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Authors

Wallner, Lauren P
Slezak, Jeffrey M
Loo, Ronald K
et al.

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Ten-Year Trends in Preventive Service Use Before and After Prostate Cancer Diagnosis: A Comparison with Noncancer Controls

Lauren P Wallner, PhD, MPH; Jeffrey M Slezak, MS; Ronald K Loo, MD; Roshan Bastani, PhD; Steven J Jacobsen, MD, PhD

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ABSTRACT

Context: Few studies have assessed the longer-term quality of preventive care in prostate cancer (PCa) survivors.

Objective: To compare the rates of preventive services among PCa survivors five years before and after diagnosis, to men without PCa.

Design: Men enrolled in Kaiser Permanente Southern California with newly diagnosed PCa (2002-2008) were matched 1:1 to men without a PCa diagnosis on age, race, and timing of prostate-specific antigen test (N = 31,180). The use of preventive services, including colorectal cancer screening, diabetes tests, lipid panels, and influenza and pneumococcal vaccinations was assessed 5 years before and after diagnosis (or index date for controls).

Main Outcome Measures: Relative rates (RRs) of use were calculated for cases and controls separately and compared using Poisson regression, adjusting for comorbidities and outpatient utilization in 2014.

Results: Overall, the rates of preventive services were lower among men with PCa vs men without PCa. However, in the 5 years after diagnosis, rates of preventive service use for all services were greater among PCa survivors vs men without PCa (colorectal cancer: RR = 1.05, 95% confidence interval [CI] = 1.01-1.10; lipids: RR = 1.10, 95% CI = 1.08-1.11; hemoglobin A_{1C}: RR = 1.17, 95% CI = 1.14-1.19; glucose: RR = 1.24, 95% CI = 1.23-1.26; influenza vaccine: RR = 1.05, 95% CI = 1.03-1.07; pneumococcal vaccine: RR = 1.03, 95% CI = 0.97-1.09).

Conclusion: Delivery of preventive care improved after PCa diagnosis, with survivors receiving comparable preventive care to men without PCa during the five years following diagnosis.

INTRODUCTION

There are currently more than 15.5 million cancer survivors in the US, and it is estimated that the number of survivors will exceed 20 million by 2026.[1,2] Prostate cancer survivors now account for the largest proportion of male cancer survivors (3.3 million) and the second largest proportion of cancer survivors overall.[1] Prostate cancer is a largely survivable chronic condition for most men, with a 5-year survival rate of nearly 100%,[2] and most prostate cancer survivors are now older than age 65 years.[1] Thus, these survivors are at increased risk of the development of other diseases of aging because of their advancing age, potential treatment effects, and prolonged survival.[3,4]

Because most men with prostate cancer will die of causes other than the prostate cancer, the delivery of appropriate preventive services to prostate cancer survivors is particularly critical.[5,6] The US Preventive Services Task Force (USPSTF) recommends that aging men receive a variety of screening and preventive services.[7] However, the complex delivery of prostate cancer care, which involves multiple clinicians of varying specialties over time, may lead to an inadequate transition between treatment and survivorship. This, in turn, may result in less preventive care being delivered in the survivorship period. Although previous studies suggest that prostate cancer survivors receive comparable preventive care to disease-free controls after diagnosis,[8-12] most of these studies have focused solely on patients older than age 65 years, and only 2 studies have looked at preventive care beyond the first year after diagnosis.[10,13] In addition, little is known regarding the receipt of services before prostate cancer diagnosis as a source of comparison.

Therefore, the goal of this study was to compare the use of preventive health services for other comorbid diseases of aging in the five years before and after prostate cancer diagnosis among men with prostate cancer and noncancer controls in a multiethnic population of men in general medical practice settings.

METHODS

Study Population

Kaiser Permanente Southern California (KPSC) is an integrated health care system that provides comprehensive health services for approximately 4.4 million residents of Southern California via 14 hospitals, 222 medical offices, and more than 7000 physicians. The population served by KPSC is socioeconomically diverse and broadly representative of the racial/ethnic groups living in Southern California.[14] Members enroll through the Kaiser Foundation Health Plan for prepaid health care insurance, including pharmaceutical benefits. Diagnoses, treatments, and utilization of health services are linked through electronic medical records (EMRs).

Men were eligible for inclusion in this study if they received a diagnosis of prostate cancer between 2002 and 2008

Lauren P Wallner, PhD, MPH, is an Assistant Professor of Internal Medicine and Epidemiology at the University of Michigan in Ann Arbor, and an Adjunct Investigator at the Department of Research and Evaluation for Kaiser Permanente Southern California in Pasadena. E-mail: lwallner@med.umich.edu. **Jeffrey M Slezak, MS,** is the Research Manager of Biostatistics for the Department of Research and Evaluation for Kaiser Permanente Southern California in Pasadena. E-mail: jeff.m.slezak@kp.org. **Ronald K Loo, MD,** is Regional Assistant Medical Director for the Southern California Permanente Medical Group and Chair of the Kaiser Permanente Interregional Urology Chiefs. E-mail: ronald.k.loo@kp.org. **Roshan Bastani, PhD,** is a Professor of Health Management and Policy at the University of California, Los Angeles. E-mail: bastani@ucla.edu. **Steven J Jacobsen, MD, PhD,** is the Senior Director of Research in the Department of Research and Evaluation for Kaiser Permanente Southern California in Pasadena. E-mail: steven.j.jacobsen@kp.org.

(N = 17,296) and had record of a serum prostate-specific antigen (PSA) test within 6 months of diagnosis (N = 15,631). Men with missing membership length information (N = 15) or who had previously undergone a radical prostatectomy before their prostate cancer diagnosis (N = 26) were excluded, leaving 15,590 men eligible for inclusion. Men with prostate cancer were matched to men without prostate cancer 1:1 on age (within 1 year), race (non-Hispanic white, non-Hispanic black, non-Hispanic Asian/Pacific Islander, Hispanic, and other/unknown), and timing of PSA test (within 1 year). As a result, the total analytic sample size was 31,180 men. The Kaiser Permanente internal review board reviewed and approved this study; for this type of study, written informed consent was not required.

Prostate Cancer Diagnosis

Prostate cancer survivors were defined as men with a diagnosis of any stage of biopsy-confirmed prostate cancer from 2002 through 2008 who were still alive. They were identified through the KPSC cancer registry, which participates in the Surveillance, Epidemiology, and End Results (SEER) registry. The registry data are 99% complete for both inpatient and outpatient admissions for the diagnosis of new and prevalent cancers.[15]

Preventive Services

Trends in the use of preventive and health maintenance services for aging men were identified five years before and after prostate cancer diagnosis using electronic Health Plan files. The use of adult preventive services was then assessed by identifying the following testing as coded in the EMR: heart and vascular disease (total cholesterol, triglycerides, high-density lipoprotein cholesterol), colorectal cancer screening use (fecal occult blood test [FOBT] and/or sigmoidoscopy or colonoscopy), diabetes screening and monitoring (glucose testing and hemoglobin A_{1C} [HbA_{1C}] measurement), and pneumonia and influenza vaccination (seasonal).

Covariate Assessment

Age at prostate cancer diagnosis, race (non-Hispanic white, black, Hispanic, Asian, other), Health Plan membership length, and marital status were abstracted from the EMR. Medical histories, including previous diagnosis of comorbid conditions such as cardiovascular disease (including hypertension), diabetes, hyperlipidemia, and other cancers, were collected via electronic Health Plan files and on the basis of International Classification of Diseases, Ninth Revision, coding. The presence of comorbidities was also measured using a modified version of the Charlson Comorbidity Index (CCI).[16]

Statistical Analysis

In 2014, the distributions of demographic and clinical characteristics at the time of matching (prostate cancer diagnosis in cases) were compared between men with a diagnosis of prostate cancer and men without prostate cancer using χ^2 tests for association and 2-sided *t*-tests when appropriate. The rates of preventive service use per year were calculated in the

Table 1. Demographic and clinical characteristics of study sample (N = 31,180)

Characteristic	Men without prostate cancer (n = 15,590)	Men with prostate cancer (n = 15,590)	p value
Age at matching, mean (SD)	64.9 (9.51)	64.9 (9.51)	0.747
Race at matching, no. (%)			
Non-Hispanic white	8113 (52.0)	8113 (52.0)	> 0.99
Non-Hispanic black	2599 (16.7)	2599 (16.7)	
Non-Hispanic Asian/Pacific Islander	3026 (19.4)	3026 (19.4)	
Hispanic	931 (6.0)	931 (6.0)	
Other/unknown	921 (5.9)	921 (5.9)	
Charlson Comorbidity Index, no. (%)			
0	9407 (60.3)	10,518 (67.5)	< 0.0001
1	2992 (19.2)	2522 (16.2)	
≥ 2	3191 (20.5)	2550 (16.4)	
Utilization (outpatient visits/y), no. (%)			
Q1, 0-2	3038 (19.5)	3283 (21.1)	< 0.0001
Q2, 3-6	4473 (28.7)	4760 (30.5)	
Q3, 7-12	3842 (24.6)	3944 (25.3)	
Q4, ≥ 13	4237 (27.2)	3603 (23.1)	
Other characteristics			
PSA level (ng/mL), mean, median (SD)	2.8, 1.3 (16.12)	31.8, 7.0 (225.89)	< 0.0001
History of diabetes, no. (%)	3760 (24.1)	2847 (18.3)	< 0.0001
History of CVD, no. (%)	768 (4.9)	634 (4.1)	0.0003
History of hyperlipidemia, no. (%)	11,948 (76.6)	11,057 (70.9)	< 0.0001
History of other cancers, no. (%)	2181 (14.0)	2115 (13.6)	0.2782

CVD = cardiovascular disease; PSA = prostate-specific antigen; Q = quarter; SD = standard deviation.

5 years before and after prostate cancer diagnosis (or the corresponding index date for controls). They were calculated in 30-day intervals as the number of tests divided by the number of people who were eligible members at that time interval and then multiplied by 12. The annualized rates were calculated for cases and controls separately and compared within service type using Poisson regression.

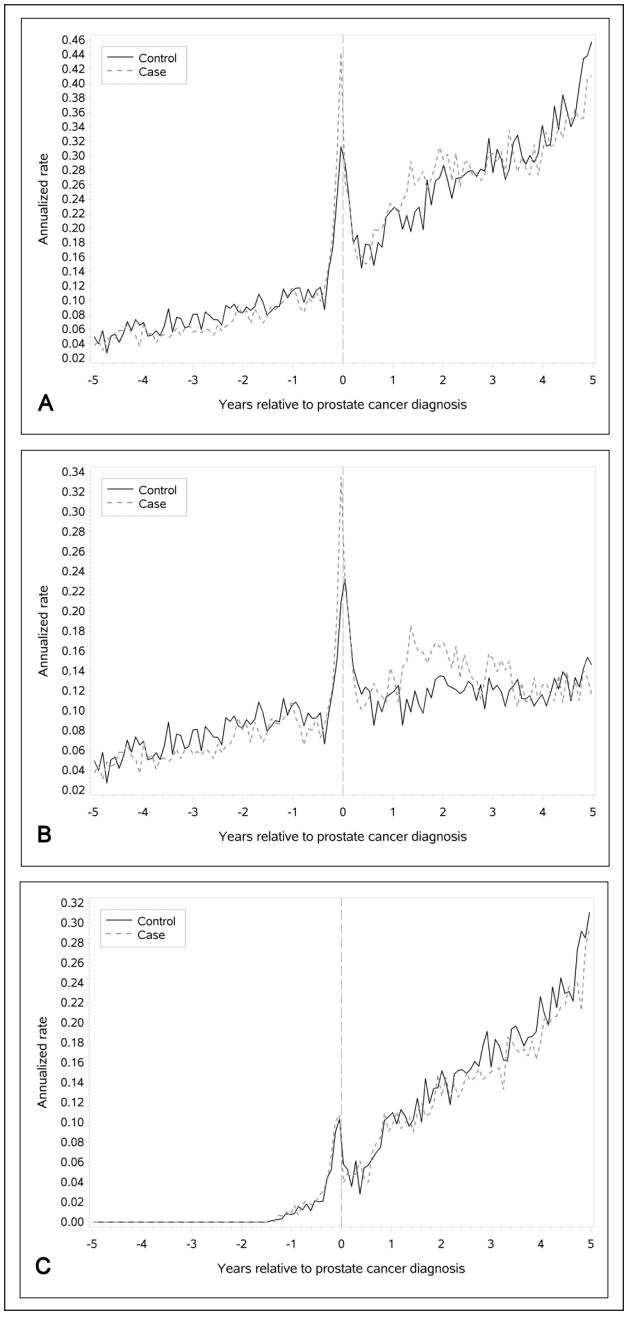

Figure 1. Rates of testing before and after diagnosis in prostate cancer cases diagnosed from 2002 to 2008 and matched controls: A. Any colorectal cancer screening; B. Fecal occult blood test and fecal immunochemical tests; C. Colonoscopy.

The relative rates (RRs) of use and 95% confidence intervals (CIs) were estimated comparing cases and controls throughout the entire period and comparing the use before and after diagnosis (regardless of case status) separately. In addition, an interaction term was fit to estimate the RR of preventive service use before and after prostate cancer diagnosis comparing cases and controls. All the models were adjusted for CCI and outpatient visit utilization. The models estimating the rates of HbA_{1C} use and lipid testing were further adjusted for the diagnosis of diabetes (HbA_{1C}), cardiovascular disease, and hyperlipidemia (lipid tests). Sensitivity analyses were run to assess the impact of removing all services within 90 days of diagnosis (or index date) in the rate calculations and adjusted models. All analyses used an α level of 0.05 to determine statistical significance and were performed using SAS 9.2 (SAS Institute Inc, Cary, NC).

RESULTS

Table 1 compares the demographic and clinical characteristics at time of matching between men with a prostate cancer diagnosis and men without prostate cancer. Age at matching ($p = 0.747$) and race ($p > 0.99$) were well balanced across groups. The median PSA level at matching was higher among men with prostate cancer (7.0 ng/mL) compared with men without prostate cancer (1.3 ng/mL; $p \leq 0.001$). Men with prostate cancer had fewer comorbidities compared with men without prostate cancer ($p < 0.001$) and were less likely to have a history of diabetes, cardiovascular disease, and hyperlipidemia (all $p < 0.001$; Table 1).

Figures 1 through 4 display the trends in the rates of each preventive service in the five years before and after diagnosis for cases and controls. For all services, the rates of use per year spiked right before prostate cancer diagnosis (or index date), most likely because these services were ordered at the same time the diagnostic PSA test was ordered. Rates of colonoscopy were notably highest among men with prostate cancer in the one to three years after diagnosis, whereas FOBT and fecal immunochemical tests (FIT) increased sharply with time after diagnosis (Figures 1B). Lipid panel test results remained stable over time, with a sharp peak just before prostate cancer diagnosis

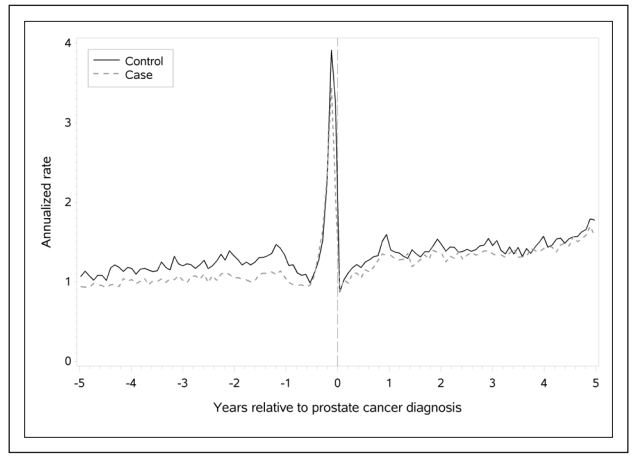

Figure 2. Rates of testing before and after diagnosis in prostate cancer cases diagnosed from 2002 to 2008 and matched controls: Lipid panel testing.

(or index date) (Figure 2). HbA_{1c} rates and glucose testing rates remained lower among cases throughout the study period compared with controls, with a more notable separation between rates among men with and without prostate cancer for HbA_{1C} testing. However, there were two peaks in glucose testing, one peak right before diagnosis and, interestingly, one in the first two months after diagnosis, potentially reflecting repeated testing among those with initially elevated levels (Figure 3). Influenza vaccination rates increased steadily during the study period and were higher among both groups after diagnosis. Finally, the pneumococcal vaccination rate remained stable over time and was equivalent between groups (Figure 4).

Men with a diagnosis of prostate cancer were 8% less likely to have a lipid test during the 10-year period compared with men without a prostate cancer diagnosis (adjusted RR = 0.91, 95% CI = 0.90-0.92) after adjustment for comorbidities, outpatient visit utilization, and diagnosis of cardiovascular disease and hyperlipidemia (Table 2, Column A). Men with prostate cancer were also 11% less likely to have an HbA_{1C} test and 12% less likely to have a glucose test than were men without prostate cancer after adjustment for diabetes diagnosis, CCI, and outpatient utilization (adjusted RR = 0.89, 95% CI = 0.88-0.91; RR = 0.88, 95% CI = 0.87-0.89; Table 2, Column A). The adjusted rates of colorectal cancer (CRC) screening were equivalent when groups were compared over the study period (RR = 0.99, 95% CI = 0.95-1.02). Although men with a diagnosis of prostate cancer were 3% less likely to have an annual influenza vaccine (adjusted RR = 0.97, 95% CI = 0.95-0.98), they were equally as likely to have a pneumococcal vaccine as men without prostate cancer after adjustment for CCI and outpatient utilization (Table 2, Column A).

Annual CRC screening rates were 2.75 times greater after diagnosis compared with before diagnosis, after adjustment for CCI and outpatient utilization (adjusted RR = 2.75, 95% CI = 2.67-2.84). When separated, FOBT/FIT was the biggest contributor to this trend: Use in the 5 years after diagnosis (or index date) was 15.2 times greater than use in the 5 years before diagnosis (adjusted RR = 15.2, 95% CI = 13.9-16.6). The rate of lipid panel testing was 8% greater in the 5 years after diagnosis (or index date) compared with before (adjusted RR = 1.08, 95% CI = 1.07-1.09). Testing for diabetes was higher in the 5 years

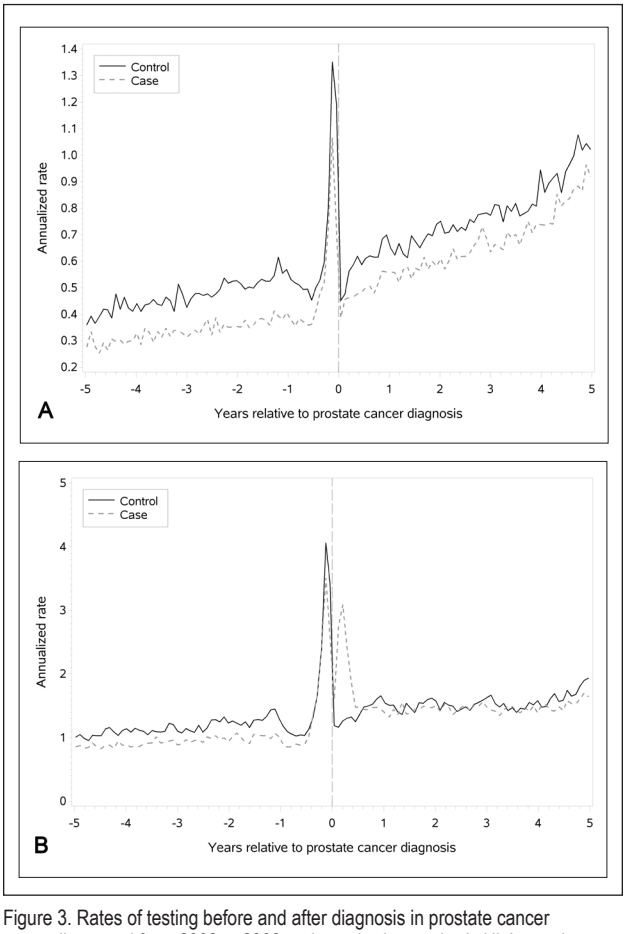

Figure 3. Rates of testing before and after diagnosis in prostate cancer cases diagnosed from 2002 to 2008 and matched controls: A. HbA_{1c} testing; B. Glucose.

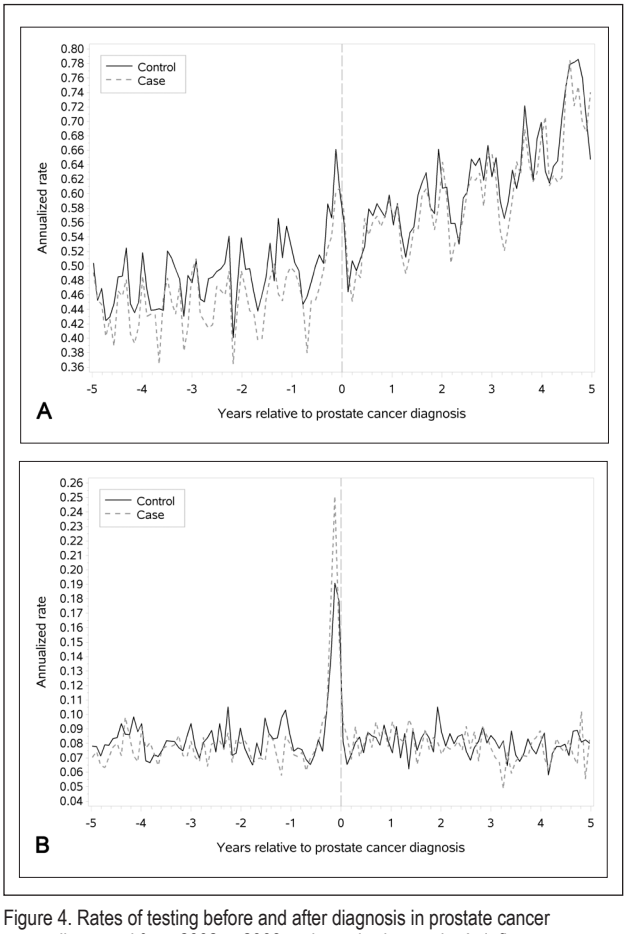

Figure 4. Rates of testing before and after diagnosis in prostate cancer cases diagnosed from 2002 to 2008 and matched controls: A. Influenza vaccinations; B. Pneumococcal vaccinations.

after diagnosis (or index date) compared with before diagnosis. Men were 45% more likely to have an HbA_{1C} test and 19% more likely to have a glucose test after diagnosis (or index date; HbA_{1C}: adjusted RR = 1.45, 95% CI = 1.43-1.47; glucose: adjusted RR = 1.19, 95% CI = 1.18-1.20) regardless of whether the men had a diagnosis of prostate cancer (Table 2, Column B).

The annual rates of CRC screening increased an additional 5% among men with prostate cancer compared with men without prostate cancer in the 5 years after diagnosis (adjusted RR = 1.05, 95% CI = 1.01-1.10). The rates of lipid testing after diagnosis or index date increased an additional 10% in men with prostate cancer relative to men without prostate cancer (adjusted RR = 1.10, 95% CI = 1.08-1.11). Rates of HbA_{1C} testing increased 17% and glucose testing increased 24% more in the men with prostate cancer after diagnosis relative to the men without prostate cancer, with the highest rate in the first 6 months after diagnosis (adjusted RR = 1.17, 95% CI = 1.14-1.19; RR = 1.24, 95% CI = 1.23-1.26). Although the rates of influenza vaccination increased 5% more after diagnosis in the men with prostate cancer compared with men without prostate cancer (adjusted RR = 1.05, 95% CI = 1.03-1.07), the trends in pneumococcal vaccination rates in the 5 years after diagnosis compared with before diagnosis were equivalent in both groups (adjusted RR = 1.03, 95% CI = 0.97-1.09; Table 2, Column C). These results remained unchanged when we removed services performed in the 90 days around the time of diagnosis or index date (results not shown).

DISCUSSION

This study evaluated the trends in preventive care in the five years before and after prostate cancer diagnosis and compared them with those in a population of men without a diagnosis of prostate cancer, to determine any care gaps in the delivery of preventive care to prostate cancer survivors in the period following diagnosis. Our results suggest that prostate cancer survivors received comparable preventive care in the five years after diagnosis compared with men without prostate cancer, particularly around the time that the PSA test was ordered that ultimately led to the diagnosis. In this integrated health care system, the diagnosis of prostate cancer seems to result in improved preventive care being delivered to survivors.

Our results suggest that colorectal cancer screening, lipid and diabetes testing, and influenza and pneumococcal vaccination were slightly greater among prostate cancer survivors in the five-year period after diagnosis; these findings are consistent, albeit more conservative, compared with prior studies in the SEER-Medicare database and in the United Kingdom.[10,13] Our findings expand on these results and suggest that despite increased use of colonoscopies among survivors and FOBT/FIT overall in more recent years, there remains room for improvement in the use of FOBT/FIT among men with prostate cancer after their diagnosis. Because patients with diagnosed prostate cancer who undergo treatment may be at increased risk of second primary cancers,[17,18] delivering appropriate screening for these cancers should be an important part of their survivorship care.

When we assessed the rates of preventive services use during the entire 10-year study period, the rates of screening and monitoring tests for diabetes (HbA_{1C} and glucose) were lower among men with prostate cancer compared with men without prostate cancer. Although fewer men with prostate cancer received a diagnosis of diabetes during the study period compared with men without prostate cancer (24% vs 18%), the difference in the rates of HbA_{1C} and glucose testing during the entire study period persisted after

Table 2. Adjusted relative rates (RR) and 95% confidence intervals (CI) comparing use of preventive services between prostate cancer cases and matched controls over 10-year study period (A), before and after diagnosis (or index date) overall (B), and before and after diagnosis (or index date) (C)[a]

	Adjusted RR (95% CI)		
Preventive service	A. Use in prostate cancer cases vs use in controls over entire study period	B. Use after prostate cancer diagnosis (or index date) vs use before diagnosis (or index date) overall	C. Use after prostate cancer diagnosis vs use before diagnosis compared between cases and controls
CRC screening			
Colonoscopy with or without FOBT/FIT	0.99 (0.95-1.02)	2.75 (2.67-2.84)	1.05 (1.01-1.10)
Colonoscopy only	0.96 (0.93-1.00)	1.45 (1.40-1.50)	1.18 (1.13-1.24)
FOBT/FIT only	1.27 (1.14-1.43)	15.2 (13.9-16.6)	0.79 (0.70-0.89)
Heart disease[b]			
Lipid panel	0.91 (0.90-0.92)	1.08 (1.07-1.09)	1.10 (1.08-1.11)
Diabetes[c]			
Hemoglobin A_{1c}	0.89 (0.88-0.91)	1.45 (1.43-1.47)	1.17 (1.14-1.19)
Glucose	0.88 (0.87-0.89)	1.19 (1.18-1.20)	1.24 (1.23-1.26)
Vaccinations			
Influenza	0.97 (0.95-0.98)	1.25 (1.23-1.27)	1.05 (1.03-1.07)
Pneumococcal	0.99 (0.96-1.03)	0.92 (0.89-0.96)	1.03 (0.97-1.09)

[a] Models were adjusted for Charlson Comorbidity Index and utilization (number of outpatient visits).
[b] Diagnosis of cardiovascular disease and/or hyperlipidemia was also included in the adjusted model.
[c] Diagnosis of diabetes also included in the adjusted model.
CRC = colorectal cancer; FOBT/FIT = fecal occult blood test/fecal immunochemical test.

adjustment for diabetes. However, the use of HbA_{1C} testing increased steadily during the study period, which in part may have mitigated the rate differences between groups, resulting in higher rates of the use of HbA_{1C} testing among men with prostate cancer after diagnosis. This is most likely the reflection of overall increasing the use of HbA_{1C} testing in clinical practice to monitor and screen for diabetes.

Previous studies have assessed a variety of factors associated with receiving preventive care after a cancer diagnosis.[12,19] It is possible that the high use of services in this cohort is related to higher utilization among men in whom cancer was once diagnosed, as shown in studies by Snyder and colleagues,[20-23] which focused on patients with colorectal cancer and breast cancer. The number of outpatient visits per year was high in this sample, with more than half of the sample with seven or more visits. However, when adjusting for utilization, the results remained largely unchanged. It is also possible that the high use of preventive services in this sample is because this is an entirely insured population who received care in an integrated system, where the use of preventive care is promoted widely regardless of clinician specialty. These reasons would align with the results from Robin Yabroff et al,[24] suggesting that access to care plays an important role in the use of preventive services among survivors, with use lowest among uninsured survivors and the highest use among those who are privately insured.

As a result of assessing the rates of preventive service granularly (30-day intervals), we found a noticeable and sharp increase in use of these preventive services just before or at prostate cancer diagnosis, suggesting that these services are ordered as part of a preventive panel along with the PSA test that ultimately led to the cancer diagnosis. We accounted for this increase in use, which was also evident among controls by matching on the timing of the PSA test that led to the cancer diagnosis in the case. We also performed sensitivity analyses that excluded the services used in the 90 days around the prostate cancer diagnosis/index date and found the results to be very similar. It is therefore possible that the increased use of services seen among cases in prior studies, particularly in the first year, may in part be driven by this sharp increase in use of preventive services around the time of PSA testing. However, the increased rates of use among prostate cancer survivors compared with men without prostate cancer in our study persisted even after excluding the services around the time of diagnosis, making this possibility less likely in this sample.

The increased rates of use after prostate cancer diagnosis (or index date) in this sample are most likely a result of a redesigned health care delivery model that was implemented during the study called Complete Care.[25] As part of this Complete Care model, several clinician-targeted and system-level interventions are in place to promote the use of preventive services among eligible members. These include a proactive office encounter tool embedded in the EMR that prompts the physician (regardless of specialty) to order appropriate preventive services, including the vaccinations and CRC screening tests in this study.[26] In addition, a successful CRC screening outreach program was launched during the study period to increase the use of FOBT/FIT among all age-eligible members,[27] which most likely caused the sharp increase in the use of these tests among both men with and without prostate cancer in this sample.

This study is unique in that it granularly assessed the use of preventive care services among prostate cancer survivors in a large, diverse cohort of men and compared it with noncancer controls. We assessed the use of preventive services both before and after diagnosis to get a better sense of how the quality of preventive care changed over time among survivors. It also included additional preventive services that were not assessed in prior studies, including pneumococcal vaccination and testing for diabetes. However, there are some potential limitations to consider. This analysis did not account for previous use of preventive services or whether men were due to receive these services. Because of varying schedules for these services, it is possible men may not have been due to receive the services in the period studied. In addition, we are unable to distinguish between testing done for screening vs maintenance or diagnostic purposes, as a proportion of the testing done may have been for the maintenance of already existing comorbidities or diagnostic in response to symptoms. However, adjustment for important comorbidities that would influence the use of these tests did not change our results. There are also system-level factors that are specific to this managed care organization that influenced the use of preventive services, which may limit the generalizability of these findings to other populations in which these interventions are not employed. However, our results support the notion that system interventions may play an important role in promoting the use of preventive services after cancer diagnosis.

CONCLUSION

In this integrated health care system, prostate cancer survivors received comparable preventive care for colorectal cancer, heart disease, diabetes, influenza, and pneumonia in the five years after diagnosis compared with men without a diagnosis of prostate cancer. These results provide reassurance that the quality of general preventive care is not diminished after a prostate cancer diagnosis. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. The Kaiser Permanente internal review board reviewed and approved this study.

Kathleen Louden, ELS, of Louden Health Communications provided editorial assistance.

Author Contributions

Lauren P Wallner, PhD, contributed to project development and manuscript writing and editing; Steven J Jacobsen, MD, PhD, to project development and manuscript editing; Jeffrey M Slezak, MS, to data collection and data analysis; and Roshan Bastani, MD, and Ronald Loo, MD, to project development and manuscript editing.

How to Cite this Article

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