusions. Urologist changing is associated with the observed variation in complications following radical prostatectomy. This may suggest that patients are responding to aspects of surgical quality not captured in surgical volume.

Key Words. Quality of care, physician switching, cancer care

Identifying factors associated with surgical quality is important for helping patients receive better care. Patients treated by higher volume surgeons have, on average, better surgical outcomes (Halm, Lee, and Chassin 2002; Hu et al. 2003; Wilt et al. 2008; Eastham 2009; Barocas et al. 2010). However, not all

men receive their care from high-volume surgeons (Bianco et al. 2005; Putt et al. 2009; Pollack et al. 2011; Al-Refaie et al. 2012), and many patients seeing low-volume surgeons have good surgical outcomes. While surgical volume is one indicator of quality, it does not fully explain the variation in surgical outcomes. Previous studies of physician characteristics such as board certification and medical malpractice claims have reported weak or no association with quality of care and clinical outcomes (Chen et al. 2006; Reid et al. 2010).

In this article, we seek to examine a process that may reflect surgical quality. In particular, we ask whether patients who have a different surgeon for their initial diagnosis and their definitive surgical procedure—patients who have changed surgeons—have lower rates of complications. Our underlying hypothesis is that changing surgeons is unlikely to be a random process and may instead be a "signal" about surgical quality.

Previous work on patterns of care suggests that physician selection, and by extension surgeon changing, is a complex decision-process (Shortell 1973; Forrest et al. 2001, 2006; Kinchen et al. 2004; Mukamel, Weimer, and Mushlin 2006; Mehrotra, Forrest, and Lin 2011). Surgeon selection may rely upon a number of sources of information (including a referral from the primary care provider, other surgeons, patient or family, other patients) and types of evidence (e.g., surgical volume, "best" doctor lists, anecdotes, and other quality metrics). Existing work stresses the important role that referring physicians play in determining from whom patients receive care (Harris 2003; Mukamel, Weimer, and Mushlin 2006; Bouche et al. 2008; Barnett et al. 2012), although a small portion of patients will choose their physician primarily on the advice of friends or family or proximity to home (Harris 2003; Katz et al. 2007). The process of surgeon selection and changing remains poorly understood.

We use prostate cancer as a case study for examining these care patterns. It is the second most common form of cancer among men, affecting an

Address correspondence to Eva H. DuGoff, M.P.P., Department of Health Policy and Management, Johns Hopkins Bloomberg School of Public Health, 624 N. Broadway, Rm 301, Baltimore, MD 21205; e-mail: edugoff@jhsph.edu. Justin E. Bekelman, M.D., is with the University of Pennsylvania Perelman School of Medicine Philadelphia, PA. Elizabeth A. Stuart, Ph.D., is with the Johns Hopkins Bloomberg School of Public Health Baltimore, MD. Katrina Armstrong, M.D., is with the Department of Medicine, Massachusetts General Hospital, Boston, MA. Craig Evan Pollack, M.D, M.H.S, is with the Johns Hopkins Bloomberg School of Public Health, Baltimore, MD, and the Johns Hopkins School of Medicine, Baltimore, MD.

estimated 238,590 men in the United States during 2013 (Siegel, Naishadham, and Jemal 2013); radical prostatectomy is commonly performed for men with localized disease (Siegel et al. 2012); and complications—including 30-day surgical complications, late urinary complications, and long-term incontinence—occur in a large percentage of men and have been associated with surgical volume (Begg et al. 2002; Hu et al. 2003). Given a substantial proportion of men with localized prostate cancer have a different diagnosing and treating urologist (Pollack et al. 2011), we sought to examine whether changing urologists is associated with surgical complications following radical prostatectomy. Furthermore, because black men are significantly less likely to change urologists for radical prostatectomy than white men (Pollack et al. 2011) and with the large disparities that have been documented in prostate cancer outcomes (Peters and Armstrong 2005; Siegel et al. 2011), we then tested whether changing urologists is differently associated with surgical outcomes among black and white men.

METHODS

Data Sources

The study was a retrospective, observational cohort study using registry and administrative claims data from the Surveillance, Epidemiology, and End Results (SEER)-Medicare database. The SEER-Medicare database links patient demographic and tumor-specific data collected by SEER cancer registries to longitudinal health care claims for Medicare enrollees (Potosky et al. 1993). Previous studies of the SEER-Medicare linkage have found a 93 percent match rate between the two datasets (Warren et al. 2002). This study was approved by the University of Pennsylvania and Johns Hopkins University School of Medicine Institutional Review Boards.

Study Population

We identified men age 65 years or older who were diagnosed with prostate cancer from 1995 to 2005 across 16 SEER sites. Men who were enrolled in the fee-for-service Medicare program were included. The sample was limited to men with localized or regional disease defined as American Joint Committee on Cancer Stage 1, 2, or 3 without nodal invasion or metastases who underwent radical prostatectomy. Radical prostatectomy was identified from Medicare inpatient, outpatient, and physician/supplier

component files as described previously (Bekelman et al. 2007; Jang et al. 2010).

Because we were particularly interested in creating balanced treatment and control groups, the sample was limited to white and black men. By definition, men whose diagnosing urologist (see below) did not bill for any prostatectomies were required to have a different urologist who performed their surgery ($N = 1{,}997$). We therefore focus our main analyses on the cohort of patients whose diagnosing urologist billed for at least one radical prostatectomy during the study period ($N = 24{,}061$).

Assignment of Patients to Urologists

Diagnosing Urologist. The physician most likely to have diagnosed the patient's prostate cancer was defined as the urologist who billed for a prostate biopsy in the 3 months prior to the date of diagnosis. If no claim was identified, then the urologist was chosen based on the following order: (1) the urologist who billed for a claim on the date of diagnosis; (2) the urologist who billed for the greatest number of visits in the 3-month window prior to diagnosis; and (3) the urologist who billed for the greatest number of claims in the 3 months following diagnosis. Physician specialty was determined using the Medicare Physician Identification and Eligibility Registry (MPIER) data. Patients were matched to 2,538 unique urologists.

Treating Urologist. The urologist who billed for the patient's radical prostatectomy was defined as the treating urologist. Patients were matched to 2,058 treating urologists. We categorized patients as having "changed urologists" if they had different diagnosing and treating urologists.

Surgical Complications. Complications were defined according to the work of Begg and colleagues using ICD-9 diagnosis and procedure codes (Begg et al. 2002). Thirty-day surgical complications included cardiac, respiratory, vascular, wound, genitourinary, miscellaneous medical, miscellaneous surgical, and blood transfusion complications. Late urinary complications were defined as occurring from 31 to 365 days following surgery and included bladder neck obstruction, urethral stricture, intestinal fistula, lymphocele, and definitive incontinence repair. Long-term incontinence was defined as occurring 18 months or more after the surgery (Hu et al. 2003).

Patient and Tumor Characteristics. Age was classified as 65–74 and 75 and over. Individuals were considered black if they were classified as black in either SEER or Medicare data without a codesignation of Hispanic or Asian and white if they were classified as white in either data source without a classification of black. Patient comorbidities were identified by classifying all available inpatient and outpatient Medicare claims for the 90-day interval preceding prostate cancer diagnosis into 46 categories (Elixhauser et al. 1998; Silber et al. 2001; Wong et al. 2006). Comorbidity is reported as the number (0, 1, ≥2) of the possible 46 comorbidity groups. Marital status was classified as married, single, or unknown. U.S. Census information was used as a proxy for individual measures of socioeconomic status. Men were linked to their census tract and, when not available, zip code to determine median income which was aggregated into quartiles. Tumor grade corresponds to Gleason status and was categorized as well differentiated, moderately differentiated, poorly differentiated and undifferentiated, and unknown.

Urologist Characteristics. Board certification and year of graduation from medical school were determined using MPIER data. Number of years in practice was determined as the number of years from medical school graduation year to 2005. We aggregated years in practice into quartiles based on the urologist sample distribution. Yearly prostatectomy volume was identified for each urologist in the study sample by summing the number of radical prostatectomies for which a urologist billed divided by the total number of years in which the urologist performed at least one prostatectomy. Consistent with Begg et al. (2002), urologist volume was classified into four quartiles categories based on the distribution in the patient cohort. High volume was defined as being in the top quartile of the sample distribution, and low volume is defined as the bottom three quartiles.

Statistical Analyses

Our focus is identifying whether there is an association between changing urologists and surgical complications. To account for differences among patients who did and did not change urologists, we used propensity score weighting (Lunceford and Davidian 2004; Stuart 2010). The propensity score was estimated by predicting changing urologists as a function of observed characteristics thought to be associated with urologist change, including

patient characteristics (age, race, number of co-morbidities, area income, marital status, year of diagnosis, SEER site), characteristics of the diagnosing urologist (prostatectomy volume, board certification, years since medical school gradation), and characteristics of the treating urologist (whether the treating physician had experience performing laparoscopic or robotic prostatectomies). To measure the average treatment effect on the treated (i.e., the effect of changing urologists for those individuals who did change), the propensity score weight was calculated for each control subject (non-changers) as $e_i/(1 - e_i)$, where e is the propensity score for person i, and each treated subject (changers) was given a weight of 1. The propensity score was calculated in R version 15.0 using MatchIt (Ho et al., 2011).

To estimate the effect of changing urologist on outcomes, we used "doubly robust" logistic regression models. For each surgical complication, we ran a propensity score weighted logistic regression model that adjusted for all covariates used in the propensity score construction as well as factors potentially related to surgical outcome but not necessarily observed prior to changing urologists. These included characteristics of the treating urologist (prostatectomy volume, board certification, and years since graduation) and the type of prostatectomy the patient received (open vs. laparoscopic/robotic). We used robust standard errors clustered on treating urologists to account for clustering within treating urologists. To estimate subgroup effects, we further examined models using interaction terms with urologist change and (1) treating urologist surgical volume; (2) patient race; and (3) receipt of a laparoscopic or robotic procedure.

We performed multiple sensitivity analyses. First, because some patients may select their treating urologist based on the treating urologist's volume, board certification, and years in practice, we repeated the analysis but with propensity score models that included these treating urologist characteristics. Second, we reclassified high-volume diagnosing and treating urologist as the top two quartiles of the sample distribution for all analyses. Third, we reclassified urologist's surgical volume based on the number of radical prostatectomies performed during the previous year (e.g., the year prior to the patient's diagnosis date). Fourth, we included patients whose diagnosing urologist did not perform any radical prostatectomies in our sample ($N = 1{,}997$), all of whom were classified as having changed urologists. Fifth, we assessed whether the relationship between urologist change and surgical outcomes varied over time by using an interaction term between urologist change and year. All regression analyses were conducted in Stata version 12 (StataCorp 2011).

FINDINGS

Table 1 presents the characteristics of the study sample by whether the patient had a different diagnosing and treating urologist. Overall, 37 percent of patients changed urologists. In unadjusted analyses, patients who changed were significantly more likely to be white, younger, and in the highest income quartile. Among patients who changed urologist 11.6 percent had laparoscopic or robotic surgery compared with 2.5 percent of those who did not change.

Patients were significantly less likely to change if their diagnosing urologist was high volume (4.5 percent vs. 21.1 percent, $p < .001$), and patients who changed were more likely to be treated by a high-volume urologist (32.7 percent vs. 21.1 percent, $p < .001$) (Table 2). Conversely, patients who did not change were more likely to be both diagnosed and treated by a board-certified urologist. Tables S1 and S2 further characterize differences among the urologists in our sample according to whether they only diagnose patients, diagnose and perform surgeries on patients, or perform surgeries but do not diagnose.

After propensity score weighting, the two groups of patients—those who remain with their diagnosing urologist for treatment and those who have a different urologist who performs their surgery—were no longer significantly different on sociodemographic characteristics, clinical factors, diagnosing urologist characteristics, treating urologist experience with laparoscopic or robotic prostatectomy, year or site of surgery (see Tables 1 and 2, $p > .05$ for each comparison; standardized mean differences <0.20, data not shown). Propensity score adjustment, which balanced the groups on diagnosing urologist characteristics, increased the differences between the two groups on treating physician volume status (32.7 percent of patients who changed saw high-volume urologists vs. 4.6 percent of patients who did not, $p < .001$).

Table 3 presents the results of the doubly robust models assessing the effect of changing urologists on odds of surgical complications. Men who changed urologists had significantly lower odds of 30-day surgical complications (odds ratio [OR]: 0.82, 95 percent confidence interval [CI]: 0.76–0.89). We did not observe a significant relationship between changing urologists and either late urinary complications or long-term incontinence. Men who were treated by a high-volume urologist had significantly lower odds of 30-day surgical complications (OR: 0.86, 95 percent CI: 0.77–0.97). We did not observe a significant relationship between surgical out-

Table 1: Demographic and Health Characteristics of Study Sample by Whether the Patient Had a Different Diagnosing and Treating Urologist, SEER-Medicare 1995 to 2005

	Unadjusted			*Propensity Score Weighted**		
Individual Characteristics	*No Change*	*Urologist Change*	*p-value*	*No Change*	*Urologist Change*	*p-value*
N(%)	15,369 (100)	8,892 (100)		8,685 (100)	8,862 (100)	
Race						
White	14,071 (91.6)	8,178 (94.1)	<.001	8,185 (94.2)	8,178 (94.1)	.741
Black	1,298 (8.4)	514 (5.9)		500 (5.8)	514 (5.9)	
Age						
65–74	13,387 (87.1)	7,881 (90.7)	<.001	7,884 (90.8)	7,881 (90.7)	.766
≥75	1,982 (12.9)	811 (9.3)		801 (9.2)	811 (9.3)	
Comorbidities						
0	5,425 (35.3)	3,297 (37.9)	<.001	3,296 (37.9)	3,297 (37.9)	.323
1	5,120 (33.3)	2,938 (33.8)		2,934 (33.8)	2,938 (33.8)	
≥2	4,824 (31.4)	2,457 (28.3)		2,455 (28.3)	2,457 (28.3)	
Marital status						
Married	12,410 (80.8)	7,039 (81.0)	<.001	7,028 (80.9)	7,039 (81.0)	.829
Not married	2,407 (15.7)	1,277 (14.7)		1,292 (14.9)	1,277 (14.7)	
Unknown	552 (3.6)	376 (4.3)		365 (4.2)	376 (4.3)	
Median income						
Lowest	3,981 (25.9)	1,941 (22.3)	<.001	1,900 (21.9)	1,941 (22.3)	.884
Middle low	4,023 (26.2)	2,102 (24.2)		2,120 (24.2)	2,102 (24.2)	
Middle high	3,899 (25.4)	2,184 (25.1)		2,160 (24.9)	2,184 (25.1)	
Highest	3,466 (22.6)	2,465 (28.4)		2,505 (28.8)	2,465 (28.4)	
Grade differentiation						
Well	494 (3.2)	202 (2.3)	<.001	200 (2.3)	202 (2.3)	.903
Moderately	10,187 (66.3)	5,563 (64.0)		5,630 (64.8)	5,563 (64.0)	
Poorly	4,550 (29.6)	2,864 (32.9)		2,788 (32.1)	2,864 (32.9)	
Unknown	138 (0.9)	63 (0.7)		67 (0.8)	63 (0.7)	
Tumor stage						
1	4,832 (31.4)	2,643 (30.4)	<.001	2,583 (29.7)	2,643 (30.4)	.485
2	9847 (64.1)	5,546 (63.8)		5,652 (65.1)	5,546 (63.8)	
3	690 (4.5)	503 (5.8)		450 (5.2)	503 (5.8)	
Type of procedure						
Open prostatectomy	14,978 (97.5)	7,682 (88.4)	<.001	7,919 (91.2)	7,682 (88.4)	.152
Minimally invasive prostatectomy	391 (2.5)	1,010 (11.6)		766 (8.8)	1,010 (11.6)	

Note. The propensity score model included patient age, race, comorbidities, marital status, tumor grade and stage, type of procedure, area income, diagnosing physician board certification, experience, and surgical volume, treating physician experience with laparoscopic or robotic procedures, SEER-site, and diagnosis year.

*Bivariate statistics calculated using R survey program (Lumley 2011), where propensity score weight is such that the treated individual receives a weight of 1 while control individuals are weighted by $e/(1-e)$, where e is the propensity score.

Table 2: Treating Urologist Volume, Type of Surgery and Surgical Outcomes by Whether the Patient Had a Different Diagnosing and Treating Urologist, SEER-Medicare 1995 to 2005

	Unadjusted			*Propensity Score Weighted**		
	No Change	*Urologist Change*	*p-value*	*No Change*	*Urologist Change*	*p-value*
Diagnosing urologist characteristics						
Volume status						
Low	12,121 (78.9)	8,302 (95.5)	<.001	8,287 (95.4)	8,302 (95.5)	.040
High	3,248 (21.1)	390 (4.5)		398 (4.6)	390 (4.5)	
Board certified						
No	3,763 (24.5)	2,357 (27.1)	<.001	2,454 (28.3)	2,357 (27.1)	.648
Yes	11,606 (75.5)	6,335 (72.9)		6,231 (71.7)	6,335 (72.9)	
Years since medical school graduation†						
Top quartile (oldest)	3,498 (22.8)	2,319 (26.7)	<.001	2,226 (25.6)	2,319 (26.7)	.816
Middle top quartile	5,242 (34.1)	2,561 (29.5)		2,472 (28.5)	2,561 (29.5)	
Middle bottom quartile	4,929 (32.1)	2,454 (28.2)		2,472 (28.5)	2,454 (28.2)	
Lowest quartile (youngest)	1,700 (11.1)	1,358 (15.6)		1,516 (17.5)	1,358 (15.6)	
Treating urologist characteristics						
Volume status						
Low	12,121 (78.9)	5,853 (67.3)	<.001	8,287 (95.4)	5,853 (67.3)	<.001
High	3,248 (21.1)	2,839 (32.7)		398 (4.6)	2,839 (32.7)	
Board certified						
No	3,763 (24.5)	2,397 (27.6)	<.001	2,454 (28.3)	2,397 (27.6)	.858
Yes	11,606 (75.5)	6,295 (72.4)		6,231 (71.7)	6,295 (72.4)	
Years since medical school graduation†						
Top quartile (oldest)	3,498 (22.8)	1,694 (19.5)	<.001	2,226 (25.6)	1,694 (19.5)	.005
Middle top quartile	5,242 (34.1)	2,488 (28.6)		2,472 (28.5)	2,488 (28.6)	
Middle bottom quartile	4,929 (32.1)	3,143 (36.2)		2,472 (28.5)	3,143 (36.2)	
Lowest quartile (youngest)	1,700 (11.1)	1,367 (15.7)		1,516 (17.5)	1,367 (15.7)	
Experience with minimally invasive procedures						
No	14,685 (95.5)	7,343 (84.5)	<.001	7,365 (84.8)	7,343 (84.5)	.089
Yes	6,84 (4.4)	1,349 (15.5)		1,320 (15.2)	1,349 (15.5)	

continued

Table 2. *Continued*

	Unadjusted			*Propensity Score Weighted**		
	No Change	*Urologist Change*	*p-value*	*No Change*	*Urologist Change*	*p-value*
Patient outcomes						
30-day surgical complications						
None	11,447 (74.5)	6,768 (77.9)	<.001	6,447 (74.2)	6,768 (77.9)	<.001
At least one	3,922 (25.5)	1,924 (22.1)		2,238 (25.8)	1,924 (22.1)	
Urinary complications						
None	9,549 (62.1)	5,427 (62.4)	.650	5,256 (60.5)	5,427 (62.4)	.115
At least one	5,820 (37.9)	3,265 (37.6)		3,428 (39.5)	3,265 (37.6)	
Long-term incontinence						
None	11,940 (77.7)	6,898 (79.4)	.003	6,846 (78.8)	6,898 (79.4)	.108
At least one	3,429 (22.3)	1,794 (20.6)		1,838 (21.2)	1,794 (20.6)	

Note. The propensity score model included patient age, race, comorbidities, marital status, tumor grade and stage, type of procedure, area income, diagnosing physician board certification, years since medical school graduation experience, and surgical volume, treating physician experience with laparoscopic or robotic procedures, SEER-site, and diagnosis year.

*Bivariate statistics calculated using R survey program where propensity score weight is such that the treated individual receives a weight of 1 while control individuals are weighted by $e_i/(1 - e_i)$, where e is the propensity score.

†Years since medical school graduation was calculated as the number of years between 2005 and graduation year. This variable was then categorized into quartiles based on the physician distribution.

comes and treatment from a board-certified urologist or with the urologist's years since medical school graduation. Patients who had a minimally invasive procedure had lower odds of 30-day complications.

The interaction term between patient urologist change and treating urologist volume status was significant for long-term incontinence ($p = .049$) but not for 30-day surgical or late urinary complications. Compared to men who stayed with a low-volume urologist, men who changed to a high-volume urologist had significantly lower odds of long-term incontinence (OR: 0.70, 95 percent CI: 0.51–0.96). The relationship between urologist changing and surgical complications did not vary by patient race or by the type of surgical procedure the patient received.

Sensitivity analyses are shown in Table S3. Including additional characteristics of the treating urologist and the type of surgery the patient received when calculating the propensity score, expanding the definition of "high volume" to the top 50 percent of physicians, reclassifying surgical volume based on the preceding year, and including patients diagnosed by urologists who did not perform any radical prostatectomies all revealed

Table 3: Odds Ratios of Surgical Complications Using Doubly Robust Logistic Regression*

	Type of Complication		
	30-Day Surgical	*Late Urinary*	*Long-Term Incontinence*
Urologist change			
No change	1.00	1.00	1.00
Urologist change	**0.82 (0.76–0.89)**	0.94 (0.87–1.01)	0.97 (0.89–1.05)
Urologist volume of treating urologist			
Low	1.00	1.00	1.00
High	**0.86 (0.77–0.97)**	**0.83 (0.76–0.91)**	**0.82 (0.73–0.93)**
Years since medical school graduation for treating urologist†			
Top quartile (oldest)	1.00	1.00	1.00
Middle top quartile	0.99 (0.89–1.12)	**0.86 (0.77–0.95)**	1.03 (0.91–1.17)
Middle bottom quartile	0.97 (0.86–1.10)	1.00 (0.90–1.11)	1.08 (0.95–1.22)
Lowest quartile (youngest)	1.07 (0.91–1.26)	1.06 (0.92–1.21)	1.37 (1.15–1.62)
Board certification of treating urologist			
No	1.00	1.00	1.00
Yes	1.11 (1.01–1.24)	1.23 (1.13–1.37)	1.12 (1.00–1.25)
Type of procedure			
Open prostatectomy	1.00	1.00	1.00
Minimally invasive prostatectomy	**0.68 (0.50–0.93)**	1.15 (0.88–1.50)	0.69 (0.44–1.08)

Notes. The "doubly robust" models include all variables used in generating the propensity score as well as the variables listed in the table. The odds ratios for the covariates included in the propensity score model are not interpretable in the outcome model and therefore not listed above. Bold entries are statistically significant.

*Propensity score weighted models adjust for age, race, comorbidities, marital status, income, t-stage, grade, SEER-site, diagnosing urologist volume, laparoscopic or robotic prostatectomy experience of the treating physician, type of procedure, SEER-site, and year of diagnosis.

†Years since medical school graduation was calculated as the number of years between 2005 and graduation year. This variable was then categorized into quartiles based on the physician distribution.

qualitatively similar results to the main analysis. An interaction term between urologist change and year was not statistically significant, indicating that the relationship between urologist change and surgical outcomes did not vary by year.

DISCUSSION

We find that men who change urologists are less likely to have 30-day surgical complications compared with similar men who stayed with the same urologist from diagnosis to treatment. These results are significant for both black and

white men and remain consistent among men who change to a low-volume urologist for their radical prostatectomy.

The results suggest that the underlying surgeon change process is not random. Several potential explanations may be considered. First, men who are changing urologists may be responding to aspects of surgical quality. The finding that patients who change are more likely to be treated by high-volume urologists reinforces the interpretation that patients may be driven, at least in part, by signals about urologist quality. However, surgical volume and other provider characteristics that we were able to measure from the claims data do not appear to fully explain the reasons patients change, and lower rates of 30-day surgical complications persist after adjustment. Related to this, patients may be changing to urologists who are a better match for their particular needs. An alternative explanation is that a urologist who receives a new patient who has been diagnosed by another clinician may be more cautious or attentive to this patient's needs, leading to fewer complications. Finally, lower complication rates among men who switch may represent residual confounding. Though we adjusted for observable characteristics using propensity score weighting, incompletely observed or unobserved characteristics may be associated with both changing urologist and with complications.

Patients may choose to change or "shop" for their physician for a number of reasons. There is little evidence on what drives selection of specialists, and specifically urologists. The existing literature has focused on the selection of primary care physicians and has identified reasons, including dissatisfaction with care, geographic relocation, physician retirement, or health plan requirements (Kasteler et al. 1976; Keating et al. 2002; Harris 2003; Sorbero et al. 2003; Smith and Bartell 2004). Most frequently, patients choose physicians based upon physician referrals (Harris 2003; Mukamel, Weimer, and Mushlin 2006; Katz et al. 2007; Bouche et al. 2008; Barnett, Song, and Landon 2012). To the extent that primary care physicians and diagnosing urologists are involved in these decisions for men with prostate cancer, these results suggest that, at least on average, these physicians may be doing a good job in directing patients to change to high-quality urologists. Primary care physicians and diagnosing urologists may have information based on the experiences of their past patients, colleagues, and other informal sources that may help support patients in making appropriate changes. Other patients may select a physician based on the advice of family, friends, or other sources of information, which may also be directing patients toward higher quality care.

These results support an independent association of urologist change with 30-day surgical complications and, in some patient groups, long-term incontinence. Multiple factors may make it harder for referring physicians and patients to directly attribute late urinary complications and long-term incontinence to surgical quality, thus potentially making them less influential in assessments of urologist quality. These include the fact that these symptoms may resolve over time (Resnick et al. 2013), the relatively high prevalence of urinary symptoms prior to radical prostatectomy, and the under-reporting of these symptoms by patients (Steineck et al. 2002; Sonn et al. 2013). Furthermore, the decreased sensitivity of claims data to assess long-term incontinence may limit our power to detect a clinically significant relationship (Begg et al. 2002).

Disparities in complications following radical prostatectomy between white and black men have been documented (Godley et al. 2003; Cohen et al. 2006; Evans et al. 2008). Our prior work found that black men are less likely to change urologists overall and less likely to change to a high-volume urologist for their radical prostatectomy (Pollack et al. 2011). In our current study, we find that black and white men who change urologists have similarly lower odds of 30-day surgical complications compared with men who have the same urologists throughout their treatment. Both lower rates of changing urologists and lower odds of being treated by a high-volume urologist may be two mechanisms that compound racial disparities in prostate cancer outcomes. It will be important to investigate the underlying reasons behind urologist changing among black and white men and consider ways in which actionable information about urologist quality may be encouraged to reduce disparities in cancer outcomes.

While changing urologists is associated with lower rates of complications, it will be necessary to study how changing urologists affects other outcomes, including costs of care and the management of co-morbid conditions. Changing urologists increases the number of doctors who are involved in a patient's care, which may, in turn, increase the challenges to care coordination (Bodenheimer 2008). Clinical and policy efforts to increase the centralization of cancer care, for example with high-volume urologists or at centers of excellence, may similarly pose challenges to continuity of care (Stitzenberg et al. 2009; Stitzenberg and Meropol 2010). Furthermore, it will be important to monitor how the ability of patients to change providers and the potential effect on care coordination develop in the setting of broader health reforms such as accountable care organizations and bundled payments.

This study is subject to a number of limitations. First, the use of SEER-Medicare administrative claims data poses challenges to constructing certain variables. Our measure of diagnosing and treating urologist surgery volume does not capture all radical prostatectomies performed by these physicians; however, previous research has found Medicare constructed surgical volume to be consistent with total urologist surgical volume (Begg et al. 2002; Chowdhury, Dagash, and Pierro 2007). Second, we do not account for hospital volume, which may be associated with surgical outcomes (Eastham 2009; Barocas et al. 2010). Third, we cannot infer on what basis a patient changed urologists. Due to limitations in SEER-Medicare data, we are unable to examine how frequently patients change physicians within the same practice versus changing to physicians in other practices. Patients who change urologists within the same practice may similarly be responding to quality information (potentially from their diagnosing urologist) about who should perform their surgery. Related to this, we are unable to assess how patients selected their diagnosing urologist. To the extent that some patients (and their referring providers) were more careful in selecting their diagnosing urologist, this may bias our results on the impact of changing urologists toward the null. Fourth, we used propensity score methods to create a group of control subjects who appear to be similar to the treatment group based on observed covariates. This analysis may still be subject to omitted variable bias (unobserved confounding), although we have tried to limit that by accounting for a comprehensive range of individual and physician characteristics as well as area-level factors. It should be noted that this study cannot account for patient factors that could be related to changing urologists such as caregiver support, lack of disability, and health literacy. Fifth, these findings may not be generalizable to other cancers or surgical procedures. Sixth, this analysis uses a limited set of physician-level factors. Future analyses that model urologist-level outcomes (e.g., whether urologists have lower rates of complications for their patients who switch) are important in delineating mechanisms.

This study finds lower 30-day surgical outcomes among men with prostate cancer who change urologists between diagnosis and surgical treatment after adjusting for urologist volume and other physician characteristics. In aggregate, identifying the urologists whose patients change to for treatment may reflect important information about how patients come to receive higher quality care. Further research into why some men change urologists is important for understanding how this information may be leveraged by health plans, urologists, and patients to achieve better outcomes and reduce disparities in cancer care.

ACKNOWLEDGMENTS

Joint Acknowledgment/Disclosure Statement: Dr. Pollack's salary is supported by the National Cancer Institute (NCI) and Office of Behavioral and Social Sciences (K07 CA151910). Ms. DuGoff is supported by a T-32 National Research Service Award from the Agency for Health Care Research and Quality and a predoctoral dissertation award from the Health Assessment Laboratory. Dr. Stuart's salary is supported by the National Institute of Mental Health (K25 MH083846). Dr. Bekelman's salary is support by the NCI (K07 CA163616). We thank the support of the Maryland Cigarette Restitution Fund Research Grant to the Johns Hopkins Institutions.

Disclosures: None.

Disclaimers: None.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Table S1. Characteristics of All Urologists in the Sample Who Both Diagnose and Perform Surgery, Urologists Who Only Diagnosed Patients, and Urologists Who Only Performed Surgery, SEER-Medicare 1995 to 2005.

Table S2. Characteristics of Urologists Who Performed Any Surgeries in the Sample by Those Who Diagnosed Patients and Those Who Performed Surgery, SEER-Medicare 1995 to 2005.

Table S3. Odds Ratios of Surgical Complications Using "Doubly Robust Logistic Regression for Sensitivity Tests."

Appendix SA1: Author Matrix.