Original Article

# Variation in Quality of Care Among Older Men With Localized Prostate Cancer

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**BACKGROUND:** The objective of this study was to assess the racial and ethnic disparities in outcomes and their association with process-of-care measures for elderly Medicare recipients with localized prostate cancer. **METHODS:** The Surveillance, Epidemiology, and End Results-Medicare databases for the period from 1995 to 2003 were used to identify African-American men, non-Hispanic white men, and Hispanic men with localized prostate cancer, and data were obtained for the 1-year period before the diagnosis of prostate cancer and up to 8 years postdiagnosis. The short-term outcomes of interest were complications, emergency room visits, readmissions, and mortality; the long-term outcomes of interest were prostate cancer-specific mortality and all-cause mortality; and process-of-care measures of interest were treatment and time to treatment. Cox proportional hazards regression, logistic regression, and Poisson regression were used to study the racial and ethnic disparities in outcomes and their association with process-of-care measures. **RESULTS:** Compared with non-Hispanic white patients, African-American patients (Hazard ration [HR], 1.43; 95% confidence interval [CE], 1.19-1.86) and Hispanic patients (HR=1.39; 95% CI, 1.03-1.84) had greater hazard of long term prostate specific mortality. African-American patients also had greater odds of emergency room visits (odds ratio, 1.4; 95% CI, 1.2-1.7) and greater all-cause mortality (HR, 1.39; 95% CI, 1.3-1.5) compared with white patients. The time to treatment was longer for African-American patients and was indicative of a greater hazard of all-cause, long-term mortality. Hispanic patients who underwent surgery or received radiation had a greater hazard of long-term prostate-specific mortality compared with white patients who received hormone therapy. **CONCLUSIONS:** Racial and ethnic disparities in outcomes were associated with process-of-care measures (the type and time to treatment). The current results indicated that there is an opportunity to reduce these disparities by addressing these process-of-care measures. ***Cancer* 2011;117:2520–9.** *© 2010 American Cancer Society.*

**KEYWORDS:** prostate cancer, quality of care, mortality, health resource utilization, race and ethnicity, radical prostatectomy, external beam radiation therapy.

**Prostate** cancer is the most common malignancy among men in the United States. The burden of prostate cancer on the healthcare system is immense in both human and economic terms.[1] Added to this, substantial disparities exist in the pattern of prostate cancer care and outcomes across institutions, regions, age groups, and ethnic groups.[1-8] Racial and ethnic disparities also have been documented in various phases of prostate cancer care. Improving the quality of healthcare across racial and ethnic groups requires attention to the process and outcomes of health services rendered to individuals with adequate adjustments for various risk factors and personal characteristics.[2,8,9] Although it is a priority in the health policy arena, quality of care continues to be uneven.[1,2,8] Addressing the variation in quality of care is widely regarded as an important healthcare policy objective, and racial ethnic disparities in quality of care are recognized as a major quality problem. Increased variations in care patterns and outcomes are linked to a lack of agreement on the identification of quality-of-care measures.[2-11]

Surveillance, Epidemiology, and End Results (SEER)-Medicare–linked data have been used to document the variation in health resource utilization and outcomes for prostate cancer.[4-7] Reports indicated that African-American men were less likely to receive aggressive therapy (odds ratio [OR], 0.74; 95% confidence interval [CI], 0.70-0.79) compared with non-Hispanic white men.[6,12] In addition, African-American men who received curative treatment reported a differential recovery pattern compared with non-Hispanic white men who had prostate cancer.[13] Because of higher use of prostate-

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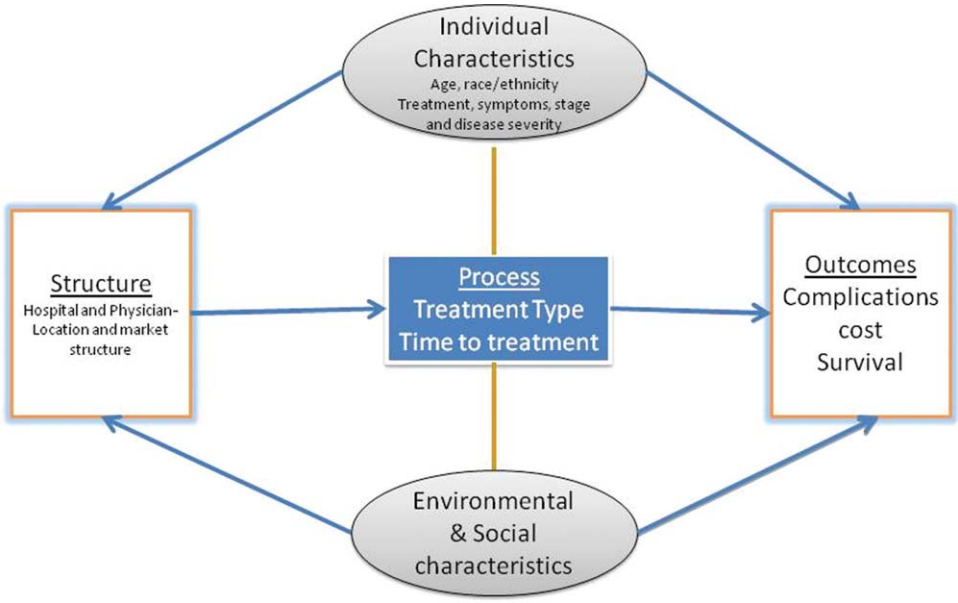


**Figure 1.** This chart illustrates the quality-of-care conceptual model.

specific antigen screening coupled with uncertainty in screening and treatment effects, debate continues about the effectiveness of various treatments. In another study that used SEER-Medicare data by Godley et al, racial and ethnic disparities were evident both in overall survival and prostate cancer-specific survival.[14] African-American patients had poorer overall survival among those who underwent surgery.[14,15] Studies indicate that treatments for a given stage of prostate cancer vary by geographic region, age, and race, and ethnicity.[4-7,12-24] In men who undergo prostatectomy, the rates of postoperative and late urinary complications are significantly reduced if the procedure is performed in a high-volume hospital and by a high-volume surgeon.[16]

## MATERIALS AND METHODS

### *Conceptual Model of Quality of Care*

Quality of healthcare is defined as the degree to which healthcare services for individual patients and populations increase the probability of desired health outcomes and are consistent with current professional knowledge.[3,10] Figure 1 illustrates our conceptual model of quality of care, which consists of 3 main components: structure, process, and outcomes.[9,25] The structural component consists of characteristics of hospitals, physicians, and other healthcare workers and is defined as those resources used by providers or organizations that support the delivery of care to patients.[8-11] Process of care includes the way physicians and patients interact, the appropriateness and timeliness of treatment, and other clinical and nonclinical factors associated with care. The outcome is derivative of the structure and process and includes change in patient health status, satisfaction with care, health-related quality of life, and functional status.[8-11]

Efforts to reduce racial and ethnic disparities must acknowledge the multidimensional nature of quality of care. There is paucity of knowledge regarding the process-of-care factors that contribute to racial and ethnic disparity in prostate cancer outcomes among elderly Medicare recipients. Hence, the objective of this study was to analyze the interplay of process-of-care measures (treatment type and time to treatment) and patient characteristics and their relation with short-term outcomes (mortality, complications, readmissions, and emergency room [ER] visits) and long-term outcomes (prostate-specific and all-cause mortality) among elderly patients with prostate cancer. We used SEER-Medicare–linked data to examine the racial and ethnic disparities in outcomes and their association with quality-of-care measures for elderly African-American, Hispanic, and non-Hispanic white men who were diagnosed with localized prostate cancer. We hypothesized that some of the racial and ethnic disparity

in prostate cancer outcomes can be explained by process-of-care measures.

### Data Sources and Study Sample

We adopted a retrospective design using the linked SEER-Medicare database. All African-American, Hispanic, and non-Hispanic white men aged ≥66 years who were diagnosed with prostate cancer (International Classification of Diseases codes: 185, 233.4, and 236.5) between 1995 and 1998 (n = 50,147) were identified. From this cohort, we retained those men who had localized stage (n = 42,522). Of these, 8476 men were excluded because information was not available regarding their treatment and treatment date in the SEER and Medicare claims data. Thus, the final cohort included 34,046 patients. For this cohort, data were obtained for the 1-year period before the diagnosis of prostate cancer and up to 8 years postdiagnosis. The lists of procedure codes, revenue center codes, and service codes were reviewed to ensure that appropriate codes were used for each year, because *Healthcare Common Procedure Coding System* codes change over time.

The SEER-Medicare–linked database brings together Medicare administrative claims data and clinical tumor registry data for Medicare recipients.[26] The SEER program collects data on cancer incidence, treatment, and mortality in a representative sample of the US population. The data used in this analysis included 13 SEER sites (San Francisco, Connecticut, Detroit, Hawaii, Iowa, New Mexico, Seattle, Utah, Atlanta, San Jose, Los Angeles, Rural Georgia, and Alaska), encompassing 14% of the US population. With the exception of individuals who are enrolled in health maintenance organizations (HMOs) or who do not have Part B coverage, Medicare data provide information about all inpatient and outpatient use of medical care for residents of the United States aged ≥65 years. The SEER-Medicare file integrates the individual's SEER and Medicare records into a single data file. Among individuals in the SEER registry who were diagnosed with cancer at age ≥65 years, 93% have been matched with their Medicare enrollment records in a linked, customized file—the Patient Entitlement and Diagnosis Summary File. In addition to SEER diagnostic information, this file provides Medicare entitlement, utilization, and census tract and zip code-based socioeconomic data. SEER database provides characteristics of the tumor that are crucial to adequately adjust for disease severity, including histology, stage, and grade. SEER also provides information on the extent of disease that may have prognostic significance, such as the size of the primary tumor and the extent and location of lymph node involvement. The SEER-Medicare–linked record includes service codes in 3 Medicare files: 1) the inpatient file, 2) the hospital outpatient standard analytical file (claims for outpatient facility services), and 3) the physician part B file (claims for physician and other medical provider services).

### Measurement Strategy

#### Process-of-care measures

As depicted in the conceptual model (Fig. 1), process of care measures are: 1) treatment type and 2) time to treatment. Treatment was categorized into 3 groups. The surgery group included mono therapy (surgery alone) or multimodal therapy (surgery with external-beam radiation therapy or brachytherapy or surgery with a combination of radiation and hormone therapy). The radiation therapy group included radiation therapy alone (external-beam radiation or brachytherapy) or radiation therapy with hormone therapy (multimodal). The third treatment group consisted of hormone therapy alone. The time to treatment (number of days) was defined as the time between diagnosis and treatment.

#### Outcome measures

The short-term outcome measures (within 30 days from treatment date) were: 1) mortality, 2) complications, 3) the number of readmissions, and 4) the number of ER admissions. The long-term outcome measures (up to 8 years) were prostate cancer-specific mortality and overall mortality. Survival was determined by Medicare vital statistics as well as SEER linkage to death certificates (the National Death Index). Consistent with Alibhai et al, and Beard et al, using Medicare inpatient and outpatient claims data, we identified the following groups of complications that occurred within 30 days from treatment: cardiac, respiratory, vascular, wound/bleeding, genitourinary, bowel, miscellaneous medical, and miscellaneous surgical.[27-31]

#### Disease severity and demographic covariates

Disease severity was adjusted by using data on prostate cancer stage, grade, and histology from the SEER database. The Charlson comorbidity index was used to assess medical comorbidity using inpatient and outpatient Medicare claims.[32,33] We used diagnostic information from all encounters 1 year before prostate cancer diagnosis to determine comorbidity, as outlined by Klabunde et al.[32,33] Age, race and ethnicity, marital status,

**Table 1.** Baseline Demographic and Clinical Characteristics (n = 34,046)

| Variable | Non-Hispanic whites, n = 28,200 | African Americans, n = 3642 | Hispanics, n = 2204 | *P* |
|---|---|---|---|---|
| Age at diagnosis: Mean ± SD, y | 73.1 ± 5.4 | 72.4 ± 5.1 | 72.5 ± 5.4 | <.0001 |
| **Geographic area, %** | | | | |
| Metropolitan | 86.8 | 98.5 | 91.9 | <.0001 |
| Urban and rural | 13.2 | 1.5 | 8.1 | |
| **Marital status, %** | | | | |
| Married | 75.8 | 59.3 | 73.6 | <.0001 |
| Single | 19.2 | 34.5 | 22 | |
| Unknown | 5 | 6.2 | 4.4 | |
| Charlson comorbidity score: Mean ± SD | 0.33 ± 0.86 | 0.60 ± 1.1 | 0.08 ± 0.44 | <.0001 |
| Annual median income of census tract: Mean ± SD, $US | 42,330 ± 19,176 | 25,979 ± 13,237 | 33,408 ± 13,574 | <.0001 |
| **Tumor grade, %** | | | | |
| Well differentiated | 10.07 | 7.6 | 11.9 | <.0001 |
| Moderately differentiated | 65.62 | 66.4 | 61.5 | |
| Poorly differentiated/undifferentiated | 24.31 | 26 | 26.6 | |
| **Tumor classification, %** | | | | |
| ≤T2a | 48.1 | 46.2 | 48.5 | <.0001 |
| T2b and T2c | 41.6 | 40.7 | 39.8 | |
| ≥T3a | 10.3 | 13.1 | 11.7 | |

SD indicates standard deviation.

geographic area, and income data were obtained from the Patient Entitlement and Diagnostic Summary File.

### *Statistical Analysis*

We tested for the underlying difference in demographic and clinical attributes between African-American, Hispanic, and non-Hispanic white patients using *t* tests and chi-square tests. Our analyses, as indicated in our conceptual model (Fig. 1), consisted of 2 sets of models. In the first set (Models 1-6), we analyzed the association between race and ethnicity and outcomes (short-term mortality, complications, the number of readmissions and ER visits, prostate cancer-specific mortality, and all-cause mortality). A Cox proportional-hazards model was used for mortality outcomes, logistic regression was used for modeling any complications, and Poisson models (with zero inflation corrections) were used to model the number of ER visits and readmissions after adjusting for age, marital status, income, TNM stage, grade, comorbidity, and SEER region. The primary variable of interest in all models was race/ethnicity.[34,35] In the second set of models, we analyzed the modifying effects of process-of-care measures on outcomes. Separate models were developed for treatment (Model 7) and time to treatment (Model 8). We also tested for the effect of the interaction of race/ethnicity and process-of-care measures on outcomes. Analyses were conducted using Statistical Analysis System (SAS) version 9.2 (SAS Institute Inc., Cary, NC).

## RESULTS

### *Sample Characteristics*

The study sample consisted of 34,046 men who had localized prostate cancer. Table 1 indicates that the mean age of the non-Hispanic white group was slightly older than that of the other groups. The small difference in mean age was statistically significant, possibly because of the large sample size. Also, marital status and median income differed between the 3 groups. African-American men were less likely to be married and had lower income compared with their non-Hispanic white and Hispanic counterparts. The mean Charlson comorbidity score was higher for the African-American group compared with other 2 groups.

### *Variation in Process and Outcome Measures*

Unadjusted comparison of process and quality-of-care measures revealed significant variation between racial and ethnic groups (Table 2). A higher proportion of Hispanic patients underwent radical prostatectomy (monomodal or multimodal), whereas a higher proportion of African-American patients received external-beam radiation therapy (monomodal or multimodal). African-American

**Table 2.** Unadjusted Process and Quality-of-Care Measures Across Racial and Ethnic Groups (n = 34,046)

| Variable | Non-Hispanic whites, n = 28,200 | African Americans, n = 3642 | Hispanics, n = 2204 | *P* |
|---|---|---|---|---|
| **Treatment, %** | | | | |
| Surgery (monotherapy or multimodal therapy) | 42.3 | 35.1 | 47.9 | <.0001 |
| Radiation therapy (monotherapy or multimodal therapy) | 47.5 | 50.6 | 39.3 | |
| Hormone therapy alone | 12.2 | 14.3 | 12.8 | |
| **Time to treatment, d** | | | | |
| Mean ± SD | 64.9 ± 142.3 | 95.8 ± 231.9 | 60.6 ± 111.4 | <.0001 |
| Median | 31.0 | 59.0 | 31.0 | |
| ER visits within 30 d of treatment, % | 3.41 | 4.78 | 2.99 | <.0001 |
| Inpatient hospitalization within 30 d of treatment, % | 33.94 | 28.47 | 33.71 | <.0001 |
| **Complications at 30 d, %** | | | | |
| Any | 22.06 | 20.81 | 22.87 | .1345 |
| Cardiac | 2.76 | 2.9 | 2.36 | .4375 |
| Respiratory | 1.63 | 1.76 | 1.59 | .6793 |
| Vascular | 0.62 | 0.55 | 0.41 | .9345 |
| Wound | 9.59 | 8.1 | 9.07 | .0004 |
| Genitourinary | 10.2 | 10.85 | 11.12 | .5183 |
| Miscellaneous | 4.47 | 4.39 | 5.22 | .0009 |
| Miscellaneous surgery | 0.52 | 0.55 | 0.59 | .7803 |
| Bowel | 1.96 | 2.44 | 2.51 | .0075 |
| Short-term all-cause mortality at 30 d, % | 0.31 | 0.38 | 0.45 | .4419 |
| All-cause mortality at 8-y follow-up, % | 19.99 | 25.89 | 18.10 | <.0001 |
| Prostate cancer-specific mortality at 8-y follow-up, % | 1.59 | 2.03 | 2.04 | .0549 |

SD indicates standard deviation; ER, emergency room.

patients had a longer mean time to treatment from the date of diagnosis (95.8 days; $P < .0001$) and higher all-cause mortality. A greater proportion of African-American patients had ER visits within 30 days of treatment, whereas a greater proportion of white patients had inpatient visits. Overall, the proportion of patients with any complication was greater for the non-Hispanic white and Hispanic groups compared with the African-American group.

Table 3 presents the results from Cox models for the association between race and ethnicity and outcomes with adjustments for age, marital status, TNM stage, comorbidity, geographic area, and SEER region. Race/ethnicity was not associated with short-term all-cause mortality. Compared with non-Hispanic white patients, Hispanic patients had a greater odds of developing any complications (odds ratio [OR], 1.12; 95% confidence interval [CI], 1.02-1.22). African-American patients had more ER visits and fewer inpatient visits compared with their non-Hispanic white counterparts (OR, 1.64 [95% CI, 1.42-1.89] and 0.93 [95% CI, 0.89-0.99], respectively). African-American patients (hazard ratio [HR], 1.43; 95% CI, 1.19-1.86) and Hispanic patients (HR, 1.39; 95% CI, 1.03-1.84) had a greater hazard of prostate cancer-specific mortality compared with non-Hispanic white patients. African-American patients also had a greater hazard of overall long-term mortality (HR, 1.39; 95% CI, 1.30-1.50) compared with non-Hispanic white patients.

### *Modifying Effect of Process-of-Care Measures on Racial and Ethnic Disparity in Outcomes*

Models 7 and 8 present the effects of the interactions of process-of-care measures and race/ethnicity on short-term outcomes (Table 4). Model 7 indicated that the interaction between race/ethnicity and treatment type was not associated with 30-day all-cause mortality. However, Hispanic men who received radiation therapy were less likely to have complications (OR, 0.56; 95% CI, 0.33-0.95) compared with their non-Hispanic white counterparts who received hormone therapy (Table 4). Similarly, African-American patients who underwent surgery or received radiation were less likely to have more ER visits or inpatient visits compared with their non-Hispanic white counterparts who received hormone therapy. Model 8 indicated that African-American patients who had a longer time to treatment had a greater odds of more ER visits (OR, 1.4; 95% CI, 1.2-1.7). The interaction between

**Table 3.** Association Between Race and Ethnicity and Outcomes (n = 34,046)

| Variable | Short Term | | | | | |
|---|---|---|---|---|---|---|
| | HR (95% CI) | | OR (95% CI) | | Long Term Up to 8 Years: HR (95% CI) | |
| | Model 1: Mortality | Model 2: Any Complications | Model 3: No. of ER Visits | Model 4: No. of Inpatient Visits | Model 5: Prostate Cancer-Specific Mortality | Model 6: All-Cause Mortality |
| **Race** | | | | | | |
| African American | 1.52 (0.92-2.6) | 1.06 (0.92-1.15) | 1.64 (1.42-1.89) | 0.93 (0.89-0.99) | 1.43 (1.19-1.86) | 1.39 (1.3-1.5) |
| Hispanic | 1.7 (0.89-3.3) | 1.12 (1.06-1.25) | 1.04 (0.83-1.29) | 1.02 (0.94-1.1) | 1.39 (1.03-1.84) | 0.93 (0.84-1.01) |
| Non-Hispanic white, reference | | | | | | |
| Age | 1.2 (1.14-1.39) | 1.03 (1.01-1.15) | 1.1 (1.09-1.10) | 1.01 (0.99-1.02) | 1.13 (1.10-1.42) | 1.1 (1.1-1.13) |
| Married | 0.67 (0.45-0.98) | 0.99 (0.93-1.14) | 0.76 (0.68-0.85) | 1.0 (0.98-1.11) | 0.79 (0.66-0.94) | 0.81 (0.77-0.85) |
| **TNM classification** | | | | | | |
| T2b andT2c | 0.49 (0.38-0.79) | 0.69 (0.66-0.74) | 0.72 (0.64-0.82) | 0.73 (0.69-0.76) | 1.5 (1.3-1.91) | 1.13 (1.1-1.2) |
| ≥T3a | 0.93 (0.54-1.6) | 0.73 (0.67-0.79) | 1.10 (0.89-1.3) | 0.76 (0.72-0.81) | 3.6 (2.8-4.5) | 2.74 (2.39-2.69) |
| ≤T2a, reference | | | | | | |
| **Geographic area** | | | | | | |
| Metropolitan | 0.41 (0.27-2.7) | 0.55 (0.42-0.67) | 0.69 (0.49-1.05) | 0.75 (0.66-0.86) | 0.73 (0.39-1.3) | 0.78 (0.65-0.92) |
| Urban | 0.82 (0.28-2.3) | 0.90 (0.74-1.11) | 0.99 (0.65-1.53) | 0.98 (0.86-1.12) | 1.0 (0.55-1.9) | 0.94 (0.78-1.12) |
| Rural, reference | | | | | | |
| Charlson comorbidity score | 1.04 (0.73-1.33) | 1.07 (1.04-1.09) | 1.15 (1.10-1.22) | 0.95 (0.93-0.97) | 1.07 (1.04-1.10) | 1.07 (1.04-1.5) |

HR indicates hazard ratio; CI, confidence interval; OR, odds ratio; ER, emergency room; TNM, tumor, lymph node, metastasis classification system.

**Table 4.** Association Between Race and Ethnicity, Process Variables, and Short-Term (30-Day) Outcomes (n = 34,046)

| Model | Mortality: HR (95% CI) | OR (95% CI) | | |
|---|---|---|---|---|
| | | Any Complications | No. of ER Visits | No. of Inpatient Visits |
| **Model 7: Interaction between race and treatment[a]** | | | | |
| Race | | | | |
| African American | 1.9 (0.65-5.7) | 1.41 (0.97-1.8) | 2.7 (1.9-3.61) | 1.5 (1.2-1.8) |
| Hispanic | 2.6 (0.77-8.9) | 1.04 (0.71-1.54) | 1.3 (0.71-2.2) | 1.19 (0.82-1.5) |
| Non-Hispanic white, reference | | | | |
| **Treatment** | | | | |
| Surgery | 1.7 (1.0-2.94) | 6.8 (5.71-7.7) | 1.9 (1.6-2.39) | 5.9 (4.69-6.4) |
| Radiation therapy | 0.14 (0.05-0.39) | 0.61 (0.54-0.69) | 0.46 (0.37-0.57) | 0.42 (0.38-0.48) |
| Hormone therapy alone, reference | | | | |
| Interaction | | | | |
| African American×surgery | 0.64 (0.17-2.43) | 0.77 (0.57-1.14) | 0.51 (0.36-0.73) | 0.64 (0.52-0.79) |
| African American×radiation therapy | 1.7 (0.23-12.1) | 0.78 (0.55-1.12) | 0.52 (0.33-0.82) | 0.71 (0.54-0.95) |
| Hispanic×surgery | 0.50 (0.12-2.2) | 0.99 (0.66-1.5) | 0.72 (0.38-1.4) | 0.79 (0.58-1.1) |
| Hispanic×radiation therapy | 0.05 (0.10-1.3) | 0.56 (0.33-0.95) | 0.64 (0.27-1.5) | 0.88 (0.58-1.3) |
| **Model 8: Interaction between race and time to treatment[a]** | | | | |
| Race | | | | |
| African American | 0.70 (0.05-11.1) | 1.17 (0.83-1.50) | 0.56 (0.43-0.85) | 1.16 (0.86-1.39) |
| Hispanic | 0.35 (0.02-5.3) | 1.56 (1.08-2.52) | 1.3 (0.57-2.83) | 0.99 (0.77-1.31) |
| Non-Hispanic white, reference | | | | |
| Time to treatment | 0.19 (0.12-0.30) | 0.75 (0.73-0.77) | 0.72 (0.68-0.77) | 0.79 (0.78-0.81) |
| African American×time to treatment | 1.30 (0.46-3.93) | 0.99 (0.89-1.14) | 1.40 (1.16-1.67) | 0.96 (0.91-1.01) |
| Hispanic×time to treatment | 1.9 (0.67-5.12) | 0.91 (0.82-1.01) | 0.93 (0.76-1.21) | 0.99 (0.94-1.14) |

OR indicates odds ratio; CI, confidence interval; HR, hazard ratio; ER, emergency room.
[a] All models are adjusted for age, marital status, disease stage, comorbidity, and geographic area.

**Table 5.** Association Between Race and Ethnicity, Process Variables, and Long-Term (Up to 8-Year) Outcomes (n = 34,046)

| Model | HR (95% CI) | |
|---|---|---|
| | All-Cause Mortality | Prostate Cancer-Specific Mortality |
| **Model 7: Interaction between race and type of treatment, surgery[a]** | | |
| Race | | |
| African American | 1.3 (1.10-2.61) | 1.3 (0.82-2.1) |
| Hispanic | 0.79 (0.63-0.99) | 0.30 (0.09-0.95) |
| Non-Hispanic white, reference | | |
| Treatment | | |
| Surgery | 0.83 (0.77-0.89) | 0.89 (0.71-1.1) |
| Radiation therapy | 0.63 (0.58-0.67) | 0.35 (0.27-0.46) |
| Hormone therapy, reference | | |
| Interaction | | |
| African American× surgery | 1.02 (0.87-1.2) | 1.2 (0.64-2.1) |
| African American× radiation therapy | 1.10 (0.91-1.3) | 1.0 (0.54-2.1) |
| Hispanic×surgery | 1.20 (0.88-1.5) | 5.4 (1.6-18.1) |
| Hispanic×radiation therapy | 1.31 (0.96-1.7) | 5.4 (1.5-19.7) |
| **Model 8: Interaction between race and time to treatment[a]** | | |
| Race | | |
| African American | 1.13 (0.86-1.4) | 1.40 (0.60-3.2) |
| Hispanic | 0.79 (0.55-1.13) | 1.4 (0.49-4.2) |
| Non-Hispanic white, reference | | |
| Time to treatment | 0.80 (0.78-0.82) | 0.72 (0.65-0.79) |
| African American×time to treatment | 1.1 (1.05-1.2) | 1.0 (0.82-1.3) |
| Hispanic×time to treatment | 1.1 (0.951.2) | 0.98 (0.72-1.4) |

HR indicates hazard ratio; CI, confidence interval.
[a] All models are adjusted for age, marital status, stage, comorbidity, and geographic area.

race/ethnicity and treatment type was not associated with all-cause mortality or prostate cancer-specific mortality (Table 5). However, African-American patients who had a longer time to treatment had a greater hazard of all-cause mortality (HR, 1.1; 95% CI, 1.05-1.2) compared with non-Hispanic white patients. Hispanic patients who underwent surgery (HR, 5.4; 95% CI, 1.6-18.1) or received radiation therapy (HR, 5.4; 95% CI, 1.5-19.7) had a greater hazard of long-term prostate cancer-specific mortality compared with non-Hispanic whites who received hormone therapy.

## DISCUSSION

Medicare-enrolled, elderly patients with prostate cancer have great variability in healthcare utilization, morbidity, and other quality outcomes.[1-8] Quality of care in prostate cancer is a multidimensional construct that consists of structure, process, and outcomes. Racial and ethnic disparities in prostate cancer care are documented for each phase of care: prevention, treatment, follow-up, and terminal care.[4-7,12-24] In continuation of our earlier research on quality of prostate cancer care assessment, in the current study, we have documented the modifying effect of process-of-care measures on the racial and ethnic differences in prostate cancer outcomes using an administrative database. To begin with, we observed that, in concordance with earlier research, our results confirmed racial and ethnic disparities in prostate cancer outcomes.[4-7] We observed racial and ethnic disparity in the process-of-care measures (treatment type and time to treatment). Both the mean and the median time to treatment were longer for African-American patients, who also were more likely to receive radiation therapy. The results lend substantial support to our hypothesis that some of the racial and ethnic disparity in prostate cancer outcomes can be explained by process-of-care measures. The longer time to treatment among African-American patients was indicative of a greater hazard of overall mortality as well as more ER visits. Also, the interaction between treatment and race/ethnicity was significant for the outcomes of complications, ER visits, inpatient visits, and prostate cancer-specific and overall mortality.

The journey to assessing quality-of-care measures in the arena of prostate cancer began with an exploration of the variations in outcomes across geographic regions,

age groups, and racial and ethnic groups. The foundation for assessing quality of care was built by earlier RAND studies.[36-43] In those studies, the Donabedian model of structure, process, and outcome was used to conceptualize the dimensions of quality of care. Quality-of-care assessment is essential to develop appropriate clinical and healthcare policy measures that address the burden exerted by prostate cancer. In a premier study, Spencer et al developed 63 potential indicators and covariates to measure quality of care in prostate cancer,[40] which is a multidimensional construct that encompasses various levels of care and clinical and environmental domains.[36] Given the multiple treatment options for localized prostate cancer, quality-of-care measures are useful for comparing treatment efficacy and variations across provider and geographic level attributes. Process-of-care quality indicators were identified as superior for those who received radiation therapy compared with those who underwent radical prostatectomy.[38] An examination of compliance with 25 quality-of-care measures that were developed by RAND to assess structure and process indicated significant variation across hospital type and census-based geographic regions.[43] A recent study demonstrated that prostate cancer treatments differed significantly between county hospitals and private providers.[44] Although those studies successfully applied quality-of-care measures, clearly, there is room for further measurement and assessment of the quality of care for patients with prostate cancer.[41]

Our findings must be considered in light of limitations that are intrinsic to the SEER-Medicare–linked dataset. The study sample included only African-American, Hispanic, and non-Hispanic white men aged $\geq$66 years who lived in a SEER area and were not enrolled in an HMO. Although SEER is designed to provide a representative sample of the United States, it includes only a relatively small Hispanic population. However, the age and sex distributions for individuals aged $\geq$66 years in the SEER areas are comparable to those of the US elderly population. Our findings may not be generalizable to men aged $<$66 years or men enrolled in HMOs. Medicare claims data provide an excellent opportunity to analyze prostate cancer care in a broad population, however, these data have certain limitations. Although our analysis controlled for treatment and other covariates, there is potential for some unaccounted bias. Finally, as depicted in the conceptual model, in this study, we did not address the effect of measures of structure (such as hospital and physician attributes) and other potential process-of-care measures on outcomes. Our objective is to address these measures in future studies.

In conclusion, healthcare quality, which is a key concept for medical practice and research, also is a widely used construct in healthcare administration and market research. A major concern of policymakers in the United States is the persistent presence of unacceptable variation in quality of care across racial and ethnic groups.[1-12] The first step in eliminating these disparities is to identify their determinants and minimize the overuse, under use, and misuse of health resources while accounting for individual preferences. More important, policy measures are needed to identify and implement strategies at the geographic level, health system level, and individual level. A 2-dimensional approach can be used to address the issues of quality of care. One dimension is the internal or system/individual-level effort to improve the quality of care. The second dimension is the broader or external level, in which monitoring efforts can be incorporated through collaborations among organizations, such as the American Urological Association, the National Cancer Institute, the American Society of Clinical Oncology, and the Agency for Healthcare Research and Quality. Some of the measures that can be adopted at the external level are establishing guidelines and achievable performance targets, an infusion of technology and expertise, monitoring structure and process measures to ensure enhanced outcomes, and, finally, providing the necessary funding.

Consistent with earlier studies, our study revealed ethnic variations in quality of care and outcomes. However, our data suggest opportunities to reduce these disparities. For example, the large difference in time to treatment (approximately an entire month) suggests the need for an aggressive, patient-centered approach immediately after the diagnosis is established. Systems can be modified to ensure that the initial appointment with patient and family occurs as soon as possible. During the first and subsequent visits, practitioners can demonstrate sensitivity to the emotional impact of this diagnosis, explore attitudes of suspicion and distrust, and exhibit respect for the individual as a person. Health systems can implement proactive, aggressive monitoring systems from diagnosis through treatment and early recovery to ensure that minority patients do not delay care because of a lack of understanding or miscommunication. Finally, the current data speak to a need for health systems and health plans to identify minority patients. Without this identification, issues of health equity cannot be measured and, thus, cannot be improved.

In summary, significant opportunities exists to minimize ethnic variations in the process of care for patients with prostate cancer and to improve their overall quality of care. In the era of value-based healthcare and accountability in healthcare, it is vital to consider these factors while developing appropriate performance incentives to minimize ethnic disparity in prostate cancer care. We have developed a conceptual model of quality of care that consists of elements of structure, process, and outcome of care. This model was envisioned to facilitate linkage of the multiple dimensions of quality of care, and our study is a small step in this direction. Many studies have demonstrated that the structure of care, which includes the hospital and the physician, is associated with improved outcomes. Future studies are planned to identify additional measures of structure and process and their association with racial and ethnic disparity in outcomes.

## CONFLICT OF INTEREST DISCLOSURES

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## REFERENCES

1. Penson DF, Chan JM. Interstitial cystitis and painful bladder syndrome. In: Litwin MS, Saigal CS, eds. Urologic Diseases in America. US Department of Health and Human Services, Public Health Service, National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases. NIH Publication No. 07-5512. Washington, DC: US Government Printing Office; 2007:71-123.
2. Smedley BD, Stith AY, Nelson AR, eds. Unequal Treatment—Confronting Racial and Ethnic Disparities in Health Care. Institute of Medicine of the National Academies. Washington, DC: National Academies Press; 2003.
3. Committee on Quality of Health Care in America. Crossing the Quality Chasm—A New Health System for the 21st Century. Washington, DC: National Academy Press; 2001.
4. Gross CP, Smith BD, Wolf E, Anderson M. Racial disparities in cancer therapy—did the gap narrow between 1992 and 2002? *Cancer*. 2008;112:900-908.
5. Underwood W 3rd, Jackson J, Wei JT, et al. Racial treatment trends in localized/regional prostate carcinoma: 1992-1999. *Cancer*. 2005;103:538-545.
6. Zeliadt SB, Potosky AL, Etzioni R, et al. Racial disparity in primary and adjuvant treatment for nonmetastatic prostate cancer: SEER-Medicare trends 1991 to 1999. *Urology*. 2004;64:1171-1176.
7. Kirby JB, Taliaferro G, Zuvekas SH. Explaining racial and ethnic disparities in health care. *Med Care*. 2006;44:I-64-I-72.
8. Fiscella K, Franks P, Gold MR, et al. Inequality in quality: addressing socioeconomic, racial and ethnic disparities in health care. *JAMA*. 2000;283:2579-2584.
9. Donabedian A. Evaluating the quality of medical care. *Milbank Mem Fund Q*. 1966;44(suppl):166-206.
10. Lohr KN, ed. Institute of Medicine. Medicare: A Strategy for Quality Assurance. Washington, DC: National Academy Press; 1990.
11. Kahn KL, Malin JL, Adams J, Ganz PA. Developing a reliable, valid and feasible plan for quality-of-care measurement for cancer: how should we measure? *Med Care*. 2002;40(6 suppl); III-73-III-85.
12. Underwood W, De Monner S, Ubel P, et al. Race/ethnicity disparities in the treatment of localized/regional prostate cancer. *J Urol*. 2004;171:1504-1507.
13. Jayadevappa R, Johnson JC, Chhatre S, et al. Ethnic variations in return to baseline values of patient reported outcomes in older prostate cancer patients. *Cancer*. 2007;109: 2229-2238.
14. Godley PA, Schenck AP, Amamoo A, et al. Racial difference in mortality among Medicare recipients after treatment for localized prostate cancer. *J Natl Cancer Inst*. 2003;95:1702-1710.
15. Chu KC, Tarone RE, Freeman HP. Trends in prostate cancer mortality among black men and white men in the United States. *Cancer*. 2003;97:1507-1516.
16. Lu-Yao GL, Albertsen PC, Moore DF, et al. Outcomes of localized prostate cancer following conservative management. *JAMA*. 2009;302:1202-1209.
17. Robbins AS, Whittemore AS, Van Den Eeden SK. Race, prostate cancer survival and membership in a large health maintenance organization. *J Natl Cancer Inst*. 1998;90:986-990.
18. Polednak AP. Prostate cancer treatment in black and white men: the need to consider both stage at diagnosis and socioeconomic status. *J Natl Med Assoc*. 1998;90:101-104.
19. Shavers VL, Brown ML, Potosky AL, et al. Race/ethnicity and the receipt of watchful waiting for the initial management of prostate cancer. *J Gen Intern Med*. 2004;19:146-155.
20. Xiao H, Warrick C, Huang Y. Prostate cancer treatment patterns among racial/ethnic groups in Florida. *J Natl Med Assoc*. 2009;101:936-943.
21. Jayadevappa R, Chhatre S. Bloom BS, Malkowicz SB Medical care cost of patients with prostate cancer. *Urol Oncol*. 2005;23:155-162.
22. Klabunde CN, Potosky AL, Harlan LC, et al. Trends and black-white differences in treatment for nonmetastatic prostate cancer. *Med Care*. 1998;36:1337-1348.
23. Krupski TL, Kwan L, Afifi AA, et al. Geographic and socioeconomic variation in the treatment of prostate cancer. *J Clin Oncol*. 2005;23:7881-7888.
24. Powell IJ, Dey J, Dudley A, et al. Disease-free survival difference between African Americans and whites after radical prostatectomy for local prostate cancer: a multivariate analysis. *Urology*. 2002;59:907-912.
25. Jayadevappa R, Schwartz SC, Chhatre S, et al. Satisfaction with care: a measure of quality of care in prostate cancer patients. *Med Decision Making*. 2010;30:234-245.
26. Warren JL, Klabunde CN, Schrag D, et al. Overview of the SEER-Medicare data—content, research application and generalizability to the United States elderly population. *Med Care*. 2002;40(suppl):IV-3-IV-18.
27. Virnig BA, Warren JL, Cooper GS, et al. Studying radiation therapy using SEER-Medicare-linked data. *Med Care*. 2002;40(suppl):IV-49-IV-54.

28. Potosky AL, Warren JL, Riedel ER, et al. Measuring complications of cancer treatment using the SEER-Medicare data. *Med Care*. 2002;40(suppl):IV-62-IV-68.
29. Alibhai SMH, Leach M, Tomlinson G, et al. Thirty-day mortality and major complications after radical prostatectomy: influence of age and comorbidity. *J Natl Cancer Inst*. 2007;97:1525-1532.
30. Alibhai SMH, Leach M, Warde P. Major 30-day complications after radical radiotherapy. *Cancer*. 2009;115:293-302.
31. Beard CJ, Propert KJ, Rieker PP, et al. Complications after treatment with external beam irradiation in early stage prostate cancer patients: a prospective multi-institutional outcomes study. *J Clin Oncol*. 1997;15:223-229.
32. Klabunde CN, Warren JL, Legler JM. Assessing comorbidity using claims data—an overview. *Med Care*. 2002;40(suppl):IV-26-IV-35.
33. Elixhauser A, Steiner C, Harris DR, et al. Comorbidity measures for use with administrative data. *Med Care*. 1998; 36:8-27.
34. Green WH. Econometric Analysis. Upper Saddle River, NJ: Prentice Hall; 2000.
35. Allison PD. Logistic Regression Using the SAS System: Theory and Application, Cary, NC: SAS Institute Inc.; 1999.
36. Miller DC, Montie JE, Wei JT. Measuring the quality of care for localized prostate cancer. *J Urol*. 2005;174:425-431.
37. Malin JL, Schneider EC, Epstein AM, et al. Results of the National Initiative for Cancer Care Quality: how can we improve the quality of cancer care in the United States? *J Clin Oncol*. 2006;24:626-634.
38. Miller DC, Spencer BA, Ritchey J, et al. Treatment choice and quality of care for men with localized prostate cancer. *Med Care*. 2007;45:401-409.
39. Litwin MS, Steinberg M, Malin JL, et al. Prostate Cancer Patient Outcomes and Choice of Providers: Development of an Infrastructure for Quality Assessment. Santa Monica, CA: RAND; 2000.
40. Spencer BA, Steiberg M, Malin J, et al. Quality-of-care indicators for early stage prostate cancer. *J Clin Oncol*. 2003;21:1928-1936.
41. Miller DC, Saigal CS. Quality of care indicators for prostate cancer: progress toward consensus. *Urol Oncol*. 2009;27: 427-434.
42. Miller DC, Litwin MS, Sanda MG, et al. Use of quality indicators to evaluate the care of patients with localized prostate carcinoma. *Cancer*. 2003;97:1428-1435.
43. Spencer BA, Miller DC, Litwin MS, et al. Variations in quality of care for men with early-stage prostate cancer. *J Clin Oncol*. 2008;20:3735-3742.
44. Parsons JK, Kwan L, Connor SE, et al. Prostate cancer treatment for economically disadvantaged men: a comparison of county hospitals and private providers. *Cancer*. 2010; 116:1378-1384.