

Limited PSA Testing in Indigent Men in South Texas: An Appropriate Care or Missing a Prevention Opportunity?

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Abstract

Background: No previous study has examined racial ethnic differences in prostate-specific antigen (PSA) testing and followup in primary care practices serving an indigent population.

Methods: From electronic medical records of primary care practices affiliated with one health care system in San Antonio, we identified 9,267 men aged 50 to 74 with 2+ clinic visits from 2008 through 2010 and no prior prostate cancer diagnosis. Logistic regression was used to examine the association of race ethnicity with the use of PSA testing and, if tested, with an abnormal result (≥ 4 ng/mL) adjusted for demographics, health care, and clinical factors. Time to a follow-up activity after an abnormal PSA was assessed using Cox proportional models.

Results: The race ethnicity of this cohort was 63% Hispanic, 27% non-Hispanic white, 7% African-American, and 3% other. In a 3-year period, 26.8% of men had at least one PSA test. Compared with African-Americans, non-Hispanic whites were less likely to be tested [OR, 0.68; 95% confidence interval (CI), 0.55–0.83] but Hispanics did not differ (OR = 0.95; 95% CI 0.79–1.15). African-Americans were more likely to have an abnormal PSA than others (12.4% vs. 5.2%, $P < 0.001$) and the shortest adjusted time to follow-up ($P = 0.004$).

Conclusions: In this 3-year indigent cohort, about one quarter had a PSA test, approximately half of the national testing rate.

Impact: African-Americans were more likely to be tested than non-Hispanic whites but had more abnormal results, raising concerns about missed prevention opportunities. African-Americans with high PSA results had the shortest time until follow-up, reflecting awareness of the threat of prostate cancer for African-Americans by physicians. *Cancer Epidemiol Biomarkers Prev*; 21(9); 1489–96. ©2012 AACR.

Introduction

Prostate-specific antigen (PSA) testing has become widespread in the United States since 1980. A 2001 population-based telephone survey of U.S. adults conducted by the Centers for Disease Control and Prevention showed that 75% of men more than the age of 50 years had had a PSA test and 54% had a PSA test within the previous year (1). A 2005 National Health Interview Survey reported that 49% of 50- to 79-year-old men had a PSA test in the past 2 years (2). However, PSA testing has

been hotly debated as a means to screen for prostate cancer after 2 large prospective randomized control trials reported conflicting results, one demonstrating a reduction in cancer-specific mortality because of PSA screening (3, 4) and another finding no benefit (5–7). Citing more harms than benefits from screening, the United States Preventive Services Task Force (USPSTF) recommended in October 2011 against PSA testing in healthy men (8). However, this recommendation has been criticized by many prostate cancer experts (9–12). A major concern relates to the greater morbidity and mortality of prostate cancer in African-American and other minority men with poor insurance who may have a greater risk of advanced prostate cancer at diagnosis and mortality from the disease (13–18).

Yet, few studies have examined use of PSA testing and appropriate follow-up after abnormal PSA results in minority and low-income cohorts of men before the USPSTF recommendations. It is possible that PSA testing rates are already quite low in these groups. We hypothesized that low-income, minority men would have a lower frequency of PSA testing than nationally (1–2). Because of widespread recognition of the risks of prostate cancer in African-American men (2), we also predicted that, in low-income population, African-Americans would be more

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likely to be tested and, when tested, to have an abnormal result (≥ 4 ng/mL) compared with other racial ethnic groups. As a quality of care metric, we also examined the timeliness of follow-up after an abnormal PSA. Our study cohort included indigent men aged 50 to 74 years treated in safety net primary care practices in San Antonio, Texas from 2008 to 2010. These data offer a valuable baseline assessment in PSA testing before the USPSTF recommendations to cease using this screening test.

Materials and Methods

Study subjects and variables

From electronic medical records (EMR) of primary care practices in one health care system serving primarily San Antonio's low-income population, we identified 9,506 men aged 50 to 74 years with longitudinal care as evidenced by at least 2 completed clinical encounters (>6 months apart) in 2 consecutive years between January 1, 2008, and December 31, 2010. We excluded 195 men with a prostate cancer diagnosis (ICD-9-CM code = 185) before the first PSA test within the study period as well as 44 men with missing data on race ethnicity, resulting in a final sample size of 9,267 men (Fig. 1).

The following demographic and clinical data were collected over the 3-year timeframe: age at first clinical visit; self-identified race ethnicity; insurance type; presence of benign prostatic hyperplasia (BPH, ICD-9-CM code = 600.XX); presence of non-prostate-related clinical

conditions including cancer of colon, rectum, breast, lung, or genitourinary system (ICD-9-CM code = 153.X, 154.X, 174.X, 162.X, 188.X, or 189.X), diabetes (ICD-9-CM code = 250.XX or 250.X), hypertension (ICD-9-CM code = 401.X), ischemic heart disease (ICD-9-CM code = 410.X, 411.X, 413.X, or 414.X), and depression (ICD-9-CM code = 296.2X, 196.3X, or 311); length of stay in the 3-year study period (date of last visit – date of first visit); PSA test(s) ordered; PSA test(s) conducted; PSA test results; and follow-up evaluation after a PSA test (a repeat PSA, a urology consult, or a new diagnosis of prostate cancer). For patients with multiple insurance plans during the study period, we selected the frequent insurance type after excluding self-pay. For those who used self-pay only, their insurance type was defined as self-pay. We also evaluated the duration of observation based on the time from the first to last encounter within the study interval. The study was approved as exempt by the Institutional Review Board at the University of Texas Health Science Center at San Antonio and the University Health System.

Statistical analyses

We calculated the proportions of men with a PSA test ordered and conducted over the 3 study years. PSA values were categorized for analysis as <1 , 1–2.4, 2.5–3.9 and ≥ 4 ng/mL, with ≥ 4 ng/mL, for the purpose of this study, considered "abnormal." (17, 19–21). Differences among racial ethnic groups were evaluated using the Fisher's exact test for categorical variables and the Kruskal–Wallis test for continuous variables. Univariate analyses were used to examine associations between patient characteristics and receipt of PSA testing. In multivariable logistic regression models, we examined the association of race ethnicity with receiving a PSA test and, if tested, having an abnormal PSA result after adjusting for age, insurance type, length of observation, and comorbidities (BPH, and number of non-prostate-related clinical conditions). Examinations of interactions found none were significant.

The log-rank test was used to compare Kaplan–Meier survival curves (time from first PSA test in the study period until a follow-up evaluation based on the first event of the following: a repeat PSA test, a follow-up urology visit ordered, or a diagnosis of prostate cancer) for following grouping factors: (i) race ethnicity, (ii) level of first PSA, (iii) number of non-prostate-related clinical conditions (0, 1, 2, and ≥ 3), and (iv) BPH diagnosis. A Cox proportional hazards model was estimated to examine time to follow-up after a PSA test adjusted for demographics (i.e., age, race ethnicity, insurance type, and length of observation) and clinical conditions (BPH, number of non-prostate-related clinical conditions, and PSA test result) (22). Proportional hazards assumptions were tested and validated on the basis of Schoenfeld residuals (23). Sensitivity analyses were conducted for a subset of patients who could be linked based on location codes on encounters to a most commonly visited primary care clinic to examine (i) variation by clinic in the 3 outcomes (i.e., PSA testing, abnormal PSA result, and time to follow-up

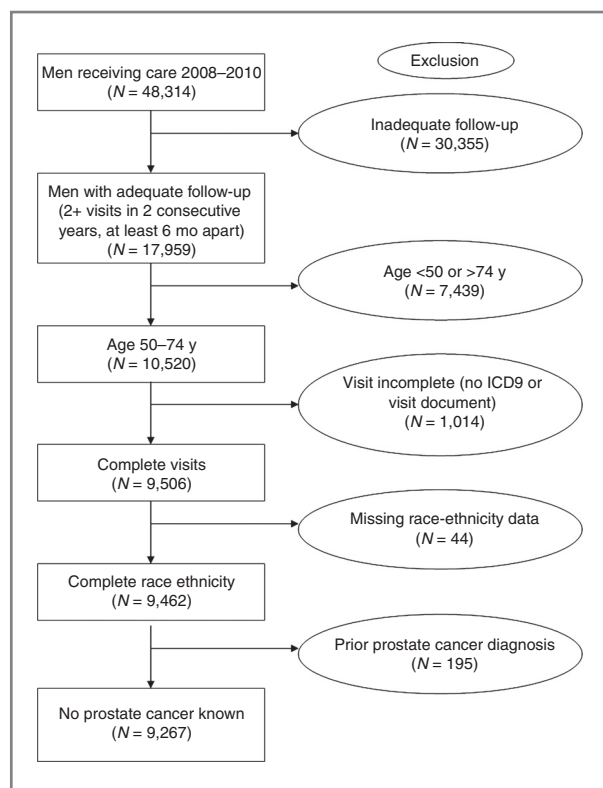


Figure 1. Flow chart.

after a PSA test) and (ii) whether clinic location modified the association of our key independent variable, race ethnicity, with these outcomes. All statistical tests were conducted at a 2-sided significance level of 0.05 and all analyses were conducted using SAS (Version 9.2).

Results

Among the 9,267 men aged 50 to 74 years in the study cohort, 5,876 (63%) were Hispanic, 2,470 (27%) were non-Hispanic white, 632 (7%) were African-American, and 289 (3%) were from other racial ethnic groups (Table 1). The median duration of observation from first to last encoun-

ter during the study period was 2.1 years (interquartile range: 1.4–2.7 years). The mean age was 58 years (SD = 5.8) but African-American men were younger than other racial ethnic groups ($P < 0.001$). African-American men were also more likely to have coverage for health care through CareLink A, a Bexar County supported financial assistance program for uninsured persons, than all other racial ethnic groups (17% vs. 12%, $P < 0.001$). CareLink A is the category for the most financially needy residents, whereas other CareLink eligibility categories have higher (more generous) income criteria (24). The diagnosis of BPH did not differ by race ethnicity. Compared with other

Table 1. Characteristics of primary care patients by race ethnicity

	African-American N = 632 (6.8%)	Hispanic N = 5,876 (63.4%)	Non-Hispanic white N = 2,470 (26.7%)	Other N = 289 (3.1%)	All patients N = 9,267 (100%)	P value^a
<i>Demographic outcomes</i>						
Age, y, mean (SD)	57 (5.4)	58.1 (5.7)	58.1 (5.9)	58.3 (6.1)	58.1 (5.8)	<0.001
Insurance type, n (%)						<0.001
CareLink A ^b	108 (17.1)	784 (13.3)	231 (9.4)	31 (10.7)	1,154 (12.5)	
CareLink other ^c	129 (20.4)	2,091 (35.6)	696 (28.2)	125 (43.3)	3,041 (32.8)	
Medicaid	90 (14.2)	498 (8.5)	181 (7.3)	20 (6.9)	789 (8.5)	
Medicare	171 (27.1)	1,723 (29.3)	616 (24.9)	40 (13.8)	2,550 (27.5)	
Private/state agency	82 (13)	654 (11.1)	622 (25.2)	67 (23.2)	1,425 (15.4)	
Other ^d	52 (8.2)	126 (2.1)	124 (5)	6 (2.1)	308 (3.3)	
Length of observation ^e (y), mean (SD)	2 (0.7)	2.1 (0.7)	1.9 (0.8)	2 (0.7)	2 (0.7)	<0.001
<i>Clinical outcomes, n (%)</i>						
BPH ^f	34 (5.4)	344 (5.9)	127 (5.1)	11 (3.8)	516 (5.6)	0.32
Cancer ^g	20 (3.2)	123 (2.1)	84 (3.4)	10 (3.5)	237 (2.6)	0.003
Diabetes ^h	235 (37.2)	3,182 (54.2)	852 (34.5)	116 (40.1)	4,385 (47.3)	<0.001
Hypertension ⁱ	455 (72)	4,049 (68.9)	1,400 (56.7)	176 (60.9)	6,080 (65.6)	<0.001
Ischemic heart disease ^j	111 (17.6)	1,348 (22.9)	482 (19.5)	69 (23.9)	2,010 (21.7)	<0.001
Depression ^k	77 (12.2)	755 (12.8)	310 (12.6)	14 (4.8)	1,156 (12.5)	0.001
No. of non-prostate-related clinical conditions ^l						
0	125 (19.8)	1,052 (17.9)	708 (28.7)	76 (26.3)	1,961 (21.2)	<0.001
1	213 (33.7)	1,576 (26.8)	760 (30.8)	88 (30.4)	2,637 (28.5)	
2	206 (32.6)	2,049 (34.9)	690 (27.9)	83 (28.7)	3,028 (32.7)	
≥3	88 (13.9)	1,199 (20.4)	312 (12.6)	42 (14.5)	1,641 (17.7)	

^aComparison among different racial ethnic groups.

^bCareLink plan A: poverty guideline range (PGR) 75% or below (24).

^cIncluding CareLink plan B (PGR = 76–150%), CareLink plan C (PGR = 151–200%), and CareLink plus plan (PGR = 201–300%) (24).

^dIncluding self-pay, indigent care, Tricare/VA, research billing, prisoner-Bexar county, prisoner-other and projects.

^eLength of observation (y): time from the first to last encounter in the 3-year study period.

^fBenign prostatic hyperplasia (BPH): ICD9 = 600.XX.

^gCancer of colon, rectum, breast, lung, or genitourinary system: ICD9 = 153.X, 154.X, 174.X, 162.X, 188.X or 189.X.

^hDiabetes: ICD9 = 250.XX or 250.X.

ⁱHypertension: ICD9 = 401.X.

^jIschemic heart disease: ICD9 = 410.X, 411.X, 413.X, or 414.X.

^kDepression: ICD9 = 296.2X, 196.3X, or 311.

^lNon-prostate-related clinical conditions include diseases in notes g to k.

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racial ethnic groups combined, Hispanic men were significantly more likely ($P < 0.001$) to have diabetes (35% vs. 54%, respectively) and 2 or more non-prostate-related comorbidities (42% vs. 55%, respectively).

Over a 3-year period, 2,525 (27.2%) men had a PSA ordered and nearly all had the test conducted (98%; Table 2). Among the 2,486 men who were tested, 79% had one PSA test and 17% had 2 PSA tests within the study period. African-American and Hispanic men were more likely to have a PSA test than non-Hispanic white men ($P < 0.001$). Men with BPH or non-prostate-related comorbidities or higher income groups receiving CareLink support were more likely to have a PSA test ($P < 0.001$). After adjustment, non-Hispanic white men were 32% less likely to be tested than African-American men ($P < 0.001$) but Hispanic men were almost equally likely to be tested (Table 3). After adjustment, men with CareLink support were more likely to be tested. Longer duration of observation was associated with an increased likelihood of being tested, whereas 2 or more comorbidities were not significantly associated.

As shown on Table 2, among the 2,486 men who had a PSA test, 5.7% men had an abnormal result (≥ 4 ng/mL), but this proportion was highest for African-American men (12.4%), ($P < 0.001$). Men with BPH were somewhat

more likely to have a high PSA result (8.4% vs. 5.4%, $P = 0.06$). After adjustment, compared with African-American men, all other racial ethnic men were more than 60% less likely to have an abnormal PSA (Table 3). In addition, the adjusted odds of an abnormal PSA increased by 8% per 1-year increase in age ($P < 0.001$). Comorbidities, insurance, and duration of observation were not significantly associated with having an abnormal PSA after adjustment.

Among 141 men with a PSA ≥ 4 ng/mL, 110 (78%) men had a follow-up initiated, with the median time to the follow-up being only 16.5 days (interquartile range, 4–94 days). The proportions without any follow-up after an abnormal PSA were 9%, 22%, 29%, and 50% for African-American, Hispanic, non-Hispanic white, and other racial ethnic men, respectively, a remarkable race ethnicity-related set of differences in follow-up after PSA testing although not statistically significant ($P = 0.16$).

In unadjusted Kaplan–Meier plots (Fig. 2) and adjusted survival analysis (Table 4), follow-up was more rapid for men with the following characteristics: African-American, an abnormal PSA result, BPH, and longer observation time. Specifically, all other racial ethnic groups had at least a 27% reduction in the adjusted hazard of follow-up, signifying more delayed follow-up versus African-

Table 2. Unadjusted association between patients' characteristics and PSA results

	N	PSA ordered		PSA conducted		PSA ≥ 4 ng/mL	
		N (%) ^a	P value	N (%) ^b	P value	N (%) ^c	P value
All patients	9,267	2,525 (27.2)		2,486 (26.8)		141 (5.7)	
Race ethnicity			<0.001		<0.001		0.001
African-American	632	181 (28.6)		178 (28.2)		22 (12.4)	
Non-Hispanic white	2,470	529 (21.4)		517 (20.9)		28 (5.4)	
Hispanic	5,876	1,738 (29.6)		1,717 (29.2)		87 (5.1)	
Other	289	77 (26.6)		74 (25.6)		4 (5.4)	
Benign prostatic hyperplasia			<0.001		<0.001		0.06
Yes	516	229 (44.4)		226 (43.8)		19 (8.4)	
No	8,751	2,295 (26.2)		2,260 (25.8)		122 (5.4)	
No. of non-prostate-related clinical conditions			<0.001		<0.001		0.31
0	1,961	461 (23.5)		449 (22.9)		24 (5.3)	
1	2,637	758 (28.7)		748 (28.4)		51 (6.8)	
2	3,028	852 (28.1)		843 (27.8)		47 (5.6)	
≥ 3	1,641	454 (27.7)		446 (27.2)		19 (4.3)	
Insurance type			<0.001		<0.001		0.12
CareLink A	1,154	328 (28.4)		322 (27.9)		11 (3.4)	
CareLink Other	3,041	953 (31.3)		941 (30.9)		57 (6.1)	
Medicaid	789	190 (24.1)		185 (23.4)		6 (3.2)	
Medicare	2,550	654 (25.6)		644 (25.3)		47 (7.3)	
Private/state agency	1,425	356 (25.0)		353 (24.8)		18 (5.1)	
Other	308	44 (14.3)		41 (13.3)		2 (4.9)	

^aProportion of men had a PSA ordered.

^bProportion of men had a PSA conducted.

^cProportion of men had an abnormal PSA among those who had a PSA conducted.

Table 3. Adjusted association between patients' characteristics and PSA results

	PSA conducted (<i>N</i> = 9,267)		PSA \geq 4 ng/mL (<i>N</i> = 2,486)	
	OR (95% CI)	<i>P</i> value	OR (95% CI)	<i>P</i> value
Age	1.00 (0.99–1.01)	0.466	1.08 (1.04–1.12)	<0.001
Race ethnicity		<0.001 ^a		<0.001 ^a
African-American	1.00 (–)	–	1.00 (–)	–
Non-Hispanic white	0.68 (0.55–0.83)	<0.001	0.38 (0.21–0.70)	0.002
Hispanic	0.95 (0.79–1.15)	0.604	0.34 (0.20–0.57)	<0.001
Other	0.79 (0.57–1.09)	0.148	0.35 (0.12–1.08)	0.068
Benign prostatic hyperplasia	1.99 (1.63–2.36)	<0.001	1.24 (0.73–2.11)	0.432
No. of non-prostate-related clinical conditions		0.014 ^a		0.381 ^a
0	1.00 (–)	–	1.00 (–)	–
1	1.14 (0.99–1.31)	0.070	1.10 (0.66–1.84)	0.711
2	1.01 (0.88–1.16)	0.926	0.90 (0.53–1.51)	0.680
\geq 3	0.90 (0.77–1.06)	0.214	0.67 (0.35–1.28)	0.228
Insurance type		<0.001 ^a		0.497 ^a
CareLink A	1.33 (1.12–1.58)	0.001	0.74 (0.36–1.55)	0.429
CareLink Other	1.46 (1.28–1.66)	<0.001	1.25 (0.79–1.99)	0.348
Medicaid	0.96 (0.79–1.17)	0.703	0.64 (0.26–1.56)	0.325
Medicare	1.00 (–)	–	1.00 (–)	–
Private/state agency	1.17 (1.00–1.38)	0.055	1.00 (0.54–1.84)	0.997
Other	0.65 (0.46–0.92)	0.016	0.87 (0.19–3.92)	0.859
Length of observation	1.58 (1.47–1.70)	<0.001	1.10 (0.82–1.48)	0.512

^aBased on Wald χ^2 test for testing the overall effect of a categorical variable.

American men (Table 4). Time to follow-up did not differ by age, non-prostate-related comorbidities, or insurance type.

In sensitivity analyses for the subset of patients (*n* = 6,081) whose usual source of care was one of 11 primary care clinics, overall 30% had a PSA test within a 3-year period but with a wide range across clinics from 19% to 51% (*P* < 0.001, Supplementary Table S1). After adjustment for clinic location and the other factors in Table 3, both non-Hispanic white men (*P* < 0.001) and Hispanic men (*P* = 0.009) were significantly less likely to be tested than African-American men. Among the 1,820 men who had a PSA test, 5.2% had an abnormal result and this did not vary significantly by clinic (*P* = 0.14, Supplementary Table S1); and after adjustment Hispanic (*P* < 0.001), non-Hispanic white (*P* < 0.001), and other minority men (*P* = 0.029) were still significantly less likely to have an abnormal PSA than African-American men. Time to follow-up after a PSA test differed by clinic as well (*P* = 0.03). After adjustment for clinic location and the other factors in Table 4, follow-up was still slower for Hispanic men (*P* = 0.017) and other minority men (*P* = 0.003) but non-Hispanic white men no longer differed significantly compared with African-American men (*P* = 0.106).

Discussion

Among nearly 10,000 older indigent men in South Texas, only slightly more than one quarter had a PSA

test from 2008 to 2010, which is far lower than the national studies finding that roughly 50% of men report being tested annually (*P* < 0.001) (1–2, 25). Among men who were PSA tested, 12% of African-American men had a test result more than 4 ng/mL, more than twice the proportion of men from other racial ethnic groups. These findings are consistent with other studies of PSA screening for prostate cancer that report higher PSA test results in African-American men (25, 26) and with African-American men's higher risk of high-grade (more aggressive) prostate cancer (27). In addition, most men in our study had a follow-up assessment ordered quite rapidly if they had an abnormal PSA test result, but follow-up was most rapid for African-American men.

These results should be viewed in context of the current controversy about PSA testing. Although the USPSTF recommends against PSA testing, the American Cancer Society among other groups still support informed decision making with physicians because the PSA test is our primary screening tool to identify prostate cancer early enough to potentially reduce the morbidity and mortality from prostate cancer (28). Limited PSA testing may be a more significant health threat for African-American men because their age-adjusted death rate from prostate cancer per 100,000 men in 2007 was 226.0 versus 145.1 for non-Hispanic white men (29). At least in our study, physicians in primary care practices caring for a largely minority, indigent patient population appear to be more attentive to

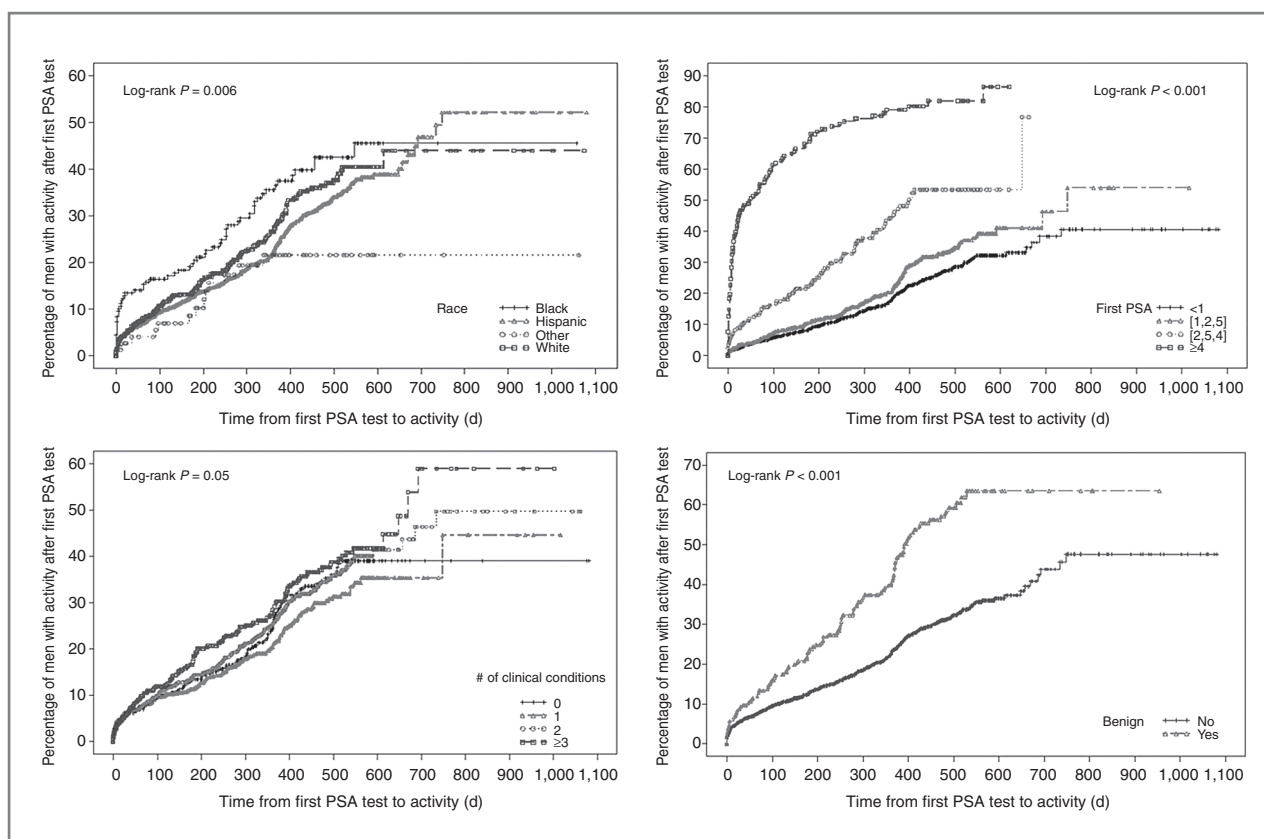


Figure 2. Time from the first PSA to a follow-up activity by race, the first PSA result, number of non-prostate-related clinical conditions, and presence of BPH.

conducting PSA testing in African-American men and to rapidly following up abnormal test results. However, it is not known whether the USPSTF recommendations will result in a rapid decline among men who have greater risk for adverse outcomes from prostate cancer. In our indigent practices, the baseline PSA testing rate was already about half the national rate before the change in recommendations occurred. Now PSA testing may be conducted primarily among men who are proactive in requesting it, however, it is unclear if this will occur.

After adjusting for age, length of observation, comorbidities and insurance type (a proxy for socioeconomic status), the odds of having PSA testing was 47% higher for African-American men than non-Hispanic white men in this cohort. It is possible that non-Hispanic white men in this indigent care setting are not asking for the test and physicians do not see them as being at increased risk of this disease. Interestingly, there was no adjusted difference with PSA testing in Hispanic men even though they have a significantly lower likelihood of developing prostate cancer (13). Again, physicians may be aware that Hispanic men, when diagnosed with prostate cancer, are more likely to have advanced disease than non-Hispanic white men (13). The number of comorbidities was not strongly associated with PSA testing, raising a question of

overtesting among men with a limited life expectancy because of the conditions such as diabetes, other cancers, and ischemic heart disease.

As another quality of care metric, we examined time to a follow-up evaluation ordered after an abnormal PSA result of 4 ng/mL, because it has been associated with an increased risk of death from prostate cancer (17). African-American men with a high PSA had the shortest time until an evaluation, and 91% of African-American men with an elevated PSA had a follow-up activity. However, overall 22% of men with an elevated PSA did not have any follow-up ordered. Our group previously documented that the average time to having a follow-up ordered among older men with a very abnormal PSA test result (≥ 10 ng/mL) was 3.8 months (30). Quality of care in this indigent cohort appears to be better in this regard.

Our study has several limitations. First, observation times varied from patient to patient in this 3-year study. The low PSA testing rate may be because of a brief time that the patient was receiving care from these practices, even though the median observation time was 2.1 years (Interquartile range: 1.4–2.7 years). However, the racial ethnic differences in PSA testing and follow-up activities after a PSA test were still evident after adjusting for the duration of observation. Second, we did not have

Table 4. Adjusted HRs of time from the first PSA to a follow-up activity using Cox proportional hazards models ($N = 2,486$)

Covariates	HR (95% CI)	P value
Age	1.00 (0.99–1.02)	0.941
Race ethnicity		0.004 ^a
African-American	1 (—)	—
Non-Hispanic white	0.73 (0.54–0.99)	0.042
Hispanic	0.64 (0.49–0.84)	0.001
Other	0.45 (0.24–0.81)	0.009
Benign prostatic hyperplasia	1.60 (1.29–1.98)	<0.001
No. of non-prostate-related clinical conditions		0.051 ^a
0	1 (—)	—
1	0.80 (0.63–1.01)	0.058
2	0.94 (0.75–1.19)	0.616
≥3	1.09 (0.84–1.41)	0.524
Insurance type		0.146 ^a
CareLink A	1.13 (0.84–1.50)	0.419
CareLink other	1.25 (1.01–1.54)	0.039
Medicaid	1.05 (0.75–1.4)	0.796
Medicare	1 (—)	—
Private/state agency	1.41 (1.08–1.83)	0.011
Other	1.28 (0.67–2.46)	0.458
First PSA result (ng/mL)		<0.001 ^a
<1	1 (—)	—
1–2.4	1.27 (1.05–1.53)	0.013
2.5–3.9	2.48 (1.91–3.22)	<0.001
≥4	8.11 (6.44–10.22)	<0.001
Length of observation	1.44 (1.26–1.65)	<0.001

^aOn the basis of Wald χ^2 test for testing the overall effect of the category variable of interest.

information about other prostate cancer risk factors such as family history, which should affect decision making about PSA testing. Third, we could only evaluate whether a follow-up evaluation was ordered but not whether it was actually received, because that occurs in practices that do not share our EMR system. Fourth, the results of our study were based on low-income men and may not be generalizable to all men. Fifth, we could not link all men in the study to a single location/clinic and we did not have demographic data for the provider ordering the PSA test. Among patients who could be linked to a clinic as their usual source of care, we observed wide variations in the use of PSA testing and time to follow-up consistent with the findings of a recent Veterans' study on older men (aged 70+; ref. 31). Adjusting for clinic location in our model showed a few differences compared with our analyses for the entire cohort. In this sensitivity analysis, PSA testing was significantly less likely for Hispanic men as well as non-Hispanic white men compared with African-American men but time to follow-up of a PSA test no longer differed significantly between African-American

and non-Hispanic white men. Sixth, we do not know if the provider offered a PSA test but the patient declined which might contribute to the relatively low PSA testing rates. Finally, we had smaller numbers of African-American men than other racial ethnic groups in this diverse population.

However, an important strength of study is our ability to evaluate longitudinal care for men in a unique safety net health care setting. In addition, we were able to account for multiple potential confounders that may affect the use of PSA testing. Although we expected that PSA testing would be less common in this indigent cohort, we were surprised to find that the rate was about half that nationally and recommend further studies to determine how patient choice may be affecting these results. We are concerned that the USPSTF guidelines may result in a further diminishment of PSA testing, particularly among African-American men and poor Hispanic men because of their greater risk of poor outcomes from prostate cancer. On a more positive note, in our indigent setting, physicians appear to be aware of the threat of prostate cancer for African-American men as reflected by greater testing rate and more rapid follow-up of abnormal PSA test results. Cohorts such as ours should be the focus of continued examination of the performance of PSA testing as well as the morbidity and mortality of prostate cancer.

Conclusions

In this indigent cohort, about one quarter had a PSA test from 2008 to 2010, approximately half of the national testing rate. African-American men were more likely to be tested than non-Hispanic white men but had more abnormal results, raising concerns about missed prevention opportunities. African-American men with high PSA results had the shortest time until follow-up, reflecting awareness of the threat of prostate cancer for African-Americans by physicians.

Disclosure of Potential Conflicts of Interest

B.J. Turner, receives compensation as the Director of Health Outcomes Improvement at the University Health System. No potential conflicts of interest were disclosed by the other authors.

Authors' Contributions

Conception and design: Y. Liang, I.M. Thompson, Jr., B.J. Turner
Development of methodology: Y. Liang, B.J. Turner
Acquisition of data (provided animals, acquired and managed patients, provided facilities, etc.): I.M. Thompson, Jr., B.J. Turner
Analysis and interpretation of data (e.g., statistical analysis, biostatistics, computational analysis): Y. Liang, F. Du, B.J. Turner
Writing, review, and/or revision of the manuscript: Y. Liang, F. Du, I.M. Thompson, Jr., B.J. Turner
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References

- Sirovich BE, Schwartz LM, Woloshin S. Screening men for prostate and colorectal cancer in the United States: does practice reflect the evidence? *JAMA* 2003;289:1414–20.
- Ross LE, Berkowitz Z, Ekwueme DU. Use of the prostate-specific antigen test among U.S. men: findings from the 2005 National Health Interview Survey. *Cancer Epidemiol Biomarkers Prev* 2008;17:636–44.
- Schroder FH, Hugosson J, Roobol MJ, Tammela TLJ, Ciatto S, Nelen V, et al. Screening and prostate-cancer mortality in a randomized european study. *N Engl J Med* 2009;360:1320–8.
- Schröder FH, Hugosson J, Roobol MJ, Tammela TLJ, Ciatto S, Nelen V, et al. Prostate-cancer mortality at 11 years of follow-up. *N Engl J Med* 2012;366:981–90.
- Andriole GL, Crawford ED, Grubb RL III, Buys SS, Chia D, Church TR, et al. Mortality results from a randomized prostate-cancer screening trial. *N Engl J Med* 2009;360:1310–9.
- Pinsky PF, Blacka A, Kramer BS, Miller A, Prorok PC, Berg C. Assessing contamination and compliance in the prostate component of the prostate, lung, colorectal, and ovarian (PLCO) cancer screening trial. *Clin Trials* 2010;7:303–11.
- Andriole GL, Crawford ED, Grubb RL III, Buys SS, Chia D, Church TR, et al. Prostate cancer screening in the randomized prostate, lung, colorectal, and ovarian cancer screening trial: mortality results after 13 years of follow-up. *J Natl Cancer Inst* 2012;104:125–32.
- Chou R, Croswell JM, Dana T, Bougatsos C, Blazina I, Fu R, et al. Screening for prostate cancer: a review of the evidence for the U.S. preventive services task force. *Ann Intern Med* 2011;155:762–71.
- Kim J, Davis JW. Prostate cancer screening—time to abandon one-size-fits-all approach? *JAMA* 2011;306:2717–8.
- Miller DC, Hollenbeck BK. Missing the mark on prostate-specific antigen screening. *JAMA* 2011;306:2719–20.
- Volk RJ, Wolf AMD. Grading the new US preventive services task force prostate cancer screening recommendation. *JAMA* 2011;306:2715–6.
- Welch HG. Making the call. *JAMA* 2011;306:2649–50.
- Intercultural cancer council. Hispanics/Latinos and cancer. [cited 2010 Dec 1]. Available from: <http://iccnetwork.org/cancerfacts/>.
- Jones BA, Liu W-L, Araujo AB, Kasl SV, Silvera SN, Soler-Vilá H, et al. Explaining the race difference in prostate cancer stage at diagnosis. *Cancer Epidemiol Biomarkers Prev* 2008;17:2825–34.
- Su LJ, Arab L, Steck SE, Fontham ETH, Schroeder JC, Bensen JT, et al. Obesity and prostate cancer aggressiveness among african and caucasian americans in a population-based study. *Cancer Epidemiol Biomarkers Prev* 2011;20:844–53.
- Chomokur G, Dalton K, Borysova ME, Kumar NB. Disparities at presentation, diagnosis, treatment, and survival in African American men, affected by prostate cancer. *Prostate* 2011;71:985–97.
- Tang P, Sun L, Uhlman MA, Polascik TJ, Freedland SJ, Moul JW. Baseline PSA as a predictor of prostate cancer-specific mortality over the past 2 decades. *Cancer* 2010;116:4711–7.
- Mordukhovich I, Reiter PL, Backes DM, Family L, McCullough LE, O'Brien KM, et al. A review of African American-white differences in risk factors for cancer: prostate cancer. *Cancer Causes Control* 2011;22:341–57.
- Mettlin C, Lee F, Drago J, Murphy GP. The american cancer society national prostate cancer detection project. Findings on the detection of early prostate cancer in 2425 men. *Cancer* 1991;67:2949–58.
- Brawer MK, Chetner MP, Beatie J, Buchner DM, Vessella RL, Lange PH. Screening for prostatic carcinoma with prostate specific antigen. *J Urol* 1992;147 (3 Pt 2):841–5.
- Crawford ED, DeAntoni EP, Etzioni R, Schaefer VC, Olson RM, Ross CA. Serum prostate-specific antigen and digital rectal examination for early detection of prostate cancer in a national community-based program. The Prostate Cancer Education Council. *Urology* 1996;47:863–9.
- Cox DR. Regression models and life-tables. *J R Stat Soc Ser B (Methodological)* 1972;34:187–220.
- Schoenfeld D. Chi-squared goodness-of-fit tests for the proportional hazards regression model. *Biometrika* 1980;67:145–53.
- Hernández GB, Fornos LB, Mika VS, Urbansky K, Villarreal R. One regional health system's innovative steps to deal with the uninsured. *J Health Care Finance* 2009;36:70–84.
- Zhu Y, Sorkin JD, Dwyer D, Groves C, Steinberger EK. Predictors of repeated PSA testing among black and white men from the Maryland Cancer Survey, 2006. *Prev Chronic Dis* 2011;8:A114.
- Fowke JH, Schlundt D, Signorello LB, Ukoli FAM, Blot WJ. Prostate cancer screening between low-income African-American and Caucasian men. *Urol Oncol* 2005;23:333–40.
- Thompson IM, Ankerst DP, Chi C, Goodman PJ, Tangen CM, Lucia MS, et al. Assessing prostate cancer risk: results from the prostate cancer prevention trial. *J Natl Cancer Inst* 2006;98:529–34.
- Wolf AMD, Wender RC, Etzioni RB, Thompson IM, D'Amico AV, Volk RJ, et al. American Cancer Society guideline for the early detection of prostate cancer: update 2010. *CA Cancer J Clin* 2010;60:70–98.
- Centers for Disease Control and Prevention. United States Cancer Statistics. 2007 Cancer Types Grouped by Race and Ethnicity. United States Cancer Statistics. [cited 2012 Mar 29]. Available from: <http://apps.nccd.cdc.gov/uscs/cancersbyraceandethnicity.aspx>.
- Turner BJ, Mavandadi S, Weiner MG. Association of black race with follow-up of an abnormal prostate-specific antigen test. *J Natl Med Assoc* 2011;103:150–7.
- So C, Kirby KA, Mehta K, Hoffman RM, Powell AA, Freedland SJ, et al. Medical center characteristics associated with PSA screening in elderly veterans with limited life expectancy. *J Gen Intern Med* 2012;27:653–60.