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Racial disparities in guideline-concordant cancer care and mortality in the United States

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Abstract

Purpose: We identified the frequency of racial disparities in guideline-concordant cancer care for select common disease sites in the United States and the impact of guideline concordance on mortality disparities.

Methods and materials: Using Surveillance, Epidemiology, and End Results Medicare data, we evaluated patients age >65 years of black or non-Hispanic white race who were diagnosed with stage III breast (n = 3607), stage I (n = 14,605) or III (n = 15,609) non-small cell lung, or stage III prostate (n = 3548) cancer between 2006 and 2011. Chemotherapy, surgery, and radiation therapy (RT) treatments were identified using claims data. Pearson χ^2 was used to test the associations between race and guideline concordance on the basis of National Comprehensive Cancer Network curative treatment guidelines. Mortality risks were modeled using Cox proportional hazards.

Results: Black patients were less likely to receive guideline-concordant curative treatment than non-Hispanic white patients for stage III breast cancer postmastectomy RT (53% black, 61% white; $P = .0014$), stage I non-small cell lung cancer stereotactic radiation or surgery (61% black, 75% white; $P < .0001$), stage III non-small cell lung cancer chemotherapy in addition to RT or surgery (36% black, 41% white; $P = .0001$), and stage III prostate cancer RT or prostatectomy (82% black, 95% white; $P < .0001$). Disparities in guideline concordance impacted racial mortality disparities. Specifically, hazard ratios that demonstrated elevated all-cause mortality risks in black patients were lowered (and more closely approached hazard ratio of 1.00) after adjusting for guideline concordance. A similar impact for cause-specific mortality was observed.

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Conclusions: Racial disparities in the receipt of curative cancer therapy impacted racial mortality disparities across multiple cancer sites. Benchmarking adherence to guideline-concordant care could represent an opportunity to stimulate improvements in disparities in cancer treatment and survival.

Introduction

Racial disparities in cancer treatment and outcomes have been demonstrated in several population-based studies but targets for interventions to improve disparities have been challenging to identify.[1,2] Studies have shown disparities in cancer-specific mortality among black versus non-Hispanic white patient populations with breast, lung, and prostate cancer, which are the leading causes of cancer death among men and women in the United States.[3-7] The adoption of evidence-based cancer treatments[8,9] in black patient cohorts has similarly lagged behind that of white patients.[4-7,10]

Cancer treatment guidelines have been developed to promote evidence-based cancer treatment and consequently outcomes.[11] Whether guideline concordance—or disparities in such concordance—meaningfully impacts racial disparities in cancer outcomes is not known. Quantifying the magnitude of racial disparities in the use of standard treatments across the United States is an important step toward identifying and ultimately targeting a reduction in barriers to high-quality cancer care.

Accordingly, we sought to more comprehensively understand guideline-concordant practice in black and white patients with cancer. We sought to quantify the frequency and magnitude of disparities across disease sites in key patient cohorts in which curative treatments are delineated in national practice guidelines,[11] understand the impact of racial disparities on mortality, and understand the impact of guideline-concordant care on racial disparities in mortality. We hypothesized that racial disparities exist in the practice of guideline-concordant care. We further hypothesized that guideline concordance would be a significant contributor to racial disparities in cancer outcomes even after adjustment for discrepancies in clinical and socioeconomic status (SES) factors.

Study methods

Data source and patient cohort

We used the Surveillance, Epidemiology, and End Results (SEER) Medicare data set to examine oncology treatment utilization (ie, chemotherapy, surgery, and radiation) in patients age >65 years with incident American Joint Committee on Cancer stage III breast cancer, stage I non-small cell lung (NSCLC), stage III NSCLC, or stage III prostate cancer between 2006 and 2011. The period of analysis was chosen to evaluate the use of well-established curative treatment guidelines with sufficient follow-up time for analysis of mortality outcomes. The stages/therapies were chosen based on availability of evidence that observation is not considered a standard curative option (eg, in stage I-II prostate cancer, some patient subsets are considered eligible for observation or active surveillance where appropriateness of treatment could not be evaluated on the basis of administrative claims).

We sequentially excluded patients with a prior history or diagnosis of a secondary malignancy within the first year of diagnosis, unknown histology, no pathologic confirmation, and cancer diagnosis at the time of autopsy/by death certificate (eTables 1-3; available as supplementary material online only at www.practical.radonc.org). Full Medicare Parts A and B coverage and no health maintenance organization enrollment 12 months prior to and 12 months after diagnosis was required. Patient and disease factors at the time of diagnosis that were extracted from SEER data included age, diagnosis year, disease stage, and tumor grade. Final samples included 3607 patients with stage III breast cancer; 14,605 patients with stage I and 15,609 patients with stage III NSCLC; and 3548 patients with stage III prostate cancer.

Race

Patients of black and non-Hispanic white race were categorized as documented by SEER. Patients of Hispanic white and Asian Pacific Islander race were excluded due to the relatively small sample sizes.

Other covariates

A modified Charlson comorbidity index was derived based on Medicare diagnosis claims for noncancer, comorbid diseases[12-14] that occurred between 12 months prior and up to 1 month before the cancer diagnosis date. As established in prior studies, to enhance specificity, diagnosis codes identified in Part B files must have occurred in 2 separate claims over >30 days or also in Part A claims.[15,16] A score that indicates that performance status was derived from the Medicare Durable Medical Equipment file with use of home oxygen, cane, commode, wheelchair, or hospital bed,[17,18] was categorized as 0 (none), 1 (1 equipment item), or 2 (2 or more items).[17]

SES covariates were derived from the Area Health Resources File linked by county and included rural and urban

status, percentage of population by county who were living in poverty, median household income, and educational level (ie, percentage with college education or more).[19,20]

Cancer treatment

To determine treatment received up to 1 year from the date of diagnosis, International Classification of Diseases (ICD)-9 procedure and Health Care Common Procedure Coding System (HCPCS) claims codes were used to define chemotherapy, site-specific surgery (eg, mastectomy, radical prostatectomy, sub-lobar resection, lobar resection, lobectomy), and radiation therapy (RT).[18,21,22] Details of the radiation technique including stereotactic body radiation therapy (SBRT) were classified on the basis of procedure claims. SBRT treatment was defined by the claim for technique regardless of the number of radiation fractions. Chemotherapy codes identified systemic therapies.[23]

Concordance with practice guidelines

The frequency of concordance of treatment with select practice guidelines for curative treatment on the basis of National Comprehensive Cancer Network guidelines[11] for each disease site was assessed. In select patients with advanced stage breast cancer (stage III, treated with mastectomy), we assessed the use of postmastectomy RT. In patients with stage I NSCLC, we assessed the use of SBRT, external beam RT, or surgery including sub-lobar resection, lobectomy, and pneumonectomy. In patients with stage III NSCLC, we assessed the use of RT or surgery plus chemotherapy and in patients with stage III prostate cancer, the use of RT (external beam RT) or prostatectomy in patients age ≤75 years.[24]

Statistical analyses

Associations between race and guideline-concordant treatment use were tested using the Pearson χ^2 test. Multivariate Cox proportional hazards models examined associations between race, guideline concordance, clinical factors, SES factors, and all-cause and cause-specific mortality outcomes with dates and cause of death documented by the SEER data set. The adjustment for clinical factors included age, sex, clinical T stage, clinical N stage, comorbidity, performance status, and the adjustment for SES factors included insurance status, income, and rural/urban location. Covariates were selected a priori based on a univariate significance of $P < .25$ and/or clinical significance.

Tests for proportionality indicated that the proportionality assumption was met. Serial models were built incrementally by adding covariates (guideline concordance [dichotomous yes/no], then clinical factors, then SES factors) to explore the incremental confounding from these categories of covariates. Analyses were conducted using SAS 9.4 (SAS Institute, Cary, NC) and statistical tests were two-sided. A P-value of $< .05$ was considered statistically significant. This study was exempted by the institutional review board.

Results

Study sample

Patient characteristics by type of cancer and race are summarized in Table 1. There were significant differences in median age, clinical T stage, Charlson comorbidity index, and performance status between black and white patients across disease sites. There were also significant disparities between black and white patients with respect to insurance status, income, and education, and differences in rural/urban geographic locations across the disease sites (Table 1).

Racial disparities in guideline concordance by cancer site

When comparing raw frequencies of treatment utilization, black patients were significantly less likely to receive guideline-concordant curative treatment for stage III breast cancer, stage I and stage III NSCLC, and stage III prostate cancer. The specific frequencies of treatment utilization by cancer site are delineated below.

Breast cancer

We examined the use of postmastectomy RT in patients with stage III breast cancer by race. The use of postmastectomy RT was 53% in black patients (of n = 402) compared with 61% in white patients (of n = 3205; $P = .001$).

Non-small cell lung cancer

We examined the use of SBRT or surgery in patients with stage I NSCLC by race. The use of these curative treatments was 60% in black patients (of n = 1065) compared with 75% in white patients (of n = 13,540; $P < .0001$). Additionally, we examined the use of RT or surgery plus chemotherapy in patients with stage III NSCLC by race. The use of these curative treatments was less frequent in black versus white patients: 36% in black patients (of n = 1527) compared with 41% in white patients (of n = 14,082; $P = .0001$).

Prostate cancer

We examined the use of RT or prostatectomy in patients with stage III prostate cancer by race. The use of these

Table 1 Patient, clinical, and socioeconomic characteristics by disease/stage and race

Characteristic	Stage III breast cancer (n = 3607)			Stage I NSCLC (n = 14,605)			Stage III NSCLC (n = 15,609)			Stage III prostate cancer (n = 3548)		
Race	**B**	**W**	*P*-value	**B**	**W**	*P*-value	**B**	**W**	*P*-value	**B**	**W**	*P*-value
Median age (years, IQR)	74 (69-81)	76 (71-82)	**.004**	74 (69-79)	76 (71-80)	**< .001**	74 (70-79)	76 (71-81)	**< .001**	68 (67-71)	69 (67-72)	**< .001**
Sex, Female %	96.8	97.6	0.29	53.0	52.4	.74	45.4	47.4	.15	-	-	-
Clinical T stage (%)												
T1	56.0	56.3	0.58	65.9	67.8	**.03**	21.4	21.8	0.76	48.5	42.1	**< .001**
T2	13.4	14.6	-	15.2	12.5	-	9.4	9.6	-	23.4	34.1	-
T3	4.5	2.9	-	18.9	19.7	-	10.7	11.7	-	28.1	23.8	-
T4	25.9	25.9	-	-	-	-	52.8	50.9	-	-	-	-
Clinical N stage (%)												
N0	7.7	7.8	.91	100	100	-	20.0	21.6	.17	100	100	-
N +	91.8	91.5	-	-	-	-	77.3	75.3	-	-	-	-
Charlson Comorbidity (%)												
0	40.3	59.3	**< .001**	81.0	84.5	**< .001**	56.8	59.8	**< .001**	57.9	75.5	**< .001**
1	29.6	23.7	-	5.4	6.1	-	14.3	18.5	-	27.8	17.6	-
≥2	30.1	16.9	-	13.6	9.4	-	28.9	21.7	-	15.3	6.9	-
Performance status (%)												
0	82.8	86.7	**.005**	71.1	73.0	**.02**	76.5	73.8	**.001**	93.2	93.4	.83
1	11.9	10.9	-	22.4	22.4	-	17.9	21.6	-	5.8	5.9	-
≥2	5.2	2.5	-	6.5	4.5	-	5.6	4.6	-	1.0	0.7	-
Insurance (%)												
Medicaid	43.0	16.5	**< .001**	40.5	13.1	**< .001**	44.0	14.5	**< .001**	19.7	3.9	**< .001**
Other	57.0	83.5	-	59.5	86.9	-	56.0	85.5	-	80.3	96.1	-
Income[a] (%)						-						
Quartile 1	12.0	26.6	**< .001**	8.1	26.3	**< .001**	8.1	26.8	**< .001**	9.2	26.4	**< .001**
Quartile 2	17.7	25.9	-	16.7	25.7	-	15.6	26.0	-	13.3	26.1	-
Quartile 3	21.2	25.5	-	21.2	25.2	-	20.3	25.5	-	20.4	25.4	-
Quartile 4	49.1	22.0	-	54.0	22.8	-	56.1	21.6	-	57.1	22.1	-
Education[b] (%)												
Quartile 1	7.2	27.3	**< .001**	8.2	26.3	**< .001**	6.7	27.0	**< .001**	6.5	26.8	**< .001**
Quartile 2	15.7	26.2	-	13.1	26.0	-	13.5	26.3	-	13.6	26.0	-
Quartile 3	25.6	24.9	-	25.6	24.9	-	25.2	24.9	-	18.4	25.6	-
Quartile 4	51.5	21.6	-	53.1	22.8	-	54.6	21.8	-	61.6	21.7	-
Rural/urban (%)												
Big metro	65.4	48.0	**< .001**	60.1	52.1	**< .001**	60.7	49.9	**< .001**	67.1	50.0	**< .001**
Metro	21.6	31.7	-	27.1	29.1	-	26.9	30.7	-	22.0	32.9	-
Urban	4.7	6.0	-	4.7	5.9	-	3.9	6.3	-	4.4	5.7	-
Less urban	7.0	11.0	-	7.3	10.5	-	7.7	10.6	-	5.4	8.7	-
Rural	1.2	3.3	-	0.8	2.5	-	0.7	2.6	-	1.0	2.6	-

B, black; IQR, interquartile range; NSCLC, non-small cell lung cancer; W, non-Hispanic white.

[a] Income quartiles (Top/quartile 2/quartile 3/lowest): Breast cancer (>58,478/43,752-58,478/32,948-43,752/ < 32,948); Stage I NSCLC (>60,421/45,037-60,421/33,763-45,037/ < 33,763); Stage III NSCLC (>58,275/43,395-58,275/32683-43,395/ < 32,683); Stage III prostate cancer (>69,336/49,761-69,336/37,608-49,761/ < 37,608).

[b] Education quartiles percentage of nonhigh school graduates (Top/quartile 2/quartile 3/lowest): Breast cancer (>27%/16-27%/ 9.5-16%/ < 9.5%); Stage I NSCLC (>26.5%/16-26.5%/ 9.5-16%/ < 9.5%); Stage III NSCLC (>27.7%/17.1-27.7%/ 10.1-17.1%/ < 10.1%); Stage III prostate cancer (>20.6%/12.6-20.6%/ 6.9-12.6%/ < 6.9%).

curative treatments was 82% in black patients (of n = 295) compared with 95% in white patients (of n = 3252; $P < .0001$).

Survival analyses

Kaplan-Meier actuarial overall and cancer-specific survival curves that compare black and white patients within each disease cohort are displayed in Figures 1 and 2. Tables 2a and b delineate the serial, incremental impact of the addition of covariates into multivariate models on the relative risks of all-cause and cause-specific mortality in black versus white patients for each disease cohort. Significantly worse, unadjusted, all-cause mortality was seen in black patients with stage I NSCLC (hazard ratio [HR]: 1.22; 95% confidence interval [CI], 1.13-1.32; $P < .0001$), stage III NSCLC (HR: 1.08; 95% CI, 1.02-1.14; $P = .006$), and stage III prostate cancer (HR: 2.16; 95% CI, 1.60-2.92; $P < .0001$) non-significantly but with a trend toward worse in black patients with stage III breast cancer (HR: 1.10; 95% CI, 0.95-1.27; $P = .20$; Models 1). Subsequently, HRs that demonstrate elevated mortality risks in black patients were diminished toward the null (HR: 1.00) after adjusting for guideline concordance in all disease cohorts (stage I NSCLC HR: 1.06; 95% CI, 0.98-1.14; $P = .18$; stage III NSCLC HR: 1.06; 95% CI, 1.00-1.12, $P = .05$; stage III prostate cancer HR: 1.99, 95% CI, 1.46-2.71; $P < .0001$; stage III breast cancer HR: 1.03; 95% CI, 0.89-1.19; $P = .70$; Models 2) and even further diminished after adjusting for clinical and SES factors (Models 4).

Significantly worse, unadjusted, cause-specific mortality was seen in black patients with stage I NSCLC and stage III prostate cancer (Models 1). Subsequently, HRs that demonstrate elevated cause-specific mortality risks in black patients were diminished toward the null after adjusting for guideline concordance in all cohorts (Models 2) and even further diminished after adjusting for SES factors (Models 4).

Discussion

In this study, we found that the absolute magnitude of disparities in guideline concordance between black and white

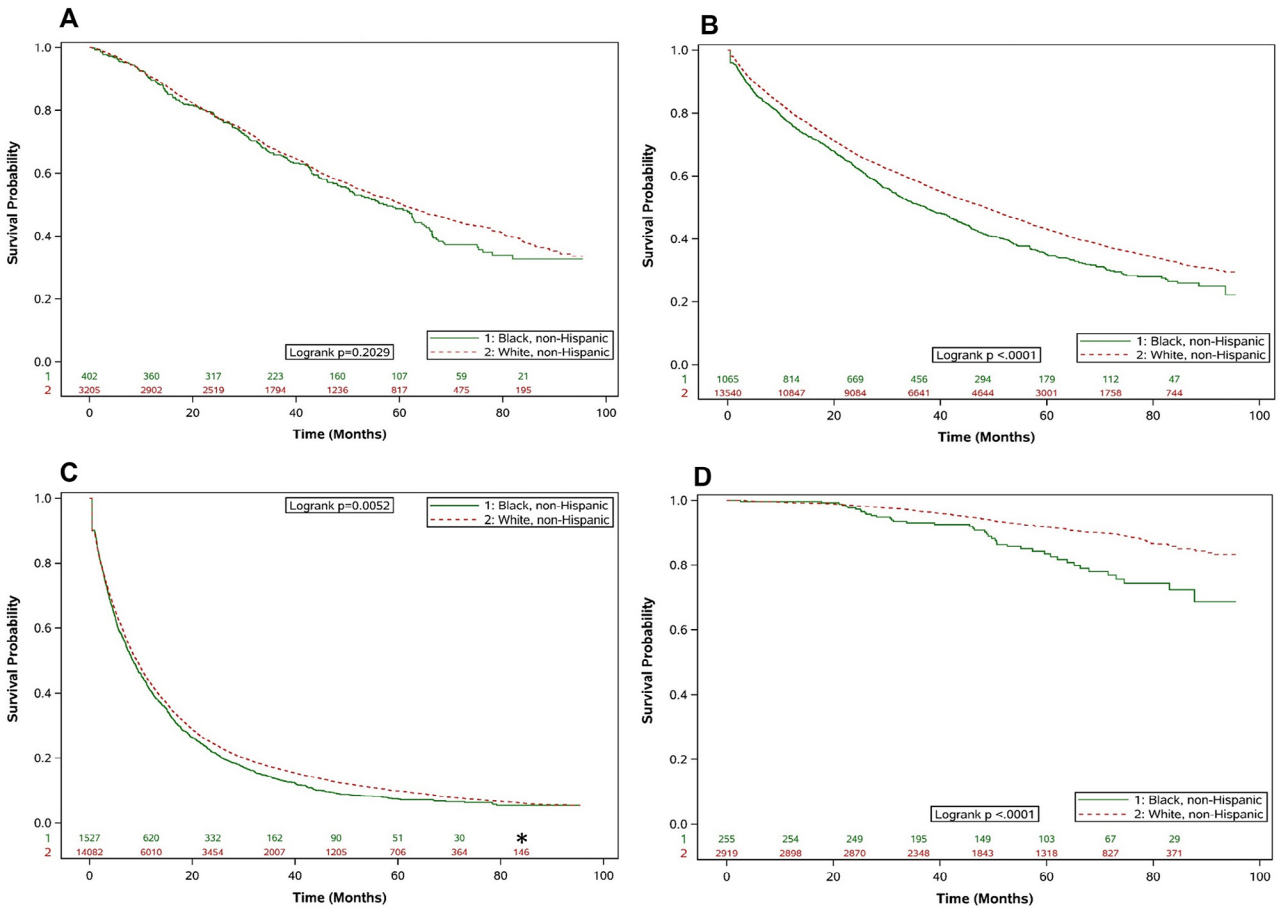

Figure 1 Actuarial overall survival curves for black versus non-Hispanic white patients. (A) Stage III breast cancer. (B) Stage I non-small cell lung cancer. (C) Stage III non-small cell lung cancer. (D) Stage III prostate cancer. * n < 11 (blinded to protect patient anonymity).

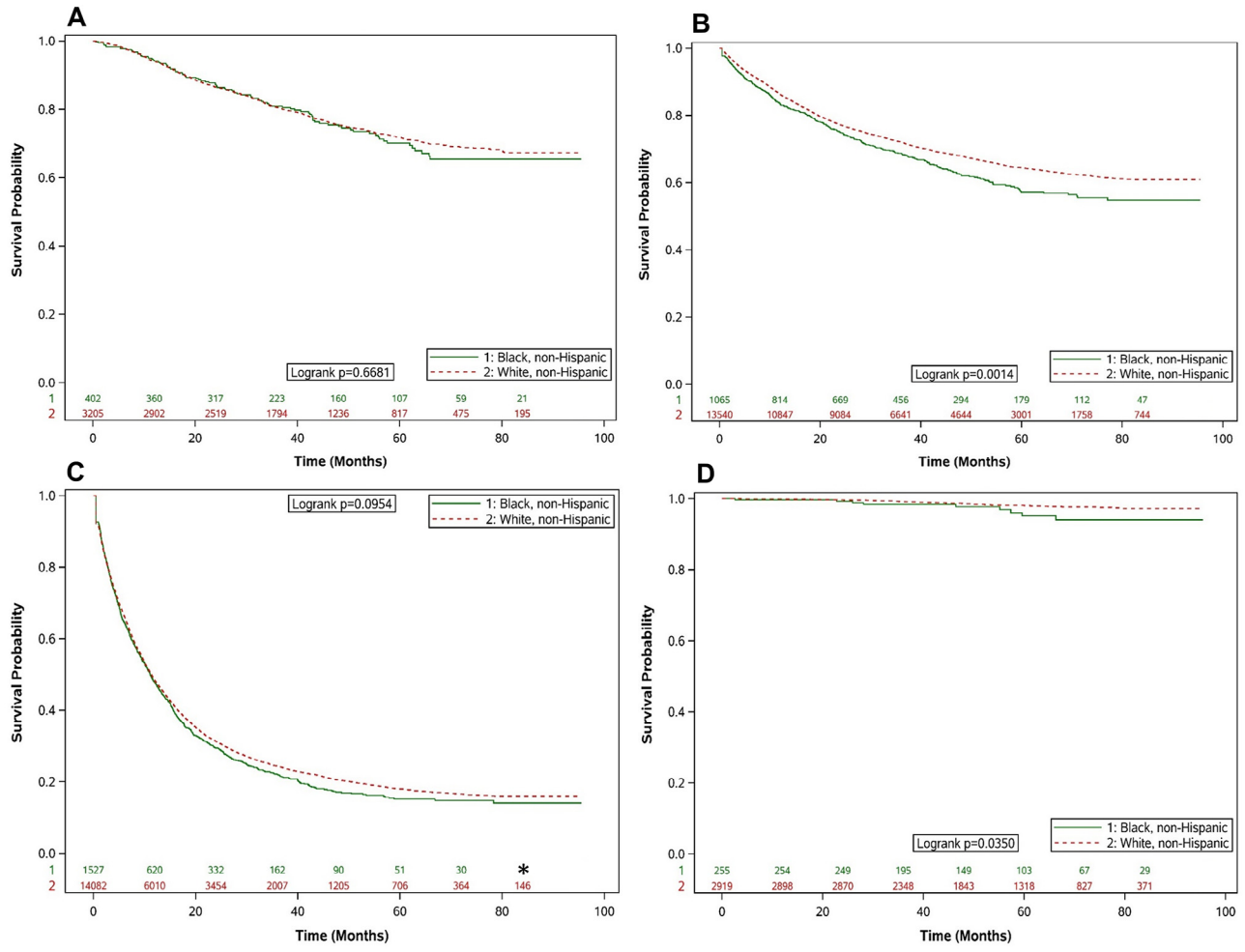

Figure 2 Actuarial cause-specific survival curves for black versus non-Hispanic white patients. (A) stage III breast cancer. (B) Stage I non-small cell lung cancer. (C) Stage III non-small cell lung cancer. (D) Stage III prostate cancer. * n < 11 (blinded to protect patient anonymity).

patients was generally consistent across disease sites, disease stages, and treatment modalities. These disparities adhered to guidelines between 5% and 14% and demonstrated the underuse of curative treatments and guideline-concordant care in black compared with white patients across the board. Adjusting for differences in guideline-concordant care appeared to substantially account for differences in both all-cause and cause-specific mortality disparities between black and white patients, especially for stage I and III NSCLC and prostate cancer.

Our results suggest that quality benchmarking of guideline-concordant care may represent an actionable target to improve disparities in the receipt of curative cancer treatment and survival outcomes for several reasons. First, our results suggest that intervening on the target of guideline adherence is feasible because despite consistent discrepancies in rates of guideline-concordance, the absolute magnitudes of the differences are not insurmountable. Second, our study also helps to demonstrate the relative contribution of guideline concordance to racial mortality disparities compared with other factors and builds on the existing scientific literature.

SES factors including insurance status and geographical access to care and clinical factors including later stage of presentation have previously been identified as contributors and potentially mediating explanatory factors of observed racial disparities in cancer outcomes.[4,25-31] For example, a study of men with prostate cancer identified that patients with Medicaid versus private insurance were more likely to present with metastatic disease, were less likely to receive definitive treatment, and had increased prostate cancer-specific mortality.[10] Similarly, in a study of patients with localized breast cancer, insurance status was found to be associated with significant variations in breast cancer care with a more frequent omission of radiation after breast conserving surgery in uninsured and Medicaid patients compared with those with other types of insurance.[31]

In another analysis of patients with early stage lung cancer, insurance type also predicted overall survival after adjusting for race.[32] Our data support that SES and clinical

Table 2 A. Unadjusted (Model 1) and adjusted hazard ratio for all-cause mortality in patients by race (black vs. white) with adjustment for guideline concordance (Model 2), guideline concordance and clinical factors (Model 3), guideline concordance/clinical factors, and SES factors (Model 4). B. Unadjusted (Model 1) and adjusted hazard ratio of cause-specific mortality in patients by race (black or white) with adjustment for guideline concordance (Model 2), guideline concordance and clinical factors (Model 3), guideline concordance/clinical factors, and SES factors (Model 4)

	Black race			
Characteristic	HR	95% CI		*P*-value
St III breast cancer				
Model 1: Race	1.10	0.95	1.27	.20
Model 2: Race + GC	1.03	0.89	1.19	.70
Model 3: Race + GC + clinical	1.02	0.88	1.18	.81
Model 4: Race + GC + clinical + SES	0.93	0.79	1.08	.33
Stage I NSCLC				
Model 1: Race	1.22	1.13	1.32	**< .0001**
Model 2: Race + GC	1.06	0.98	1.14	.18
Model 3: Race + GC + clinical	1.08	1.001	1.18	**.047**
Model 4: Race + GC + clinical + SES	1.01	0.93	1.10	.77
Stage III NSCLC				
Model 1: Race	1.08	1.02	1.14	**.006**
Model 2: Race + GC	1.06	1.00	1.12	.051
Model 3: Race + GC + clinical	0.99	0.94	1.06	.95
Model 4: Race + GC + clinical + SES	0.97	0.91	1.03	.33
Stage III prostate cancer				
Model 1: Race	2.16	1.60	2.92	**< .0001**
Model 2: Race + GC	1.99	1.46	2.71	**< .0001**
Model 3: Race + GC + clinical	1.88	1.37	2.58	**< .0001**
Model 4: Race + GC + clinical + SES	1.50	1.07	2.11	**.02**

	Black race			
Characteristic	HR	95% CI		*P*-value
Stage III breast cancer				
Model 1: Race	1.05	0.85	1.29	.66
Model 2: Race + GC	0.99	0.81	1.23	.96
Model 3: Race + GC + clinical	0.99	0.80	1.23	.96
Model 4: Race + GC + clinical + SES	0.92	0.73	1.15	.46
Stage I NSCLC				
Model 1: Race	1.19	1.07	1.33	**.001**
Model 2: Race + GC	0.99	0.89	1.10	.81
Model 3: Race + GC + clinical	1.01	0.91	1.13	.86
Model 4: Race + GC + clinical + SES	0.93	0.83	1.04	.19
Stage III NSCLC				
Model 1: Race	1.05	0.99	1.12	.10
Model 2: Race + GC	1.03	0.97	1.10	.38
Model 3: Race + GC + clinical	0.97	0.91	1.03	.30
Model 4: Race + GC + clinical + SES	0.95	0.89	1.02	.14
Stage III prostate cancer				
Model 1: Race	2.11	1.07	4.13	**.03**
Model 2: Race + GC	1.86	0.94	3.71	.08
Model 3: Race + GC + clinical	1.96	0.97	3.97	.06
Model 4: Race + GC + clinical + SES	1.80	0.84	3.85	.13

CI; confidence interval; GC, guideline concordance; HR, hazard ratio, NSCLC, non-small cell lung cancer, SES, socioeconomic status.
Variables included for Model 1 (race), Model 2 (race, guideline concordance), Model 3 (race, guideline concordance, age, sex [lung and breast cancer only], clinical T stage, clinical N stage [lung and breast cancer only], comorbidity, performance status, tumor grade [prostate cancer only]), Model 4 (Model 3 factors + insurance status, income, rural/urban).

factors—patient-oriented factors— are still indeed important influences on disparities in all-cause and cancer-specific mortality in patients. Yet, our data further suggest that guideline-concordant treatment utilization rivals these factors in its influence on disparities. Since treatment utilization is influenced by providers in addition to patient behaviors and decisions, our results additionally highlight the potential of providers as a target audience of future

interventions to help improve disparities in guideline concordance.

There were some consistent baseline differences in several socioeconomic and clinical factors that were evident in our black versus white patient study cohorts. Clinically, black patients were more likely to have increased medical comorbidities compared with white patients. Black patients also were substantially more likely to have county-level indicators of SES barriers such as Medicaid insurance and lower income and education with large absolute and relative baseline disparities in these factors. Our results suggest that, despite these large baseline SES differences, overcoming treatment disparities is a targetable goal that could potentially help narrow the gap in outcomes between populations (at least among older patients). Quality cancer treatment benchmarking measures are continually developed through initiatives such as the American Society of Clinical Oncology's Choosing Wisely and Medicare's Access and CHIP Reauthorization Act. These are examples of benchmarking vehicles under which the impact of practice improvement on cancer disparities could be evaluated in ongoing and future research efforts.

Our study has several limitations. Our analysis was limited to older (Medicare) patients; thus, validation of our findings are warranted in a younger patient cohort, particularly as insurance heterogeneity (and disparities) in a younger group may impact or interact with guideline concordance. Secondly, SES covariates that are derived from Area Health Resources files were derived at the county level. Future studies that focus on the interaction of SES with guideline concordance may be needed for additional patient-level analysis.

Conclusions

In this cohort, cancer care for black patients more frequently diverged from treatment guidelines compared with care for white patients. This divergence was consistent across breast, lung, and prostate cancer, disease stage, and treatment modalities, which has a potential negative impact on survival outcomes in patients with cancer.

Supplementary data

Supplementary material for this article (https://doi.org/10.1016/j.adro.2018.04.013) can be found at www.practicalradonc.org.

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