Published in final edited form as:

Cancer. 2014 May 15; 120(10): 1565–1571. doi:10.1002/cncr.28616.

Identification of Underserved Areas for Urologic Cancer Care

Matthew Mossanen, MD¹, Jason Izard, MD, MPH², Jonathan L. Wright, MD, MS¹, Jonathan D. Harper, MD¹, Michael P. Porter, MD, MS^{1,3}, Kenn B. Daratha, PhD⁴, Sarah K. Holt, PhD¹, and John L. Gore, MD, MS¹

¹Department of Urology, University of Washington, Seattle, Washington

²Department of Urology, Queen's University, Kingston, Ontario, Canada

³Puget Sound Veteran Affairs Health Care System, Seattle, Washington

⁴Washington State University College of Nursing, Spokane, Washington

Abstract

BACKGROUND—The delivery of urologic oncology care is susceptible to regional variation. In the current study, the authors sought to define patterns of care for patients undergoing genitourinary cancer surgery to identify underserved areas for urologic cancer care in Washington State.

METHODS—The authors accessed the Washington State Comprehensive Hospital Abstract Reporting System from 2003 through 2007. They identified patients undergoing radical prostatectomy, radical cystectomy (RC), partial nephrectomy (PN), radical nephrectomy, and transurethral resection of the prostate (TURP). TURP was included for comparison as a reference procedure indicative of access to urologic care. Hospital service areas (HSAs) are where the majority of local patients are hospitalized; hospital referral regions (HRR) are where most patients receive tertiary care. The authors created multivariate hierarchical logistic regression models to examine patient and HSA characteristics associated with the receipt of urologic oncology care out of the HRR for each procedure

RESULTS—Greater than one-half of patients went out of their HRR in 7 HSAs (11%) for radical prostatectomy, 3 HSAs (5%) for radical nephrectomy, 10 HSAs (15%) for PN, and 14 HSAs (22%) for RC. No HSAs had high export rates for TURP. Few patient factors were found to be associated with surgical care out of the HRR. High-export HSAs for PN and RC exhibited lower socioeconomic characteristics than low-export HSAs, adjusting for HSA population, race, and HSA procedure rates for PN and RC.

CONCLUSIONS—Patients living in areas with lower socioeconomic status have a greater need to travel for complex urologic surgery. Consideration of geographic delineation in the delivery of urologic oncology care may aid in regional quality improvement initiatives.

© 2014 American Cancer Society

Corresponding author: Matthew Mossanen, MD, Department of Urology, University of Washington School of Medicine, 1959 NE Pacific, Box 356510, Seattle, WA 98195; Fax: (206) 543-3272; mnmosse@uw.edu.

CONFLICT OF INTEREST DISCLOSURES

The authors made no disclosures.

Keywords

health care disparities; prostate carcinoma; bladder carcinoma; kidney carcinoma; quality of care

INTRODUCTION

The delivery of urologic oncology care is susceptible to regional variation.¹⁻³ Provider-related and patient-related factors potentially impact the use of certain urologic cancer procedures. Provider factors that may impact treatment for patients with urologic cancers include the availability and training expertise of local urologists, and these factors may directly impact access to complex urologic oncology care. Among patients with muscle-invasive bladder cancer, the use of radical cystectomy (RC) is less common among older men and women, those with a greater number of comorbidities, and those with a greater travel distance to an available surgeon.⁴ A similar reduction in rates has been demonstrated for partial nephrectomy (PN) among patients with small renal masses.^{5,6} Patient-related factors also impact the use of urologic cancer procedures by region. For example, patients who require RC already confront the natural regionalization of that procedure, which often demands travel to urban academic centers.¹ With associations between volume and outcome demonstrating lower mortality rates for patients who undergo cystectomy by high-volume providers, there is further incentive for patients to seek care from academic centers.^{7,8} Nevertheless, regionalization also results in a reduction in available providers, leading to differential access to care, which may impact health outcomes for certain patients.

Such a reduction in providers can limit a patient's capacity to receive optimal management of their genitourinary cancer. Among elderly patients, only 21% of subjects underwent RC despite having muscle-invasive bladder cancer; patients needing to travel > 50 miles were less likely to undergo RC than those who lived proximate to a cystectomy provider.⁴ Certain patients may be willing to accept higher mortality risks to avoid extensive travel for needed health care services.⁹ Patients living in rural areas have limited access to cancer screening services and treatment options after a diagnosis of nongenitourinary cancers.¹⁰⁻¹⁴ Women with breast cancer may accept suboptimal treatment due to limitations imposed by rural residence or harsh winter climates.¹⁵ Patients of lower socioeconomic status (SES) face an additional barrier to care in the setting of long travel burdens.^{16,17}

Regionalization of genitourinary cancer care may induce health care disparities. Therefore, elucidating regional health care practices may aid in quality improvement initiatives, highlight underserved areas for targeted regionalization efforts, and identify opportunities to improve health outcomes for underserved urologic oncology patients. We sought to define patterns of care for patients undergoing genitourinary cancer surgery based on their region of residence and the availability of local urologists to identify underserved areas for urologic cancer care in Washington State.

MATERIALS AND METHODS

Study Sample

We accessed the Washington State Comprehensive Hospital Abstract Reporting System (CHARS) from 2003 through 2007 to identify patients residing in the state and seeking care in Washington State hospitals. All hospital discharges statewide were analyzed through billing claims and *International Classification of Diseases, Ninth Revision* (ICD-9) codes to identify patients undergoing radical prostatectomy (RP), RC, PN, and radical nephrectomy (RN), as well as men undergoing transurethral resection of the prostate (TURP). Patients undergoing RC were identified through diagnosis codes for bladder cancer (ICD-9 codes 188-188.9, 233.7, 236.7, and 239.4) with corresponding procedure codes for cystectomy (ICD-9 codes 577, 577.1, and 577.9). Patients undergoing RP were identified by procedural ICD-9 code 60.5 in conjunction with diagnostic ICD-9 code 185.0 for prostate cancer. A previously published algorithm to identify patients undergoing PN and RN for suspicion of renal cell carcinoma was used.¹⁸ Patients undergoing TURP (ICD-9 codes 60.2, 60.21, and 60.29) for benign prostatic hyperplasia (ICD-9 codes 600.00 and 600.01) were also identified. We included information about TURP to signify access to a practicing urologist within analyzed regions of the state. TURP was then used as a reference procedure for comparison with urologic cancer surgeries. We also identified patients undergoing retroperitoneal lymph node dissection for testicular cancer (procedural ICD-9 codes 59.0, 59.00, 59.02, or 59.09 in conjunction with diagnostic ICD-9 codes 186, 186.0, 186.9, 158.0, 197.6, 211.8, and 235.4), but we identified too few cases (n = 20) to evaluate patients' travel burdens.

Washington State ZIP codes were linked with the *Dartmouth Atlas* to create demarcated areas of health care delivery.¹⁹ Based on patterns of care for Medicare beneficiaries, the *Dartmouth Atlas* categorized US ZIP codes into hospital service areas (HSAs) and hospital referral regions (HRRs).¹⁹ HSAs correspond to areas in which the majority of patients from that region are hospitalized (65 HSAs in Washington State). HRRs correspond to areas in which the majority of patients within that region receive their tertiary care and include Seattle, Everett, Spokane, Yakima, Tacoma, and Olympia (6 HRRs in Washington State). We identified the hospital at which care was received as well as the patient's HSA and HRR of residence and compared use of the urologic oncology procedures with use of TURP. In addition, we identified HSAs with high export rates for genitourinary oncology surgery and evaluated patient and HSA characteristics associated with travel for genitourinary oncology surgery.

ICD-9 codes were used to determine the number of comorbidities using the method of Elixhauser et al.²⁰ Information regarding race or ethnicity was not available in CHARS for the time period of this study. An SES index was derived by forming a composite of US population-standardized HSA characteristics (z-scores) including the percentage of the population with a college education, the percentage of the population with only a high school education, the percentage of the population with income from interest/dividends, and the percentage of the population with a professional occupation. In this index, each point equals 1 standard deviation away from the population mean. The SES index was calculated

from census tract-level characteristics found on factor analysis to be associated with individual-level SES.^{21,22} A unique identification number tracked the care history of each patient and prevented the error of multiple counting of patients with a 1-time procedure.

Statistical Analysis

We reported descriptive statistics for the percentages of patients receiving care within their HSA or HRR of residence. We compared patient characteristics by procedure type using the chi-square test for categorical variables and analysis of variance for continuous variables. We then created separate multivariable models to examine patient characteristics associated with receipt of urologic oncology care out of their HRR of residence for each procedure examined. To account for the clustering of patients within their HSA, we constructed multilevel, generalized, linear mixed models with patient characteristics as the fixed level 1 variables and HSA as the random level 2 variable. The models assume a fixed relationship between patient characteristics such as age or number of comorbidities and the dependent variable of travel out of the patient's HRR for urologic care. For each HSA, a random intercept is assigned that attempts to account for differences among HSAs. The covariance parameter estimate can then be used to calculate the percentage of variance in travel out of the HRR that is attributable to the HSA of residence.

We similarly evaluated HSA characteristics that were independently associated with travel out of the HRR for complex urologic oncology care with multivariable logistic regression models. Based on our data demonstrating higher rates of travel for patients undergoing PN and RC, we constructed models that examined HSA characteristics associated with travel out of the HRR for those 2 procedures. We a priori examined HSA characteristics that we hypothesized would be associated with the need to travel for PN and RC, including HSA population, the percentage of the population that was nonwhite, the SES index of the HSA, and the age-adjusted rate of PN and RC performed in each HSA. We included an age-adjusted procedure rate to account for the possibility that certain patients and their respective HSAs may be sufficiently limited in resources that they are excluded from needed cancer care. All statistical analyses were performed using SAS statistical software (version 9.2; SAS Institute Inc, Cary, NC) and all *P* values shown are 2-sided. Based on the deidentified nature of the data in the current study, the Institutional Review Board at the University of Washington approved a waiver for this study.

RESULTS

Characteristics of the study sample are shown in Table 1.²⁰ The most common urologic oncology procedure performed in Washington State was RP; hospital volumes for TURP were similarly high. Conversely, the least common urologic procedure was RC. Patients undergoing RC and TURP were older and more likely to have Medicare as their primary payer compared with patients undergoing RP, RN, and PN. Patients receiving RC had a greater number of comorbid conditions compared with patients receiving TURP and patients undergoing RP, RN, or PN.

A need to travel was common for patients requiring surgery for urologic malignancies (Table 2). Many patients had to travel outside of their HSA, including 30% of patients

undergoing TURP. However, the majority of patients undergoing TURP were able to receive their care within their HRR. Travel burden for urologic oncology care was highest among patients undergoing RC and lowest among those undergoing RN.

On multivariable analysis, we identified few patient factors associated with the need to travel for urologic oncology care out of the patient's HRR of residence (Table 3). Among patients receiving RP, increasing age was associated with a decreasing odds of needing to travel for surgery. For patients undergoing RC, female sex and a higher comorbidity count were associated with lower odds of travel for bladder cancer care, independent of other factors. HSA of patient residence explained a large percentage of the variance in the receipt of care outside of the HRR for all surgical procedures examined, ranging from 32% for RN to 52% for RC.

We defined high-export HSAs for urologic care as those in which > 50% of the patients traveled out of their HRR for urologic surgery. We identified 7 high-export HSAs (11%) for RP, 3 high-export HSAs (5%) for RN, 10 high-export HSAs (15%) for PN, and 14 high-export HSAs (22%) for RC. There were no high-export HSAs for TURP. High-export HSAs for PN and RC tended to exhibit lower SES characteristics compared with low-export HSAs (Table 4). This finding was corroborated on multivariable analysis, adjusting for HSA population, racial and ethnic composition, and availability of PN and RC. HSAs with high export rates were associated with significantly lower SES indices (odds ratio [OR], 0.19 [95% confidence interval (95% CI), 0.05-0.74] for PN and OR, 0.33 [95% CI, 0.11-0.94] for RC). Population density and the age-adjusted HSA procedure rate were not found to be associated with high-export HSAs. HSAs with a higher percentage of nonwhite residents had significantly lower ORs of high export for PN (OR, 0.88; 95% CI, 0.79-0.99).

DISCUSSION

In the current study, we demonstrated that patients requiring more complex surgical care for urologic malignancies can face large burdens of travel. Where a patient resides appears to be an important determinant of their access to needed urologic cancer care. Many patients living in remote areas and in underserved locales travel to distant centers to access appropriate care for procedures such as PN and RC.

Residence in lower SES areas has been linked to a lower likelihood of receiving treatment for cancer.²³ In breast cancer care, women living in socioeconomically deprived areas were found to have higher mortality rates than more socioeconomically advantaged patients.²⁴ The most common explanation for this is that a lack of health care access leads to presentation with later-stage disease.²⁵⁻²⁷ However, among stage-matched patients, lower SES has been reported to be an independent risk factor for increased cancer-specific mortality.²⁸ This may relate to differential treatment patterns: men and women of lower SES are less likely to undergo standard-of-care procedures for certain cancers, including low anterior resection for rectal cancer, breast-conserving surgery for breast cancer, and lung resection for lung cancer.²⁹

The distribution of care for many complex surgical procedures is converging toward high-volume urban centers.³⁰ The concentration of RC care at high-volume surgical centers occurred throughout the 1990s as the number of providers offering RC decreased.^{1,2} This can yield positive results: higher hospital volumes correspond to higher surgeon volumes, which have been linked to lower mortality rates.³¹ For patients undergoing RP, RN, and retroperitoneal lymph node dissection, receipt of care from high-volume surgeons and centers is associated with shorter hospital stays, lower rates of complications, decreased mortality, and improved overall survival.^{30,32-35} However, saturation of high-volume centers can lead to harmful delays in surgical care. Furthermore, these trends benefit only those patients able to undergo surgery; the need to travel to high-volume hospitals for complex surgery may lead some patients to opt for alternative treatment strategies with unproven benefit. The regionalization of PN has also been described.³ Both RC and PN are linked by their technical complexity.

Multiple factors have likely contributed to the concentration of complex urologic oncology care to select referral centers. Patients requiring complex urologic surgeries, such as RC, can have medical complexities that pose additional clinical challenges beyond technical concerns. Due to an association between tobacco use and elderly age with bladder cancer, many patients with urothelial carcinoma have multiple health problems.³⁶ Patients undergoing RC routinely possess concomitant comorbidities such as cardiovascular disease and chronic obstructive pulmonary disease, which can adversely impact postoperative outcomes.³⁷ Postoperatively, patients must also cope with adjustments relating to body function, body image, sexual relationships, and intimacy that significantly impact their quality of life.³⁸ The multi-disciplinary care of these patients can require the coordination of several medical subspecialties that are more available at larger hospitals and medical centers. However, in the current study, a higher comorbidity count was associated with a lower odds of travel outside of the patient's HRR. A combination of limited local access to care and numerous comorbidities that may limit functional status can result in long-distance travel burdens that are beyond the capacity of these patients.

Among men undergoing RP, increasing age was associated with greater odds of receiving care outside of the HRR (Table 3). This trend was only observed in patients undergoing RP and may reflect a trend in which physicians may choose to refer older patients with a potentially larger number of comorbidities to tertiary facilities. However, this may also reflect a desire for elderly patients to seek multiple opinions regarding the management of a prostate cancer diagnosis.

Many urologists may lack appropriate training to perform complex urologic cancer surgeries and prefer to refer these patients to other urologists. Guidelines recommend PN for patients with small renal masses. PN is associated with preserved cancer-specific outcomes compared with RN, and may protect patients from the renal and cardiovascular consequences of RN.³⁹ These benefits may extend to patients with clinically classified T1 tumors that are pathologically upstaged to T2 or T3 tumors.⁴⁰ Nevertheless, studies of national trends in PN use have demonstrated slow diffusion of this important surgical technique for patients with small renal masses.^{6,40,41}

Financial disincentives may dissuade general practice urologists from offering PN and RC. Medicare reimbursement rates for RC, including adjustments for inflation, declined by 32% from 1995 to 2004.⁴² Perioperative care for patients undergoing RC is burdensome. Preoperatively, individuals with muscle-invasive bladder cancer require counseling for both a large extirpative surgery as well as a life-altering urinary diversion. Patients treated with RC remain in the hospital for an average of 7 to 9 days,^{43,44} and require extensive nursing care and patient education. Complication rates after RC range from 31% to 67%, and approximately one-third of patients are readmitted within the first 30 days after surgery.⁴³⁻⁴⁶ The orchestration of this complex care is likely prohibitively time-consuming for providers in small groups or those in remote locations with limited resources.

Difficulty with access to care in underserved rural and urban areas is likely to be exacerbated by future trends in the urology workforce. Urology is considered an at-risk specialty for future deficiencies in the workforce. The US population is aging, and the majority of urological conditions disproportionately affect elderly patients, including urologic cancers. The concentration of new urologic surgeons in urban areas⁴⁷ means that urban-rural disparities in access to urologic care are likely to worsen.

We recognize several limitations to the current study. Although we were able to identify individuals undergoing urologic surgery, we recognize that there is a larger denominator of patients that may not be represented in this analysis. For example, among patients with muscle-invasive bladder cancer in the Surveillance, Epidemiology, and End Results-Medicare database, few underwent RC. We identified only those patients who actually underwent surgery for their cancers. Examination of patients with urologic cancers who were allocated to alternative nonsurgical treatments may identify more substantial disparities by travel burden. Moreover, certain patients have strong preferences for local health care, and may even forfeit improved mortality rates to avoid extensive travel.⁹ In one study, some women were willing to delay their breast cancer treatment by several weeks to avoid traveling outside of their city of residence.⁴⁸ In addition, we recognize that we may not be able to account for patients who obtain care by crossing state boundaries. A given HSA may report lower export rates if a substantial subset of patients were seeking care outside of the region in a nearby state (ie, patients in southern Washington receiving care in Oregon). Lastly, we acknowledge that we were not able to control for the severity of the cancer (ie, stage or grade) or details regarding the complexity of the surgery required. There also may be other unmeasured confounders influencing the results of the current study.

Despite these limitations, the results of the current study demonstrated that many patients must travel outside of their residential area to receive complex urologic cancer care. Patients with greater travel burdens tend to live in residential areas with lower SES. Consideration of the geographic delineation of the delivery of urologic oncology care may aid regional quality improvement initiatives and policy changes. The identification of urologically underserved areas can inform targeted out-reach clinics, streamline referral processes with outlying providers, and help to organize regionalization efforts. With improved access to care and the greater use of standard surgical procedures, we may maximize the quality of health care delivery and optimize health outcomes for patients impacted by urologic malignancies.

Acknowledgments

FUNDING SUPPORT

Supported by grant UL1RR025014 from the National Institutes of Health National Center for Research Resources.

REFERENCES

1. Black PC, Brown GA, Dinney CP. Should cystectomy only be performed at high-volume hospitals by high-volume surgeons? *Curr Opin Urol*. 2006; 16:344–349. [PubMed: 16905980]
2. Hollenbeck BK, Taub DA, Miller DC, Dunn RL, Montie JE, Wei JT. The regionalization of radical cystectomy to specific medical centers. *J Urol*. 2005; 174(4 pt 1):1385–1389. discussion 1389. [PubMed: 16145443]
3. Hollenbeck BK, Taub DA, Miller DC, Dunn RL, Wei JT. Use of nephrectomy at select medical centers—a case of follow the crowd? *J Urol*. 2006; 175:670–674. [PubMed: 16407022]
4. Gore JL, Litwin MS, Lai J, et al. Use of radical cystectomy for patients with invasive bladder cancer. *J Natl Cancer Inst*. 2010; 102:802–811. [PubMed: 20400716]
5. Tan HJ, Norton EC, Ye Z, Hafez KS, Gore JL, Miller DC. Long-term survival following partial vs radical nephrectomy among older patients with early-stage kidney cancer. *JAMA*. 2012; 307:1629–1635. [PubMed: 22511691]
6. Miller DC, Hollingsworth JM, Hafez KS, Daignault S, Hollenbeck BK. Partial nephrectomy for small renal masses: an emerging quality of care concern? *J Urol*. 2006; 175(3 pt 1):853–857. discussion 858. [PubMed: 16469564]
7. Hollenbeck BK, Wei Y, Birkmeyer JD. Volume, process of care, and operative mortality for cystectomy for bladder cancer. *Urology*. 2007; 69:871–875. [PubMed: 17482924]
8. Konety BR, Dhawan V, Allareddy V, Joslyn SA. Impact of hospital and surgeon volume on in-hospital mortality from radical cystectomy: data from the health care utilization project. *J Urol*. 2005; 173:1695–1700. [PubMed: 15821560]
9. Finlayson SR, Birkmeyer JD, Tosteson AN, Nease RF Jr. Patient preferences for location of care: implications for regionalization. *Med Care*. 1999; 37:204–209. [PubMed: 10024124]
10. Tropman SE, Hatzell T, Paskett E, Ricketts T, Cooper MR, Aldrich T. Colon cancer treatment in rural North and South Carolina. *Cancer Detect Prev*. 1999; 23:428–434. [PubMed: 10468896]
11. Tropman SE, Ricketts TC, Paskett E, Hatzell TA, Cooper MR, Aldrich T. Rural breast cancer treatment: evidence from the Reaching Communities for Cancer Care (REACH) project. *Breast Cancer Res Treat*. 1999; 56:59–66. [PubMed: 10517343]
12. Schroen AT, Brenin DR, Kelly MD, Knaus WA, Slingsluff CL Jr. Impact of patient distance to radiation therapy on mastectomy use in early-stage breast cancer patients. *J Clin Oncol*. 2005; 23:7074–7080. [PubMed: 16192590]
13. Sankaranarayanan J, Watanabe-Galloway S, Sun J, Qiu F, Boilesen EC, Thorson AG. Age and rural residence effects on accessing colorectal cancer treatments: a registry study. *Am J Manag Care*. 2010; 16:265–273. [PubMed: 20394462]
14. Baldwin LM, Cai Y, Larson EH, et al. Access to cancer services for rural colorectal cancer patients. *J Rural Health*. 2008; 24:390–399. [PubMed: 19007394]
15. Celaya MO, Rees JR, Gibson JJ, Riddle BL, Greenberg ER. Travel distance and season of diagnosis affect treatment choices for women with early-stage breast cancer in a predominantly rural population (United States). *Cancer Causes Control*. 2006; 17:851–856. [PubMed: 16783613]
16. Jones AP, Haynes R, Sauerzapf V, Crawford SM, Zhao H, Forman D. Travel time to hospital and treatment for breast, colon, rectum, lung, ovary and prostate cancer. *Eur J Cancer*. 2008; 44:992–999. [PubMed: 18375117]
17. Sauerzapf VA, Jones AP, Haynes R, Crawford SM, Forman D. Travel time to radiotherapy and uptake of breast-conserving surgery for early stage cancer in Northern England. *Health Place*. 2008; 14:424–433. [PubMed: 17951094]
18. Miller DC, Saigal CS, Warren JL, et al. External validation of a claims-based algorithm for classifying kidney-cancer surgeries. *BMC Health Serv Res*. 2009; 9:92. [PubMed: 19500395]

19. Wennberg, JE.; McAndrew Cooper, M. The Dartmouth Atlas of Health Care 1999: The Quality of Medical Care in the United States: A Report on the Medicare Program. American Hospital Association; Chicago Ill: 1999.
20. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care*. 1998; 36:8–27. [PubMed: 9431328]
21. Diez-Roux AV, Kiefe CI, Jacobs DR Jr, et al. Area characteristics and individual-level socioeconomic position indicators in three population-based epidemiologic studies. *Ann Epidemiol*. 2001; 11:395–405. [PubMed: 11454499]
22. Diez Roux AV, Merkin SS, Arnett D, et al. Neighborhood of residence and incidence of coronary heart disease. *N Engl J Med*. 2001; 345:99–106. [PubMed: 11450679]
23. Jack RH, Gulliford MC, Ferguson J, Moller H. Explaining inequalities in access to treatment in lung cancer. *J Eval Clin Pract*. 2006; 12:573–582. [PubMed: 16987120]
24. Downing A, Prakash K, Gilthorpe MS, Mikeljevic JS, Forman D. Socioeconomic background in relation to stage at diagnosis, treatment and survival in women with breast cancer. *Br J Cancer*. 2007; 96:836–840. [PubMed: 17311024]
25. Ward E, Jemal A, Cokkinides V, et al. Cancer disparities by race/ethnicity and socioeconomic status. *CA Cancer J Clin*. 2004; 54:78–93. [PubMed: 15061598]
26. Siegel R, Ward E, Brawley O, Jemal A. Cancer statistics, 2011: the impact of eliminating socioeconomic and racial disparities on premature cancer deaths. *CA Cancer J Clin*. 2011; 61:212–236. [PubMed: 21685461]
27. Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. *CA Cancer J Clin*. 2011; 61:69–90. [PubMed: 21296855]
28. Hole DJ, McArdle CS. Impact of socioeconomic deprivation on outcome after surgery for colorectal cancer. *Br J Surg*. 2002; 89:586–590. [PubMed: 11972548]
29. Raine R, Wong W, Scholes S, Ashton C, Obichere A, Ambler G. Social variations in access to hospital care for patients with colo rectal, breast, and lung cancer between 1999 and 2006: retrospective analysis of hospital episode statistics. *BMJ*. 2010; 340:b5479. [PubMed: 20075152]
30. Birkmeyer JD, Siewers AE, Finlayson EV, et al. Hospital volume and surgical mortality in the United States. *N Engl J Med*. 2002; 346:1128–1137. [PubMed: 11948273]
31. Birkmeyer JD, Stukel TA, Siewers AE, Goodney PP, Wennberg DE, Lucas FL. Surgeon volume and operative mortality in the United States. *N Engl J Med*. 2003; 349:2117–2127. [PubMed: 14645640]
32. Joudi FN, Konety BR. The impact of provider volume on outcomes from urological cancer therapy. *J Urol*. 2005; 174:432–438. [PubMed: 16006859]
33. Ellison LM, Heaney JA, Birkmeyer JD. The effect of hospital volume on mortality and resource use after radical prostatectomy. *J Urol*. 2000; 163:867–869. [PubMed: 10687994]
34. Taub DA, Miller DC, Cowan JA, Dimick JB, Montie JE, Wei JT. Impact of surgical volume on mortality and length of stay after nephrectomy. *Urology*. 2004; 63:862–867. [PubMed: 15134966]
35. Feuer EJ, Frey CM, Brawley OW, et al. After a treatment breakthrough: a comparison of trial and population-based data for advanced testicular cancer. *J Clin Oncol*. 1994; 12:368–377. [PubMed: 7509384]
36. Koppie TM, Serio AM, Vickers AJ, et al. Age-adjusted Charlson comorbidity score is associated with treatment decisions and clinical outcomes for patients undergoing radical cystectomy for bladder cancer. *Cancer*. 2008; 112:2384–2392. [PubMed: 18404699]
37. Miller DC, Taub DA, Dunn RL, Montie JE, Wei JT. The impact of co-morbid disease on cancer control and survival following radical cystectomy. *J Urol*. 2003; 169:105–109. [PubMed: 12478114]
38. Fitch MI, Miller D, Sharir S, McAndrew A. Radical cystectomy for bladder cancer: a qualitative study of patient experiences and implications for practice [article in English, French]. *Can Oncol Nurs J*. 2010; 20:177–187. [PubMed: 21171541]
39. Weight CJ, Larson BT, Fergany AF, et al. Nephrectomy induced chronic renal insufficiency is associated with increased risk of cardiovascular death and death from any cause in patients with localized cT1b renal masses. *J Urol*. 2010; 183:1317–1323. [PubMed: 20171688]

40. Weight CJ, Lythgoe C, Unnikrishnan R, Lane BR, Campbell SC, Fergany AF. Partial nephrectomy does not compromise survival in patients with pathologic upstaging to pT2/pT3 or high-grade renal tumors compared with radical nephrectomy. *Urology*. 2011; 77:1142–1146. [PubMed: 21420154]
41. Dulabon LM, Lowrance WT, Russo P, Huang WC. Trends in renal tumor surgery delivery within the United States. *Cancer*. 2010; 116:2316–2321. [PubMed: 20225227]
42. Lotan Y, Cadeddu JA, Roehrborn CG, Stage KH. The value of your time: evaluation of effects of changes in medicare reimbursement rates on the practice of urology. *J Urol*. 2004; 172(5 pt 1): 1958–1962. [PubMed: 15540765]
43. Shabsigh A, Korets R, Vora KC, et al. Defining early morbidity of radical cystectomy for patients with bladder cancer using a standardized reporting methodology. *Eur Urol*. 2009; 55:164–174. [PubMed: 18675501]
44. Chang SS, Baumgartner RG, Wells N, Cookson MS, Smith JA Jr. Causes of increased hospital stay after radical cystectomy in a clinical pathway setting. *J Urol*. 2002; 167:208–211. [PubMed: 11743307]
45. Chang SS, Cookson MS, Baumgartner RG, Wells N, Smith JA Jr. Analysis of early complications after radical cystectomy: results of a collaborative care pathway. *J Urol*. 2002; 167:2012–2016. [PubMed: 11956429]
46. Novara G, De Marco V, Aragona M, et al. Complications and mortality after radical cystectomy for bladder transitional cell cancer. *J Urol*. 2009; 182:914–921. [PubMed: 19616246]
47. Neuwahl S, Thompson K, Fraher E, Ricketts T. HPRI data tracks. Urology workforce trends. *Bull Am Coll Surg*. 2012; 97:46–49. [PubMed: 22315881]
48. Palda VA, Llewellyn-Thomas HA, Mackenzie RG, Pritchard KI, Naylor CD. Breast cancer patients' attitudes about rationing post-lumpectomy radiation therapy: applicability of trade-off methods to policy-making. *J Clin Oncol*. 1997; 15:3192–3200. [PubMed: 9336355]

TABLE 1

Patient Characteristics

Characteristic	RP, No. (%) n = 7428	RN, No. (%) n = 2778	PN, No. (%) n = 1365	RC, No. (%) n = 777	TURP, No. (%) n = 14,136	P
Age, y						
Mean ± SD	62.2 ± 7.5	61.5 ± 13.3	59.9 ± 13.2	68.4 ± 10.8	72.0 ± 9.8	<.001
18-49	339 (4.5)	529 (19.0)	284 (20.8)	35 (4.5)	174 (1.2)	<.001
50-59	2333 (31.4)	731 (26.3)	381 (27.9)	131 (16.9)	1427 (10.1)	
60-69	3460 (46.6)	718 (25.9)	362 (26.5)	245 (31.5)	3815 (27.0)	
70	1296 (17.5)	800 (28.8)	338 (24.8)	366 (47.1)	8720 (61.7)	
Sex						
Male	7428 (100)	1701 (61.2)	777 (56.9)	648 (83.4)	14,136 (100)	<.001
Female	NA	1077 (38.8)	588 (43.1)	129 (16.6)	NA	
Primary payer						
Medicare	2558 (34.4)	1099 (39.6)	502 (36.8)	450 (57.9)	9816 (69.5)	<.001
Commercial	1779 (24.0)	486 (17.5)	310 (22.7)	79 (10.2)	1110 (7.9)	
HMO	2787 (37.5)	903 (32.5)	443 (32.5)	200 (25.7)	2569 (18.2)	
Other	304 (4.1)	290 (10.4)	109 (8.0)	48 (6.2)	639 (4.5)	
No. of comorbid conditions ^a						
Mean ± SD	0.8 ± 0.9	1.4 ± 1.2	1.1 ± 1.1	1.8 ± 1.3	1.0 ± 1.1	<.001
0	3404 (45.8)	763 (27.4)	485 (35.5)	120 (15.4)	5469 (38.7)	<.001
1	2578 (34.7)	913 (32.9)	460 (33.7)	234 (30.1)	4725 (33.4)	
2	1069 (14.4)	633 (22.8)	247 (18.1)	226 (29.1)	2628 (18.6)	
3	377 (5.1)	469 (16.9)	173 (12.7)	197 (25.4)	1314 (9.3)	
Hospitals	54	55	48	38	69	
5-y volume, mean ± SD	138 ± 213	51 ± 63	28 ± 42	20 ± 28	205 ± 237	<.001

Abbreviations: HMO, health maintenance organization; NA, not applicable; PN, partial nephrectomy; RC, radical cystectomy; RN, radical nephrectomy; RP, radical prostatectomy; SD, standard deviation; TURP, transurethral resection of the prostate.

^aEnumeration of comorbidities derived from *International Classification of Diseases, Ninth Revision* (ICD-9) diagnosis codes as per the method of Elixhauser et al.²⁰

TABLE 2

Percentage of Patients Receiving Care Outside of Their Residential Area

	No.	Out of HSA	Out of HRR
Radical prostatectomy	7428	46% ^{a,b}	17% ^{a,b}
Radical nephrectomy	2778	45% ^{a,b}	15% ^{a,b}
Partial nephrectomy	1365	47% ^{a,b}	19% ^{a,b}
Radical cystectomy	777	53% ^a	24% ^a
TURP	14,136	30% ^b	7% ^b

Abbreviations: HRR, hospital referral region; HSA, hospital service area; TURP, transurethral resection of the prostate.

^a $P < .001$ compared with TURP.^b $P < .001$ compared with radical cystectomy.

TABLE 3

Multivariable Multilevel Model^a of Patient Characteristics Associated With Care Received Out of Their Residential HRR^b

	RP OR (95% CI)	RN OR (95% CI)	PN OR (95% CI)	RC OR (95% CI)	TURP OR (95% CI)
Age (vs <50 y)					
50-59 y	0.67 (0.48-0.93)	1.05 (0.74-1.48)	1.23 (0.75-2.00)	0.43 (0.14-1.35)	0.57 (0.34-0.97)
60-69 y	0.65 (0.47-0.91)	0.78 (0.53-1.14)	1.16 (0.68-1.99)	0.63 (0.21-1.91)	0.67 (0.41-1.11)
70 y	0.38 (0.26-0.57)	0.65 (0.41-1.01)	0.71 (0.36-1.38)	0.48 (0.15-1.50)	0.40 (0.24-0.67)
Female sex (vs male)	NA	0.88 (0.69-1.12)	1.17 (0.83-1.65)	0.54 (0.29-1.00)	NA
Primary payer (vs Medicare)					
Commercial	1.38 (1.10-1.73)	0.89 (0.57-1.38)	1.20 (0.67-2.16)	1.23 (0.50-3.06)	0.87 (0.64-1.19)
HMO	1.11 (0.91-1.35)	0.77 (0.54-1.10)	0.86 (0.51-1.44)	1.13 (0.60-2.12)	1.03 (0.85-1.25)
Other	1.33 (0.92-1.92)	0.65 (0.39-1.10)	1.48 (0.73-3.01)	0.56 (0.19-1.66)	1.30 (0.94-1.81)
No. of comorbidities (vs 0)					
1	1.05 (0.90-1.23)	1.12 (0.82-1.53)	0.91 (0.60-1.39)	0.89 (0.44-1.80)	0.95 (0.81-1.12)
2	0.87 (0.71-1.05)	1.03 (0.76-1.40)	0.82 (0.53-1.27)	0.51 (0.26-1.00)	0.86 (0.72-1.03)

Abbreviations: 95% CI, 95% confidence interval; HMO, health maintenance organization; HRR, hospital referral region; NA, not applicable; OR, odds ratio; PN, partial nephrectomy; RC, radical cystectomy; RN, radical nephrectomy; RP, radical prostatectomy; TURP, transurethral resection of the prostate.

^aIncluded patient characteristics as the fixed effects and patient hospital service area of residence as the random effect in the model; model was adjusted for all variables shown in the table.

^bBold type indicates a statistically significant result.

TABLE 4

Characteristics of HSAs Stratified by Export Rates^a for PN and RC^b

	PN			RC		
	Low-Export HSAs	High-Export HSAs	P	Low-Export HSAs	High-Export HSAs	P
HSA characteristics						
No. of HSAs	44	10		39	14	
Total population	112,635±174,456	62,729±81,747	.18	115,427±180,984	75,972±96,314	.31
Percent nonwhite	16.4±12.4	14.3±12.5	.32	15.1±9.3	17.0±12.6	.61
Percent with college degree	15.4±6.8	10.7±3.8	.007	15.8±6.9	10.9±3.6	.001
Percent high school only	27.2±6.1	30.4±4.8	.09	27.0±6.2	30.0±4.9	.08
SES index ^c	-0.17±1.47	-1.12±1.19	.04	-0.07±1.35	-1.08±1.24	.02
Age-adjusted rate ^d	33.7±16.3	31.5±13.7	.66	20.0±11.7	20.2±8.0	.93

Abbreviations: HSA, hospital service area; PN, partial nephrectomy; RC, radical cystectomy; SES, socioeconomic status.

^a A high export rate indicates that >50% of patients undergoing PN or RC undergo surgery out of their hospital referral region.^b Bold type indicates a statistically significant result.^c The SES index is a composite of US population standardized HSA characteristics (z-scores) including percentage of the population with a college education, percentage of the population with a high school education only, percentage of the population with income from interest/dividends, and percentage of the population with a professional occupation; each point equals 1 standard deviation away from the population mean.^d Age-adjusted rate of PN and RC, respectively, per 100,000 population.