Racial Composition of Hospitals: Effects on Surgery for Early-Stage Non–Small-Cell Lung Cancer

Christopher S. Lathan, Bridget A. Neville, and Craig C. Earle

From the Division of Population Sciences, Department of Medical Oncology, Dana-Farber Cancer Institute, Boston, MA.

Submitted November 28, 2007; accepted May 16, 2008.

Supported by National Cancer Institute Grant No. KO1 CA124581-01A (C.S.L.) and the National Cancer Institute funded Program in Cancer Outcomes Research Training (Grant No. 5R25 CA092203-04).

Presented in part at the 41st Annual Meeting of the American Society of Clinical Oncology, May 13-17, 2005, Orlando, FL.

Authors' disclosures of potential conflicts of interest and author contributions are found at the end of this article.

Corresponding author: Christopher S. Lathan, MD, MS, MPH, Center for Outcomes and Policy Research, Dana-Farber Cancer Institute, 44 Binney St, 454-STE 21-24, Boston, MA 02115; e-mail: christopher_lathan@dfci.harvard.edu.

© 2008 by American Society of Clinical Oncology

0732-183X/08/2626-4347/\$20.00

DOI: 10.1200/JCO.2007.15.5291

ABSTRACT

Purpose

Black patients undergo potentially curative surgery for early-stage lung cancer at a lower rate when compared with white patients. Our study examines the relationship between the percentage of black patients treated at a hospital to determine whether it affects the likelihood of obtaining cancer-directed surgery for patients with non–small-cell lung cancer (NSCLC).

Patients and Methods

We examined claims data of Medicare-eligible patients with nonmetastatic NSCLC living in areas monitored by the Surveillance, Epidemiology, and End Results program between 1991 and 2001. Hospitals were categorized by the percentage of black patients seen: $\leq 8\%$, more than 8% to 29%, and $\geq 30\%$. Logistic regression with clustering analysis was used to calculate the odds of undergoing surgical resection.

Results

Among 9,688 patients with NSCLC, 59% of white patients were seen at a hospital that had $\leq 8\%$ black patients, whereas 60% of black patients were seen in hospitals that had $\geq 30\%$ black patients. Regression analysis revealed that hospital racial composition of 30% or greater black patients had a significant negative effect on the likelihood of undergoing surgery for all patients (odds ratio [OR] = 0.71; 95% CI, 0.57 to 0.87), with black race (OR = 0.69; 95% CI, 0.56 to 0.85) and being seen at a low-volume hospital (OR = 0.64; 95% CI, 0.49 to 0.83) having a significant negative impact on likelihood of undergoing surgery.

Conclusion

Our study results indicate that patient and hospital characteristics are significant predictors of undergoing surgery for Medicare beneficiaries with localized lung cancer. Further examination of the role of the patient-, provider-, and hospital-level factors, in association with the decision to pursue surgical treatment of localized lung cancers, is needed.

J Clin Oncol 26:4347-4352. © 2008 by American Society of Clinical Oncology

INTRODUCTION

Lung cancer is the leading cause of cancer mortality in the United States, with 157,000 deaths each year.¹ During the past 40 years, there has been a decrease in lung cancer incidence and mortality in all races; however, a significant differential between black and white patients remains, with both incidence and mortality rates being highest in black men.² Access to care, differences in biologic response to tobacco smoke, and patient preferences have all been suggested as possible contributors to the mortality gap in lung cancer.³⁻⁶ It has also been suggested that part of the racial disparity in early-stage lung cancer survival is related to the gap in the likelihood of obtaining potentially curative surgery.⁷ Previous studies have identified several patient-, physician-, and hospital-level factors associated with lower odds of undergoing potentially curative surgery for early-

stage lung cancer, even when all patients had similar health insurance.^{6,7} Our own work has shown that even when patients had similar access to specialist care and showed a willingness to undergo invasive staging, physicians were less likely to offer potentially curative surgical procedures to black versus white patients.⁸ Other studies have evaluated physician-level factors, such as differential referral rates to surgeons and variation in surgeon specialty training. With respect to hospital-level characteristics, prior studies have focused on hospital volume and found that black patients were more likely to be seen in lower-volume hospitals.⁹⁻¹² Other hospital-level factors, particularly racial composition of the hospital and hospital ownership status, should be considered. Studies of patients with head and neck cancer have found that county hospitals disproportionately treat patients with high rates of advanced-stage cancers. Hospitals that treat relatively large

numbers of black patients have disproportionately high mortality rates after acute myocardial infarctions.¹³⁻¹⁷

This study was designed to determine the association of hospital-level characteristics on the acquisition of surgery for early-stage non-small-cell lung cancer (NSCLC) in a system where all patients have the same health insurance. Racial composition of the hospital has not been examined separately in lung cancer, but has been examined in other situations,¹³⁻¹⁶ and earlier studies have noted a separate and unequal medical system.¹⁸

PATIENTS AND METHODS

Data Sources

Patients from 11 tumor registries participating in the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) program were studied. The registries capture 97% of the incident cases,¹⁹ covering a nearly representative sample of 14% of the American population.²⁰ The registries collect data on patient age, sex, race, ethnicity, cancer site, stage, histology, and date of death and diagnosis. Medicare claims, both inpatient and outpatient, have been linked to SEER for patients aged 65 and older.²¹ Hospital-level data associated with SEER-Medicare were obtained for the years 1996, 1998, 2000, and 2001 to obtain hospital-level variables.

Cohort Selection

Our study sample consisted of SEER-Medicare patients diagnosed with NSCLC between January 1, 1991, and December 31, 1999. Medicare claims data were present through 2001. Patients with American Joint Committee on Cancer stage I, II, and III disease were included for analysis. Stage III patients were included to control for stage migration at diagnosis. Patients who might have been clinical stage II and proceeded to resection, patients who had unknown stage according to SEER and underwent resection, and patients who were clinical stage IV and underwent surgical resection were included in the cohort, but given that the model was selected to examine stages I, II, and III, patients who were stage IV or unknown stage were deleted from the logistic regression model. There were 361 patients who were removed under this criterion. In addition, the variable for nonprofit hospital status had missing data for 623 patients. These were also included in the cohort but were not included in the regression model. Results were similar if analyses were limited only to patients in stage I and II, so these subgroup analyses are not reported.

Patients were excluded if they had any prior cancers or if they were not admitted to a hospital any time after their diagnosis. We excluded patients who were enrolled in Medicare for end-stage renal disease or disability instead of age, patients whose diagnoses were made from autopsy or death certificates, patients with an unknown date of diagnosis, and those whose date of death differed by more than 3 months between SEER and Medicare. We also excluded patients if they did not have continuous Medicare enrollment (Part A and Part B) or if they were enrolled in a health maintenance organization at any time from 13 months prediagnosis (to use for comorbidity assessment) to death or last Medicare claim date (December 31, 2001).

Identification of Hospital Racial Composition

To increase the accuracy of the estimates of hospital racial composition, we combined the 5% cancer-free control population with our known cancer cohort described previously. That data set contained claims submitted from 16,862 hospitals between 1991 and 2001. To evaluate the effect of hospital volume, we counted the number of total patients and the number of black patients in each unique hospital. We then calculated the percentage of Black patients treated in those hospitals. We also constructed a similar measure based only on the proportion of black patients treated for lung cancer at a hospital, which yielded similar results. Hospital racial composition was analyzed as a categorical variable for crude analyses ($\leq 8\%$ black patients, $> 8\%$ to 29% black patients, and $\geq 30\%$ black patients). Less than 8% black patients was chosen because it was close to the national population estimates of black individuals in the United States. The other categories were chosen based on the data distribution. We associated a hospital with each patient by selecting the

first hospital the patient was admitted to after his or her lung cancer diagnosis. There were 610 separate hospitals included in the final data set for this study.

Definition of Surgery

Cancer-directed surgery procedures were defined as pneumonectomy, lobectomy, wedge resection, and local surgeries (less than wedge resection), and anything not defined as such was called miscellaneous surgery. The International Classification of Diseases ninth Revision Clinical Modification (ICD-9-CM) codes and the Current Procedural Terminology (CPT) codes were used when applicable from outpatient and inpatient billing claims to define the following procedures: ICD-9-CM 32.50 and 32.60 and CPT 32440, 32442, and 32445 for pneumonectomy; ICD-9-CM 32.40 and CPT 32480, 32482, 32484, and 32486 for lobectomy; ICD-9-CM 32.29 and 32.30 and CPT 32500 for wedge resection; ICD-9-CM 32.09 and 32.10 and CPT 32520 for local surgery; and ICD-9-CM 32.90 and CPT 32999 for miscellaneous surgery. SEER identification of surgery was used in addition to ICD-9-CM/CPT coding to classify cancer-directed surgery.

Definition of Explanatory Variables

We categorized race and ethnicity into "black" (non-Hispanic African Americans) and "white" (non-Hispanic white patients). If patients did not fall into either of these two groups, they were classified as "other." We calculated the Charlson comorbidity index by identifying billing codes²² for various conditions during the year before the diagnosis of cancer using the Deyo implementation²³ of the Charlson score applied to both inpatient and outpatient claims as suggested by Klabunde.²⁴ Low-income status was approximated by identifying patients that ever had state buy-in coverage during the study period. Hospital volume was determined by obtaining a patient count for each facility, and this was analyzed as a categorical variable divided into quartiles. Socioeconomic quintiles were developed based on the availability of information according to the following hierarchy: (1) race- and age-specific median household income by census tract, (2) unadjusted median household income by census tract, and (3) median per capita income.²⁵ Hospitals were classified as being a for-profit hospital based on the SEER-Medicare hospital designation. Patients were classified as being treated in a teaching hospital if their billing record contained a charge for indirect medical education. Urban versus rural residence was defined by the individual cancer registry, and as a result, in this cohort, all patients were classified as urban. Individual registries demonstrated varying demographic patterns. To examine the effect of racial distribution on hospitals, registries that had less than 5% black patients were not included in the main analysis.

Statistical Methods

Univariate comparisons were performed using logistic regression analysis. The significant ($P < .05$) explanatory variables, as well as those variables deemed important for face validity, were then entered into the multivariable logistic regression models to predict the likelihood of surgery. From the logistic regression models, we calculated the stratified probability of surgery by race. Generalized estimating equations were used to control for clustering of patients to specific hospitals via the use of the GENMOD procedure in SAS/STAT software version 9.1.3 of the SAS System for Windows (SAS Institute, Cary, NC; 1999 to 2001).

RESULTS

Patient Selection

Our patient cohort included 9,688 patients diagnosed with NSCLC between 1991 and 1999. There were 7,688 white patients (79%) and 1,391 black patients (14%), along with 609 patients (6%) classified as "other." Table 1 shows the characteristics of this patient cohort. The most common histology was adenocarcinoma for white and "other" patients. For black patients, the most common histology was squamous cell carcinoma. Forty-seven percent ($n = 4,563$) of all patients had surgery, with a higher percentage of white patients undergoing surgery (49%) compared with patients defined as black

Race and Hospital Composition

Table 1. Demographics of Patients With Non–Small-Cell Lung Cancer With Inpatient Admissions by Race (n = 19,081)*

Characteristic	White		Black		Other	
	No.	%	No.	%	No.	%
No. of patients	7,688		1,391		609	
Age at diagnosis, years						
Mean	74		73		74	
SD	5.9		6.3		6.4	
Male sex	4,061	53	803	58	387	64
Underwent surgery	3,814	50	482	35	267	43
Treated at teaching hospital	5,000	65	1,154	82	357	59
Disease stage						
I	3,416	44	543	39	225	36
II	561	7	69	5	43	7
IIla	1,312	17	260	19	110	18
IIlb	2,250	29	504	36	221	36
Histology						
Adenocarcinoma	3,258	42	496	36	300	49
Bronchioalveolar	559	7	61	4	52	8
Squamous	2,950	38	708	51	193	31
Large cell	921	11	126	9	64	10
Low income	857	11	497	36	349	57
Comorbidity						
0	5,038	65	854	61	387	64
1	1,902	24	345	25	151	24
2	510	6	109	8	48	8
> 3	238	3	83	6	23	4
Socioeconomic status quintile						
0	994	12	814	58	202	33
1	1,496	19	332	23	106	17
2	1,704	22	128	9	142	23
3	1,741	23	81	6	98	16
4	1,753	22	36	3	61	10
Patient volume quartile						
First	1,656	22	336	24	250	41
Second	1,917	25	336	24	178	29
Third	2,018	26	233	17	106	17
Fourth	2,097	27	486	35	75	12
Registry						
San Francisco	1,160		142		196	
Michigan	3,360		753		67	
Georgia	1,011		199		17	
Los Angeles	2,157		297		329	
Urban residence	7,688		1,391		609	
Nonprofit hospital	6,934	93	1,261	95	490	83

Abbreviation: SD, standard deviation.

*Some percentages do not total 100 as a result of rounding.

(34%; $P < .001$). Crude differences by race were also apparent in socioeconomic status, with more patients of black or other race being in the lower socioeconomic status quintile and having state buy-in coverage. A higher percentage of black patients seemed to have slightly worse comorbid disease status when compared with white patients. Median age was 74 years for white patients and patients classified as other and 73 years for black patients. The results for individual registries are also listed in Table 1. Whereas white patients were well distributed throughout the 11 registries, black patients seemed to be concentrated in the Michigan, Georgia, and Los Angeles registries, and for this reason, we chose for our analysis those registries that had at least 5% black patients. The San Francisco registry was retained, but Connecticut, New Mexico, Seattle, Utah, Iowa, San Jose, and Hawaii

were not part of the main analysis. All patients in the remaining registries were classified as urban by the SEER regional designation. Only three individual registries had more than 20% of their patients classified as rural: Iowa (45%), New Mexico (23%), and Utah (27%). Of the 610 hospitals in the study, 56% were classified as teaching hospitals, and 76% were classified as nonprofit.

Racial Distribution Across Hospitals

Figure 1 illustrates the relationship between patient race and the racial composition of the hospital where the patients were treated for their lung cancer. Fifty-nine percent of white patients were treated at a hospital that had $\geq 8\%$ black patients, whereas 60% of black patients were treated at a hospital that had $\geq 30\%$ black patients. Only 8% of

Fig 1. Distribution of patients with lung cancer by race.

white patients were treated in hospitals that had $\geq 30\%$ black patients. Those patients classified as other had similar experiences to the white patients in this study.

Multivariable Analysis

Using the percentage of black patients cared for in a hospital as a categoric independent variable, we performed a logistic regression analysis to predict likelihood of surgery. Race, age, sex, stage of disease, and state buy-in coverage (low income), as well as socioeconomic quintiles, patient volume quartiles, and registry sites, were all incorporated into the model (Table 2). The negative effect of the increasing percentage of black patients in a hospital remained significant in multivariable analysis, as did the negative effect of being seen in the lowest-volume quartile hospital. Being seen in a teaching hospital positively affected surgery. The other hospital level effect, such as nonprofit status, was not significant. Patient level effects, such as black race, increasing comorbid disease status, increasing age, low income,

Fig 2. Surgery rate by proportion of black patients by hospital.

and having stage III disease, all had a significant negative effect on obtaining surgery. Patients were more likely to have had surgery if they had been seen in a teaching hospital, had higher socioeconomic status, or had stage II disease. Individual registries were also evaluated in the model and compared with the Los Angeles registry. Both Michigan and San Francisco had significant odds ratios that indicated that patients in those registries were less likely to obtain surgery. The Georgia registry was not significant. The most powerful effect in our model outside of stage of the cancer was registry.

For sensitivity purposes, further analyses were performed. Individual hospitals had different rates of surgery that varied crudely with the racial composition of the hospital. Figure 2 shows the rate of surgery for each hospital by racial composition. Each data point indicates a hospital, and the size of the point was determined by the hospital volume from the top to the lowest quartile. The R^2 value was 0.027 for the fitted trend line.

Multivariable analysis was performed, and we restricted it to patients with stage I and II disease only. There was no change in the results (data not shown). We also performed the multivariable analysis with various interaction variables for each race combined with the hospital racial composition variable. None were significant, and thus data are not shown. In further sensitivity analysis, the complete cohort with 19,081 patients and all 11 registries was retained, and the multivariable analysis was repeated. There were no significant changes to the regression model.

DISCUSSION

Our study provides information about the association of hospital-level characteristics with the use of surgical procedures for Medicare beneficiaries with NSCLC. We found that receiving care at a teaching hospital or at hospitals with relatively larger percentages of white patients were associated with higher odds of patients undergoing surgical procedures. First, black and white patients seem to receive their lung cancer care at different hospitals. Most white patients were treated in hospitals that were predominantly white, whereas the majority of black patients were treated in hospitals that had a high number of black patients. Second, we found that the higher the percentage of black patients treated at a hospital, the less likely patients of either

Table 2. Multivariable Model Predicting the Likelihood of Receiving Surgery Based on Hospital Racial Composition

Effect	Odds Ratio	95% CI
8%–29% black patients	0.87	0.72 to 1.06
$\geq 30\%$ black patients	0.71	0.57 to 0.87
Nonprofit hospital	1.08	0.77 to 1.12
Black race	0.69	0.56 to 0.85
Other race	0.99	0.82 to 1.20
Comorbidity	0.76	0.70 to 0.82
Age	0.92	0.92 to 0.94
Low income	0.71	0.61 to 0.82
Female sex	1.06	1.00 to 1.22
Teaching hospital	1.25	1.07 to 1.46
25% Volume	0.64	0.49 to 0.83
50% Volume	0.73	0.57 to 0.94
75% Volume	0.83	0.64 to 1.08
Stage II disease	1.71	1.33 to 2.20
Stage III disease	0.12	0.11 to 0.13
Socioeconomic status	1.06	1.02 to 1.11
San Francisco	0.78	0.63 to 0.97
Michigan	0.51	0.41 to 0.63
Georgia	0.82	0.62 to 1.08

race were to undergo surgery for lung cancer. Lastly, in all hospitals, regardless of the racial mix, white patients were more likely to obtain surgery versus black patients, even when controlling for common confounders.

Our model attempted to account for the major confounders, including patient volume, income, stage of disease, and SEER registry. The role of patient factors such as insurance was difficult to ascertain, as all patients were Medicare recipients, although those patients who were listed as low income had state buy-in for insurance and were also less likely to obtain surgery. This effect is independent of the patient race and hospital effect.

Access to care has always been an important issue in discerning the cause of racial disparities in cancer treatment.²⁶ Our work looks at the effects of race in an equal access system, and recent published work has indicated that where patients obtain care can be an important factor contributing to racial disparities.^{14,16,27-29} The distribution of care demonstrated in Figure 1 is consistent with recent studies in the literature.³⁰

Our analysis, using a multivariable regression model, demonstrated that the likelihood of obtaining surgery for early-stage lung cancer decreased with increasing percentage of black patients in a hospital. The model contained the traditional patient level covariates for stage, patient race, comorbid disease, socioeconomic status, SEER registry, and sex. It is of interest to note that black race remained a significant negative predictor of surgery for lung cancer, even with the hospital-level factors, racial composition, and patient volume in the model. This indicates that hospital racial composition affects care in addition to (not because of) individual patient race.

The effect of volume of the hospital did seem to indicate that patients seen at smaller-volume hospitals also obtained surgery less than in patients seen in larger-volume hospitals. In all analyses, black race seemed to be a negative predictive factor in undergoing surgery for early-stage lung cancer, and this effect was similar in strength but was independent of the racial composition of the hospital. The effect of SEER registry is likely multifactorial, combining some elements of regional treatment patterns and proximity to major treatment centers.

There are some limitations to our study. Our analytic database combines data from the SEER registries and Medicare claims. Medicare claims were not created for research and can suffer from coding error. In addition, comorbidity adjustment using administrative data might miss some relevant factors that physicians use in choosing which patients are likely to tolerate surgery^{24,31} and is not a proxy for performance status. Because our analysis was limited to Medicare-

enrolled patients, we were unable to examine patients younger than 65 years of age. Patients in health maintenance organizations were excluded and may have different patterns of care. It is possible that the hospitals with higher numbers of black patients are safety net or county hospitals, but we were unable to discern hospital type in the SEER-Medicare database. Identifying patients based on hospital admission is imperfect but necessary, given the constraints of administrative databases like SEER-Medicare. Likewise, income estimates can also be imprecise, given the intimation of income via census tract data.

We have shown that, regardless of race, patients are less likely to have surgery for nonmetastatic NSCLC if they are treated at hospitals with larger black populations. Furthermore, black patients seem to be treated for lung cancer more often at predominantly black hospitals. It is well known that black patients have surgery less often for NSCLC compared with white patients. Hospital-level characteristics, such as racial composition of the hospital, are often determined by regional resources. The reasons for the hospital-level effect of racial composition we observed are unknown but could be the result of historical treatment and referral patterns. Indeed, many safety net or county hospitals are large-volume teaching hospitals that traditionally provide care to the underserved. If the hospitals that treat the majority of black patients are overburdened and/or underfunded, then an exacerbation of the already present treatment disparities is bound to occur. Future research should focus on the specific characteristics of the hospitals that correspond to improved access to lung cancer care for all patients, regardless of race or ethnicity.

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

The author(s) indicated no potential conflicts of interest.

AUTHOR CONTRIBUTIONS

Conception and design: Christopher S. Lathan, Craig C. Earle

Financial support: Craig C. Earle

Collection and assembly of data: Bridget A. Neville

Data analysis and interpretation: Christopher S. Lathan, Bridget A. Neville, Craig C. Earle

Manuscript writing: Christopher S. Lathan, Bridget A. Neville, Craig C. Earle

Final approval of manuscript: Christopher S. Lathan, Bridget A. Neville, Craig C. Earle

REFERENCES

1. American Cancer Society: Cancer Facts and Figures 2005. Atlanta, GA, American Cancer Society 2005
2. Stewart J: Lung Cancer in African Americans. *Cancer* 91:2476-2482, 2001
3. Mulligan CR, Meram AD, Proctor CD, et al: Unlimited access to care: Effect on racial disparity and prognostic factors in lung cancer. *Cancer Epidemiol Biomarkers Prev* 15:25-31, 2006
4. Margolis ML, Christie JD, Silvestri GA, et al: Racial differences pertaining to a belief about lung cancer surgery: Results of a multicenter survey. *Ann Intern Med* 139:558-563, 2003
5. Earle CC, Neumann PJ, Gelber RD, et al: Impact of referral patterns on the use of chemotherapy for lung cancer. *J Clin Oncol* 20:1786-1792, 2002
6. Earle CC, Venditti LN, Neumann PJ, et al: Who gets chemotherapy for metastatic lung cancer? *Chest* 117:1239-1246, 2000
7. Bach PB, Cramer LD, Warren JL, et al: Racial differences in the treatment of early-stage lung cancer. *N Engl J Med* 341:1198-1205, 1999
8. Lathan CS NB, Earle CC: The Effect of race on invasive staging and surgery in non-small cell lung cancer. *J Clin Oncol* 24:413-418, 2006
9. Bach PB, Cramer LD, Schrag D, et al: The influence of hospital volume on survival after resection for lung cancer. *N Engl J Med* 345:181-188, 2001
10. Chang MY, Sugarbaker DJ: Surgery for early stage non-small cell lung cancer. *Semin Surg Oncol* 21:74-84, 2003
11. Goodney PP, Lucas FL, Stukel TA, et al: Surgeon specialty and operative mortality with lung resection. *Ann Surg* 241:179-184, 2005
12. Neighbors CJ, Rogers ML, Shenassa ED, et al: Ethnic/racial disparities in hospital procedure volume for lung resection for lung cancer. *Med Care* 45:655-663, 2007
13. Trivedi AN, Sequist TD, Ayanian JZ: Impact of hospital volume on racial disparities in cardiovascular procedure mortality. *J Am Coll Cardiol* 47:417-424, 2006
14. Groeneveld PW, Laufer SB, Garber AM: Technology diffusion, hospital variation, and racial disparities among elderly Medicare Beneficiaries 1989-2000. *Med Care* 43:320-329, 2005

15. Patel UA, Lynn-Macrae A, Rosen F, et al: Advanced stage of head and neck cancer at a tertiary-care county hospital. *Laryngoscope* 116:1473-1477, 2006
16. Skinner J, Chandra A, Staiger D, et al: Mortality after acute myocardial infarction in hospitals that disproportionately treat black patients. *Circulation* 112:2634-2641, 2005
17. Parada JP, Deloria-Knoll M, Chmiel JS, et al: Relationship between health insurance and medical care for patients hospitalized with human immunodeficiency virus-related *Pneumocystis carinii* pneumonia, 1995-1997: Medicaid, bronchoscopy, and survival. *Clin Infect Dis* 37:1549-1555, 2003
18. Schatzkin A: Variation in inpatient racial composition among acute-care hospitals in New York State. *Social Science Medicine* 20:371-379, 1985
19. Zippin C, Lum D, Hankey BF: Completeness of hospital cancer case reporting from the SEER program of the National Cancer institute. *Cancer* 76:2343-2350, 1995
20. Nattinger AB, McAuliffe T, Schapira MM: Generalizability of the Surveillance, Epidemiology and End Results Registry population: Factors relevant to epidemiologic and health care research. *J Clin Epidemiol* 50:939-945, 1997
21. Potosky AL, Riley GF, Lubitz JD, et al: Potential for cancer related health services research using a linked Medicare-tumor registry database. *Med Care* 31:732-748, 1993
22. Charlson ME, Pompei P, Ales KL, et al: A new method for classifying prognostic comorbidity in longitudinal studies: Development and validation. *J Chronic Dis* 40:373-383, 1987
23. Deyo RA, Ciol MA: Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. *Clin Epidemiol* 45:613-619, 1992
24. Klabunde C: Development of a comorbidity index using physician claims data. *J Clin Epidemiol* 53:1258-1267, 2000
25. Krieger N: Overcoming the absence of socioeconomic data in medical records: Validation and application of a census-based methodology. *Am J Public Health* 82:703-710, 1992
26. Weissman Joel S SEC: Social disparities in cancer: Lessons from a multidisciplinary workshop. *Cancer Causes Control* 16:71-74, 2005
27. Jha AK, Fisher ES, Li Z, et al: Racial trends in the use of major procedures among the elderly. *N Engl J Med* 353:683-691, 2005
28. Lucas FL, Stukel TA, Morris AM, et al: Race and surgical mortality in the United States. *Ann Surg* 243:281-286, 2006
29. Barnato AE, Lucas FL, Staiger D, et al: Hospital-level racial disparities in acute myocardial infarction treatment and outcomes. *Med Care* 43:308-319, 2005
30. Bach PB, Pham HH, Schrag D, et al: Primary care physicians who treat blacks and whites. *N Engl J Med* 351:575-584, 2004
31. Jazieh A, Kyasa MJ, Sethuraman S, et al: Disparities in surgical resection of early stage non small cell lung cancer. *J Thorac Cardiovasc Surg* 123:1173-1176, 2002

Acknowledgment

We thank Mary Beth Landrum, PhD, for her assistance with statistical analysis.