Special Article

RACIAL DIFFERENCES IN THE TREATMENT OF EARLY-STAGE LUNG CANCER

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ABSTRACT

Background If discovered at an early stage, non–small-cell lung cancer is potentially curable by surgical resection. However, two disparities have been noted between black patients and white patients with this disease. Blacks are less likely to receive surgical treatment than whites, and they are likely to die sooner than whites. We undertook a population-based study to estimate the disparity in the rates of surgical treatment and to evaluate the extent to which this disparity is associated with differences in overall survival.

Methods We studied all black patients and white patients 65 years of age or older who were given a diagnosis of resectable non–small-cell lung cancer (stage I or II) between 1985 and 1993 and who resided in 1 of the 10 study areas of the Surveillance, Epidemiology, and End Results (SEER) program (10,984 patients). Data on the diagnosis, stage of disease, treatment, and demographic characteristics of the patients were obtained from the SEER data base. Information on coexisting illnesses, type of Medicare coverage, and survival was obtained from linked Medicare inpatient-discharge records.

Results The rate of surgery was 12.7 percentage points lower for black patients than for white patients (64.0 percent vs. 76.7 percent, P<0.001), and the five-year survival rate was also lower for blacks (26.4 percent vs. 34.1 percent, P<0.001). However, among the patients undergoing surgery, survival was similar for the two racial groups, as it was among those who did not undergo surgery. Furthermore, analyses in which adjustments were made for factors that are predictive of either candidacy for surgery or survival did not alter the influence of race on these outcomes.

Conclusions Our analyses suggest that the lower survival rate among black patients with early-stage, non–small-cell lung cancer, as compared with white patients, is largely explained by the lower rate of surgical treatment among blacks. Efforts to increase the rate of surgical treatment for black patients appear to be a promising way of improving survival in this group. (N Engl J Med 1999;341:1198-205.)

IN the United States, lung cancer is the leading cause of death attributed to cancer among both men and women, claiming the lives of more than 150,000 people each year. About one third of patients with the most common histologic type of lung cancer, non–small-cell cancer, are first given the diagnosis at an early, potentially curable stage. If treated by surgical resection, these patients have a 40 percent likelihood of surviving for five years or longer. In contrast, patients who present with advanced disease or who do not undergo surgical resection have a median survival of less than one year.[1] In the light of this information, it is important to determine whether patients who have potentially curable disease actually receive surgical treatment.

Several studies have uncovered an association between race and the likelihood of receiving surgical treatment for resectable non–small-cell lung cancer. Greenwald et al. found that patients with stage I disease in Seattle, San Francisco, and Detroit were less likely to undergo surgical resection if they were black or of lower socioeconomic status than if they were white or of higher socioeconomic status.[2] Smith et al. found similar disparities in the treatment of black patients and white patients in a cohort in Virginia.[3] Samet et al. found that older age and Hispanic ancestry were associated with lower rates of surgical treatment in a cohort in New Mexico.[4]

We undertook a study to answer two questions about the treatment of early-stage, non–small-cell lung cancer. First, is there a difference in the rate of surgical treatment between white patients and black patients with this type of lung cancer, and if so, is the discrepancy still apparent once we account for the effects of coexisting illness, socioeconomic status, insurance coverage, and availability of care? Second, does this discrepancy in part explain the differences in survival between black patients and white patients with lung cancer? To answer these questions, we

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chose a setting and design that mitigated the effect of the confounding factors. We proposed two hypotheses: that black patients would receive surgical treatment less frequently than white patients and that differences in survival between black patients and white patients would be substantially explained by the difference in the rates of surgical treatment.

METHODS

Sources of Data

We tested our hypotheses with the use of data from the Surveillance, Epidemiology, and End Results (SEER) cancer registries that have been linked with data on Medicare hospitalizations. The SEER–Medicare data base has been used extensively to assess patterns of care for persons with new diagnoses of cancer.[5,6] The SEER registries, sponsored by the National Cancer Institute, list all incident cases of cancer in five metropolitan areas (San Francisco–Oakland–San Jose, Detroit, Atlanta, Seattle, and Los Angeles County) and five states (Connecticut, Utah, New Mexico, Iowa, and Hawaii) and cover approximately 14 percent of the population of the United States.[7] These data contain information on each newly diagnosed case of cancer, including the month and year of the diagnosis; the location, histologic type, nodal involvement, and spread of the tumor; and the type of treatment provided within four months after diagnosis (e.g., surgery or radiation). The site of cancer is coded in the SEER data according to the *International Classification of Diseases for Oncology,* 2nd edition (ICD-O-2).[8]

The Medicare program, which provides health care coverage for 97 percent of persons 65 years of age or older, collects claims for all services covered by the program. Information about hospitalizations is included in the Medicare Provider Analysis and Review (MEDPAR) files, which contain information on all hospital admissions since 1984. Medicare also maintains files that document the dates of death of beneficiaries and whether they were covered by a traditional indemnity program or by a health maintenance organization (HMO).

The SEER and Medicare data bases have been linked in order to permit population-based studies of health outcomes. The data on 94 percent of the persons included in the SEER files who are 65 years of age or older have been successfully linked to Medicare records.[7] Focusing on this group of people who were eligible for Medicare led to the exclusion of the 44 percent of patients in the SEER data base who received diagnoses of lung cancer before the age of 65 years, but this allowed us to adjust for coexisting conditions, eliminated the confounding effects of insurance coverage, and provided sufficient geographic specificity to allow us to control for the availability of health care.

Study Participants

The subjects were persons with a form of lung cancer for which surgical resection has been shown to confer a definitive benefit — stage I or stage II non–small-cell lung cancer.[9] We included all patients classified as non-Hispanic white or black who were 65 years of age or older, who resided in 1 of the 10 SEER areas, and who were given a diagnosis between 1985 and 1993 of primary cancer of the lung, non–small-cell histologic type (SEER codes 34.0 to 34.9 and ICD-O-2 morphology codes 8010 to 8040, 8050 to 8076, 8140, 8250 to 8260, 8310, 8320, 8323, 8430, 8470 to 8490, 8550 to 8573, 8980, and 8981); there were a total of 59,365 patients.

From this group we excluded patients who had not undergone a complete evaluation to determine the stage of disease — that is, those for whom there was either no documentation or incomplete documentation with regard to tumor size, spread, or nodal involvement in the SEER data base (21,006 patients [35.4 percent]). We then identified patients with stage I or stage II disease (12,900 patients) according to the staging system of the American Joint Committee on Cancer,[10,11] using the information in the SEER data base on size, spread, and nodal involvement of the tumor. The definitions of these stages were constant throughout the study period. We then excluded patients for whom diagnoses were obtained from death certificates or at autopsy (127 patients [1.0 percent]) and those in whom a second cancer was diagnosed within two months of the primary lung cancer (1789 patients [13.9 percent]), leaving a cohort of 10,984.

Surgical Treatment and Survival after Diagnosis

Patients were considered to have undergone surgical resection if the variable for site-specific surgery in the SEER data base indicated that a procedure that was curative in intent had been performed. Such procedures included local resection, wedge resection, segmentectomy, lobectomy, sleeve resection, partial pneumonectomy, and radical pneumonectomy (SEER codes 10 to 70). The month and year of diagnosis were documented in the SEER data base; for analytic purposes, we assumed that the diagnosis was made on the first day of the month. Dates of death were obtained from Medicare, which receives this information from the Social Security Administration. All records of death are complete through December 31, 1994, which was therefore chosen as the date of data censoring for patients who were last known to be alive.

Characteristics of the Participants

Demographic Characteristics and Coexisting Illnesses

Information on the sex of the patients was obtained from Medicare records, and information on race and age at diagnosis was obtained from the SEER data base. The socioeconomic status of each patient was estimated on the basis of Medicare data on the median income for the ZIP Code of the patient's residence. This variable was necessarily an aggregate measurement of income, as opposed to a factor that reflected socioeconomic status on an individual basis. We constructed two strata: one containing the patients who resided in areas in the lowest quartile of median income, and the other containing the remaining patients.

The burden of coexisting illness was determined with the use of MEDPAR inpatient records through an examination of all hospital admissions occurring within the 12-month period before the month of diagnosis. We calculated two indexes of coexisting illness for each patient: one according to the method suggested by Romano et al.,[12] in which the maximal Charlson comorbidity index[13] was calculated on the basis of inpatient records during this period and the other according to the total number of hospital admissions during this period. In order to calculate these two indexes, we needed one year of recorded Medicare data before diagnosis. We therefore calculated the comorbidity indexes and conducted the adjusted analyses only for patients who at the time of diagnosis were 66 years of age or older and were covered by traditional indemnity insurance, since Medicare does not collect data on hospitalization for persons in HMOs (84 percent of the total sample of 10,984). The Romano–Charlson index could not be determined for patients without a hospitalization during this period.

Access to Care

All patients were insured by Medicare. We assigned each patient the coverage (HMO or indemnity) that he or she had during the month in which the diagnosis was made. To assess the local availability of care, we used the health care service areas defined by the Health Resources and Services Administration. These areas represent regions with certain characteristics of health care availability, and they have been used in other studies of the availability of health care.[14,15] The areas range in size from parts of a city to substantial portions of less populous states. The health care service area corresponding to each patient's area of residence was documented in the SEER data base — our 10,984 study participants resided in 80 health care service areas. To determine whether some of our findings could be related to variations in the local availability of health care services, we looked for heterogeneity in our findings with respect to the health care service areas and SEER areas.

Statistical Analysis

We assessed the association between the race of the patients and the receipt of surgical treatment by comparing the overall rates of resection (among black patients as compared with white patients) for the entire cohort; by comparing the resection rates between black patients and white patients within relevant subgroups, such as those defined by age, comorbidity index, and area of residence; by determining the effect of race on the receipt of surgical treatment while controlling for other important factors, such as sex, median income in the ZIP Code of residence, age, stage of disease, and comorbidity (one of the two measures); and by determining whether the disparities in resection rates were consistent with respect to the SEER area (with use of the Breslow–Day test for heterogeneity), health care service area (with use of the Mantel–Haenszel test for heterogeneity), and study year (with use of the Mantel–Haenszel test).[16]

Survival curves were constructed with the Kaplan–Meier method and compared with use of the log-rank statistic.[17] For analyses involving adjustments for potential confounding factors, we used the Cox proportional-hazards method.[17] All P values are two-sided. All analyses were performed with SAS software (version 6.12, SAS Institute, Cary, N.C.). The estimated survival benefit under a scenario in which black patients received surgical treatment at a rate identical to that of white patients is based on the estimated survival probabilities derived from the observed population.

RESULTS

Characteristics of the Study Participants

There were 10,984 patients in this study; 860 (8 percent) were black, and 10,124 (92 percent) were non-Hispanic white (Table 1). There were no substantial differences between the two groups with respect to the stage of disease, type of insurance, number of hospitalizations in the 12 months before the diagnosis, or the Romano–Charlson comorbidity index. Black patients were slightly younger and somewhat more likely to be men. The most important disparity between the two groups was that black patients were substantially more likely to reside in a ZIP Code area with a low median income. Also, the distribution of patients among the SEER areas differed between the two groups.

Resection Rates and Association with Survival

Black patients and white patients who underwent surgery had roughly similar rates of survival at five years — 39.1 percent among black patients and 42.9 percent among whites (P=0.10) (Fig. 1). Those who did not undergo surgery also had similar five-year survival rates (4 percent among blacks and 5 percent among whites, P=0.25) (Fig. 1). However, 76.7 percent of the white patients underwent surgery, whereas only 64.0 percent of the black patients received this treatment (P<0.001) (Table 2). The combination of discrepant resection rates and similar survival rates after treatment contributed to a substantial difference in the overall survival rates, as shown in Figure 2.

We diagrammed the effect of these results in a hypothetical cohort of 1000 white patients and 1000 black patients (Fig. 3): 76.7 percent of the whites underwent surgery, and 42.9 percent of these patients survived for five years, whereas only 5.2 percent of the remaining 23.3 percent of patients who did not receive surgical treatment survived for that long. Thus, overall, 341 patients (34.1 percent) were alive at five years. In contrast, of the 1000 black patients, only 264 patients were alive at five years — 77 (7.7 percent) fewer than in the white cohort. Two factors are responsible for this difference: the lower rate of resection among blacks (64.0 percent, vs. 76.7 percent among whites) and the slightly (though nonsignificantly)

TABLE 1. CHARACTERISTICS OF BLACK AND WHITE MEDICARE BENEFICIARIES 65 YEARS OF AGE OR OLDER WITH STAGE I OR II NON–SMALL-CELL LUNG CANCER, 1985 TO 1993.*

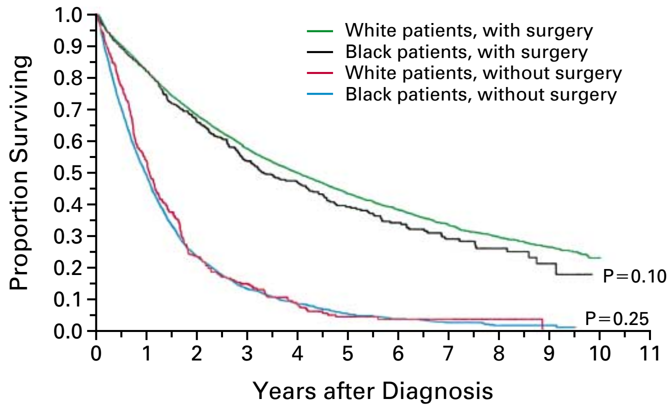
CHARACTERISTIC	BLACK PATIENTS	WHITE PATIENTS
	no. (%)	
All participants		
Total no.	860	10,124
Age (yr)		
65–69	376 (44)	3,502 (35)
70–74	280 (33)	3,261 (32)
≥75	204 (24)	3,361 (33)
Sex		
Male	583 (68)	6,264 (62)
Female	277 (32)	3,860 (38)
Stage of disease		
I	682 (79)	8,003 (79)
II	178 (21)	2,121 (21)
Median income in ZIP Code of residence		
Lowest quartile	451 (52)	1,907 (19)
Highest three quartiles	289 (34)	6,914 (68)
Not determined	120 (14)	1,303 (13)
SEER area†		
Atlanta	122 (14)	730 (7)
Connecticut	69 (8)	1,662 (16)
Detroit	375 (44)	1,792 (18)
Los Angeles County	85 (10)	589 (6)
San Francisco–Oakland–San Jose	165 (19)	1,595 (16)
Type of Medicare insurance		
Health maintenance organization	75 (9)	961 (9)
Indemnity	780 (91)	9,112 (90)
Not determined	5 (<1)	51 (<1)
Participants ≥66 yr with indemnity insurance		
Total no.	712	8,479
Total no. of hospitalizations in previous year		
0	520 (73)	6,455 (76)
1	133 (19)	1,446 (17)
2	41 (6)	368 (4)
>2	18 (3)	210 (2)
Highest Romano–Charlson index in previous year‡		
Not evaluated§	520 (73)	6,455 (76)
0	67 (9)	697 (8)
1	72 (10)	801 (9)
>1	53 (7)	526 (6)

*Because of rounding, all percentages do not total 100.

†SEER denotes the Surveillance, Epidemiology, and End Results program. Only the patients from the areas that contributed more than 5 percent of the black cohort are listed.

‡The Romano–Charlson index was calculated only for the patients who were hospitalized in the 12-month period before the diagnosis.

§These participants constitute the cohort for which comorbidity scores could not be calculated.



NO. OF PATIENTS AT RISK

White, surgery	7763	4495	2255	1069	407	12
Black, surgery	550	301	145	69	30	0
White, no surgery	2361	458	110	30	6	0
Black, no surgery	310	60	14	2	1	0

Figure 1. Survival of Medicare Beneficiaries 65 Years of Age or Older Who Were Given a Diagnosis of Stage I or II Non–Small-Cell Lung Cancer between 1985 and 1993, According to Treatment and Race.

lower five-year survival rate after surgery among blacks (39.1 percent vs. 42.9 percent). If black patients had undergone surgery at a rate similar to that for white patients, we estimate that 308 black patients would have been alive at five years, a number only 3.3 percent lower than that for whites. These figures suggest that of the 77 more deaths per 1000 black patients, the majority (44) can be attributed to the failure to provide surgical treatment for a curable disease.

Stratified and Adjusted Analyses

We performed a number of stratified and adjusted analyses to test the robustness of these results. The pivotal disparity in rates of resection was evaluated in several important subgroups (Table 2). The results show that the lower resection rate among black patients was consistent. In addition, we found no evidence that the disparity in resection rates differed according to the health care service area (P=0.85) or SEER area (P=0.64) or that the overall resection rate or the disparity in resection rates varied during the years of the study (P=0.62) (data not shown).

The disparity also persisted in two multivariable logistic-regression analyses in which we controlled for age, sex, stage of disease, median income in the ZIP Code of residence, and coexisting illness, as measured by either the Romano–Charlson index or the number of hospitalizations in the previous year. On the basis of these analyses, the odds ratios for undergoing surgery among black patients, as compared with white patients, were 0.54 when the Romano–Charlson index was used as a measure of coexisting illness and 0.53 when the number of hospitalizations was used — findings that were consistent with the unadjusted odds ratio of 0.52. The results of all the analyses support the hypothesis that race is an important independent factor in determining the likelihood that a patient with early-stage, non–small-cell lung cancer will receive surgical treatment.

The observed similarities in survival among black patients and white patients after either receiving or not receiving surgical treatment were also evaluated in analyses adjusted for factors previously identified as affecting survival. These analyses showed a slightly increased risk of death among black patients after surgery (relative risk, 1.10; P=0.18) and a slightly decreased risk of death for black patients who did not undergo surgery (relative risk, 0.84; P=0.02) (Table 3). The analyses also confirmed that in this cohort, residence in an area with a lower median income, male sex, older age, a higher stage of disease, and more coexisting illness all conferred an increased risk of death, regardless of treatment.

DISCUSSION

The optimal treatment for early-stage, non–small-cell lung cancer is surgical resection — a treatment with a substantial cure rate.[9,18,19] In this study, we determined whether the rate of surgical treatment for stage I or stage II non–small-cell lung cancer was lower for black patients 65 years of age or older than it was for white patients in the same age group. Then we compared the survival rates between black patients and white patients who had undergone surgery and between black patients and white patients who had not undergone surgery. Using several analytic techniques to control for the confounding effects of disease stage, type of insurance coverage, avail-

TABLE 2. RATE OF RESECTION AND RELATIVE RISK ACCORDING TO RACE.

VARIABLE	NO. OF PATIENTS	RESECTION RATE (%)		RELATIVE RISK (95% CI)*	P VALUE
		BLACK PATIENTS	WHITE PATIENTS		
Total	10,984	64.0	76.7	0.83 (0.79–0.88)	<0.001
Age (yr)					
65–69	3,878	73.7	85.4	0.86 (0.81–0.92)	<0.001
70–74	3,541	64.3	80.2	0.80 (0.73–0.88)	<0.001
≥75	3,565	45.6	64.2	0.71 (0.61–0.83)	<0.001
Sex					
Male	6,847	64.8	76.7	0.85 (0.80–0.90)	<0.001
Female	4,137	62.1	76.6	0.81 (0.74–0.89)	<0.001
Stage of disease					
I	8,685	64.1	77.0	0.83 (0.79–0.88)	<0.001
II	2,299	63.5	75.5	0.84 (0.75–0.94)	<0.001
Median income in ZIP Code of residence					
Lowest quartile	2,358	61.9	70.7	0.88 (0.81–0.95)	<0.001
Highest three quartiles	7,203	67.5	78.0	0.87 (0.80–0.94)	<0.001
Not determined	1,423	63.3	78.2	0.81 (0.71–0.93)	<0.001
SEER area†					
Atlanta	852	55.7	70.4	0.79 (0.67–0.93)	<0.001
Connecticut	1,731	69.6	79.5	0.88 (0.75–1.02)	0.05
Detroit	2,167	59.2	73.1	0.81 (0.74–0.89)	<0.001
Los Angeles County	674	65.9	79.3	0.83 (0.71–0.97)	0.006
San Francisco–Oakland–San Jose	1,760	74.6	79.9	0.93 (0.85–1.02)	0.10
Type of Medicare insurance‡					
Health maintenance organization	1,036	70.7	76.3	0.93 (0.80–1.08)	0.27
Indemnity	9,892	63.5	76.7	0.83 (0.78–0.87)	<0.001
Comorbidity§					
No. of hospitalizations in previous year					
0	6,975	64.0	77.6	0.83 (0.77–0.88)	<0.001
1	1,579	59.4	72.3	0.82 (0.71–0.95)	0.002
2	409	56.1	70.7	0.79 (0.60–1.05)	0.06
>2	228	50.0	56.2	0.89 (0.55–1.43)	0.61
Highest Romano–Charlson index in previous year¶					
0	764	59.7	81.6	0.73 (0.60–0.89)	<0.001
1	873	58.3	67.3	0.87 (0.71–1.06)	<0.12
>1	579	54.7	60.1	0.91 (0.71–1.18)	0.45

*Relative risks are of undergoing surgical resection for black patients as compared with white patients. CI denotes confidence interval.

†SEER denotes the Surveillance, Epidemiology, and End Results program. Only data from the areas that contributed more than 5 percent of the black cohort are listed.

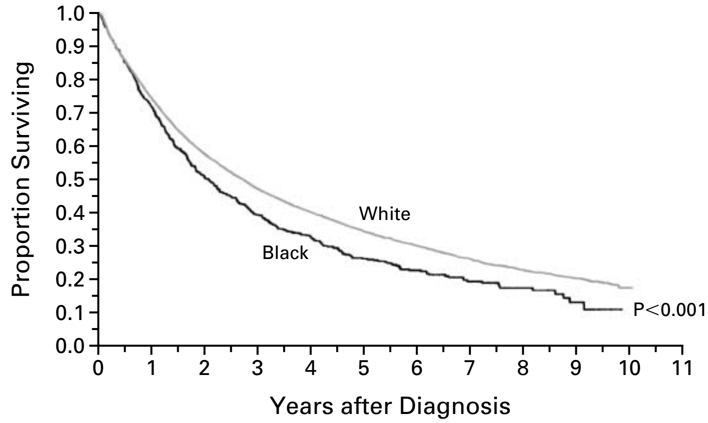
‡Data were missing for 5 black patients and 51 white patients.

§This category includes only the patients who were 66 years of age or older and who had indemnity insurance coverage at the time of diagnosis.

¶The Romano–Charlson index was calculated only for the patients who were hospitalized in the 12-month period before the diagnosis.

ability of care, socioeconomic status, age, and coexisting illnesses, we found that black patients were less likely than white patients to undergo surgical resection (a difference of 12.7 percentage points). Both unadjusted and adjusted analyses showed that black patients who underwent surgical resection had a five-year survival rate similar to that of white patients who underwent resection, and we estimated that of the 77 more deaths per 1000 black patients, the majority (44) could be attributed to the lack of surgical treatment.

If black patients were to undergo surgery at a rate equal to that of white patients, their survival rate would probably be substantially improved and would approach that of white patients. Given equal rates of resection, we estimate that there would be a 3.3 percent discrepancy in survival at five years (341 survivors among 1000 white patients vs. 308 among 1000 black patients). The survival curves shown in Figure 2 for black patients and white patients after surgery suggest a similar conclusion: given equal treatment, black patients will have a survival rate that is only marginally lower than that for white patients. The small disparity in survival between black patients and white patients with equal resection rates is not surprising, even if surgery confers an equal benefit in each group.



No. of Patients at Risk

White patients	10,124	4953	2365	1099	413	12
Black patients	860	361	159	71	31	0

Figure 2. Survival of Medicare Beneficiaries 65 Years of Age or Older Who Were Given a Diagnosis of Stage I or II Non–Small-Cell Lung Cancer between 1985 and 1993, According to Race.

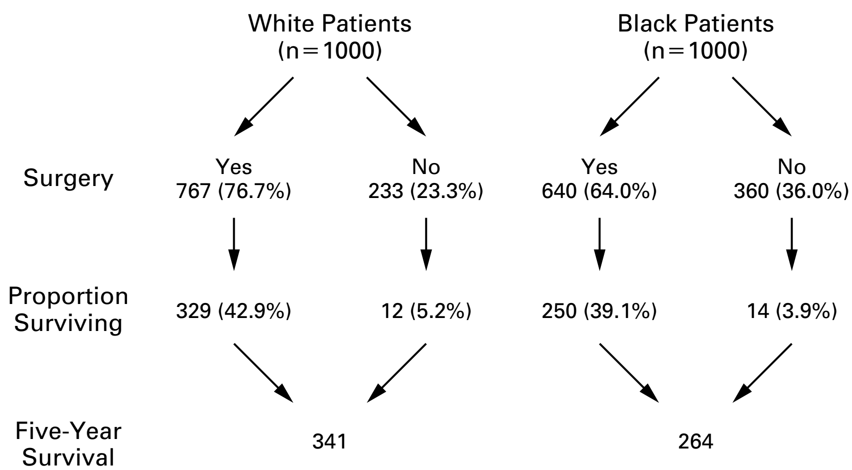


Figure 3. Relation between the Rate of Surgical Resection for Stage I or II Non–Small-Cell Lung Cancer and Five-Year Survival in Hypothetical Cohorts of 1000 Black and 1000 White Medicare Beneficiaries 65 Years of Age or Older.

If 76.7 percent of the black patients had undergone surgery, 308 of them would be expected to be alive five years after diagnosis.

The actuarial data (deaths due to all causes) in the same population show a larger gap: on average, a 73-year-old black person has a 76 percent likelihood of survival for five years, as compared with 81 percent for a 73-year-old white person.[20]

These results should be viewed with caution. We focused on Medicare beneficiaries who were 65 years of age or older, and it is not clear whether there is similar variability in the care provided to younger patients with lung cancer. In addition, in all the patients in our study, the diagnosis of non–small-cell lung cancer and the stage of disease had been established, which meant that all the patients had had extensive involvement with the health care system. Our study did not address the care received by patients who present with advanced disease or those in whom the stage of disease has not been determined. Two other factors that we did not investigate also increase mortality due to non–small-cell lung cancer in black persons. The annual incidence of non–small-cell lung cancer in this population of people who are 65 years of age or older is higher among black persons (359

TABLE 3. EFFECT OF RACE AND OTHER FACTORS ON SURVIVAL AMONG PATIENTS WHO UNDERWENT SURGERY AND THOSE WHO DID NOT.

FACTOR	RELATIVE RISK OF DEATH			
	PATIENTS UNDERGOING SURGERY	P VALUE	PATIENTS NOT UNDERGOING SURGERY	P VALUE
Race				
White*	1.00		1.00	
Black	1.10	0.18	0.84	0.02
Income				
Highest three quartiles*	1.00		1.00	
Lowest quartile	1.10	<0.05	1.15	0.007
Sex				
Female*	1.00		1.00	
Male	1.44	<0.001	1.21	<0.001
Age				
65–69 yr*	1.00		1.00	
70–74 yr	1.17	<0.001	1.10	0.17
≥75 yr	1.46	<0.001	1.20	0.004
Stage of disease				
I*	1.00		1.00	
II	1.98	<0.001	1.35	<0.001
Romano–Charlson comorbidity index				
Not available*	1.00		1.00	
0	1.01	0.84	1.25	0.02
1	1.23	<0.001	1.22	0.006
>1	1.49	<0.001	1.42	<0.001

*This was the reference category.

per 100,000 population) than among white persons (294 per 100,000).[21,22] Also, among persons 65 years of age or older in whom the stage of disease is determined at the time of diagnosis, the SEER data show that black patients are less likely than white patients to have resectable (i.e., stage I or II) disease (27 percent vs. 31 percent) (unpublished data).

In this study, we were also limited in our ability to make adjustments for two factors that might have influenced the interpretation of our results. We used an aggregate measure of income as a surrogate for the socioeconomic status of each patient. Some investigators have argued that our aggregate measure is an adequate surrogate marker for socioeconomic status,[23] but others have argued that the optimal socioeconomic variable is at the level of the patient, not at the level of the community.[24] Therefore, we cannot be sure that we have separated the effects of race from those of socioeconomic status.

In addition, we could not ascertain the Romano–Charlson comorbidity index for the 76 percent of our patients who were not hospitalized in the year before the diagnosis. However, it seems unlikely that this lack has led us to make incorrect conclusions, for three reasons. First, in the 24 percent of patients in whom we could evaluate coexisting illness in terms of the Romano–Charlson comorbidity index, the disparity in treatment was consistent. Second, most clinicians would agree that, barring the presence of severe pulmonary disease, a patient who had not required hospitalization for a year could probably tolerate a thoracotomy and partial lung resection.[25] Third, we can predict that the bias we may have introduced by using this measure of coexisting illness would, if anything, have led us to underestimate the disparity in treatment between black and white patients. Specifically, for chronic diseases that are responsive to outpatient management, such as chronic obstructive pulmonary disease, blacks are more likely than whites to be hospitalized for the same degree of illness, thus increasing our estimate of the burden of coexisting illness among blacks.[25,26]

Variations in the care of patients with similar diseases have been observed since Wennberg and Gittelsohn first called attention to the phenomenon in 1973.[27] Unlike the treatments under scrutiny in many other studies, the optimal strategy for the treatment of early-stage, non–small-cell lung cancer is unambiguous: surgical resection confers a meaningful probability of cure, whereas other therapies do not. We cannot determine from our data why black patients have a lower rate of resection than their white counterparts, but we can conclude that the difference in treatment has a substantial effect on survival. Others have argued that the preferences of black patients may differ from those of white patients or that black patients may weigh the risks of surgical therapy differently.[28,29] An alternative explanation is that black patients are offered optimal treatment less frequently than their white counterparts.[30] These are certainly issues worthy of investigation in future studies.

We are indebted to the Applied Research Branch, Division of Cancer Prevention and Population Science, National Cancer Institute; to the Office of Information Services and the Office of Strategic Planning, Health Care Financing Administration; to Information Management Services; and to the SEER program. The interpretation and reporting of the data from the linked SEER–Medicare data base are the sole responsibility of the authors.

REFERENCES

1. Lin AY, Ihde DC. Recent developments in the treatment of lung cancer. JAMA 1992;267:1661-4.
2. Greenwald HP, Polissar NL, Borgatta EF, McCorkle R, Goodman G. Social factors, treatment, and survival in early-stage non-small cell lung cancer. Am J Public Health 1998;88:1681-4.
3. Smith TJ, Penberthy L, Desch CE, et al. Differences in initial treatment patterns and outcomes of lung cancer in the elderly. Lung Cancer 1995;13:235-52.
4. Samet JM, Hunt WC, Key CR, Humble CG, Goodwin JS. Choice of cancer therapy varies with age of patient. JAMA 1986;255:3385-90.
5. Riley GF, Potosky AL, Klabunde CN, Warren JL, Ballard-Barbash R. Stage at diagnosis and treatment patterns among older women with breast cancer: an HMO and fee-for-service comparison. JAMA 1999;281:720-6.
6. Begg CB, Cramer LD, Hoskins WJ, Brennan MF. Impact of hospital volume on operative mortality for major cancer surgery. JAMA 1998;280:1747-51.
7. Potosky AL, Riley GF, Lubitz JD, Mentnech RM, Kessler LG. Potential for cancer related health services research using a linked Medicare-tumor registry database. Med Care 1993;31:732-48.
8. Percy C, Van Holten V, Muir C, eds. International classification of

diseases for oncology. 2nd ed. Geneva: World Health Organization, 1990.
9. Ettinger DS, Cox JD, Ginsberg RJ, et al. NCCN Non-Small Cell Lung Cancer Practice Guidelines. Oncology 1996;10:Suppl:S81-S111.
10. Mountain CF. A new international staging system for lung cancer. Chest 1986;89:Suppl:225S-233S.
11. *Idem*. Revisions in the International System for Staging Lung Cancer. Chest 1997;111:1710-7.
12. Romano PS, Roos LL, Jollis JG. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J Clin Epidemiol 1993;46:1075-9.
13. Charlson ME, Pompei P, Ales KL, MacKenzie CR. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J Chronic Dis 1987;40:373-83.
14. Hammond JR. Substate district, HSA, and PSRO area designations. Am J Public Health 1976;66:788-90.
15. Ballard-Barbash R, Potosky AL, Harlan LC, Nayfield SG, Kessler LG. Factors associated with surgical and radiation therapy for early stage breast cancer in older women. J Natl Cancer Inst 1996;88:716-26.
16. Schlesselman JJ, Stolley PD. Case-control studies: design, conduct, analysis. New York: Oxford University Press, 1982.
17. Collett D. Modelling survival data in medical research. London: Chapman & Hall, 1994.
18. Shields TW. Surgical therapy for carcinoma of the lung. Clin Chest Med 1993;14:121-47.
19. Lam WK. Management of non-small cell lung cancer according to staging — an update. Respirology 1998;3:51-4.
20. National Center for Health Statistics. U.S. decennial life tables for 1989-1991. Vol. 1. No. 1. Washington, D.C.: Government Printing Office, 1997.
21. Ries LAG, Kosary CL, Hankey BF, Miller BA, Harras A, Edwards BK, eds. SEER cancer statistics review: 1973-1994. Bethesda, Md.: National Cancer Institute, 1997. (NIH publication no. 97-2789.)
22. Wingo PA, Ries LAG, Giovino GA, et al. Annual report to the nation on the status of cancer, 1973-1996, with a special section on lung cancer and tobacco smoking. J Natl Cancer Inst 1999;91:675-90.
23. Krieger N. Overcoming the absence of socioeconomic data in medical records: validation and application of census-based methodology. Am J Public Health 1992;82:703-10.
24. Dale W, Vijayakumar S, Lawlor EF, Merrell K. Prostate cancer, race, and socioeconomic status: inadequate adjustment for social factors in assessing racial differences. Prostate 1996;29:271-81.
25. Gillum RF. Chronic obstructive pulmonary disease in blacks and whites: mortality and morbidity. J Natl Med Assoc 1990;82:417-28.
26. Culler SD, Parchman ML, Przybylski M. Factors related to potentially preventable hospitalizations among the elderly. Med Care 1998;36:804-17.
27. Wennberg J, Gittelsohn A. Small area variations in health care delivery. Science 1973;182:1102-8.
28. McNeil BJ, Weichselbaum R, Pauker SG. Fallacy of the five-year survival in lung cancer. N Engl J Med 1978;299:1397-401.
29. Aday LA. Economic and noneconomic barriers to the use of needed medical services. Med Care 1975;13:447-56.
30. Schulman KA, Berlin JA, Harless W, et al. The effect of race and sex on physicians' recommendations for cardiac catheterization. N Engl J Med 1999;340:618-26.