Social Factors, Treatment, and Survival in Early-Stage Non–Small Cell Lung Cancer

Howard P. Greenwald, PhD, Nayak L. Polissar, PhD, Edgar F. Borgatta, PhD, Ruth McCorkle, PhD, and Gary Goodman, MD

ABSTRACT

Objectives. This study assessed the importance of socioeconomic status, race, and likelihood of receiving surgery in explaining mortality among patients with stage-I non–small cell lung cancer.

Methods. Analyses focused on Black and White individuals 75 years of age and younger (n = 5189) diagnosed between 1980 and 1982 with stage-I non–small cell lung cancer in Detroit, San Francisco, and Seattle. The main outcome measure was months of survival after diagnosis.

Results. Patients in the highest income decile were 45% more likely to receive surgical treatment and 102% more likely to attain 5-year survival than those in the lowest decile. Whites were 20% more likely to undergo surgery than Blacks and 31% more likely to survive 5 years. Multivariate procedures controlling for age and sex confirmed these observations.

Conclusions. Socioeconomic status and race appear to independently influence likelihood of survival. Failure to receive surgery explains much excess mortality. (*Am J Public Health.* 1998;88:1681–1684)

Lung cancer today causes more deaths in the United States than any other malignancy. As in many diseases, socially disadvantaged people who develop lung cancer face greater mortality risks than the advantaged. This article examines relationships of selected social factors to treatment and survival in early-stage non–small cell lung cancer. Patterns of treatment and survival within this relatively homogeneous subgroup of lung cancer patients raise issues pertinent to the current debate over health care delivery in the United States.

Reports have appeared in clinical, public health, and epidemiological literature since the 1950s linking social factors with cancer survival. These studies have focused on 2 key social distinctions in the modern United States: race and socioeconomic status (SES). Whites enjoy a survival advantage over Blacks in nearly all cancer sites, regardless of the stage at which disease is detected.[1] Relative 5-year survival rates for all cancers diagnosed between 1983 and 1990 were 56% for White Americans and 40% for Black Americans.[2] An extensive series of studies has reported linkages between SES (defined as education, income, or a composite of both) and cancer survival.[3–7]

Research has thus far left 2 key questions unanswered. First, published studies have not determined whether SES accounts for observed relationships between race and mortality risk. An American Cancer Society panel has stated that ethnic differences (mostly Black vs White) are probably secondary to socioeconomic factors,[8] and studies of a variety of malignancies support this conclusion.[9–11] Still, extremely high relative mortality rates among Blacks in diseases such as cancer of the bladder and uterine corpus have led some to suspect an independent role for race in at least some malignancies.[12]

A second major uncertainty concerns mechanisms by which social factors affect survival differences. Studies have demonstrated that Blacks receive less intense treatment than Whites for several highly prevalent cancers[13–15] and that lung cancer patients without private health insurance (a correlate of low income) receive surgical treatment less often than those with private health insurance.[16] These studies, however, have not demonstrated that disadvantaged cancer patients experience poorer survival because they receive less appropriate care.

The research reported here addressed these concerns by focusing on a highly specific category of malignancy for which there exists a single treatment option for curative purposes. For at least the past 2 decades, surgery has constituted the predominant curative procedure for early-stage non–small cell lung cancer. Summarizing recent developments in lung cancer treatment, a National Cancer Institute report commented that surgery results in 5-year survival (which generally indicates cure of the original neoplasm) in 40% of patients with this disease and that virtually all such patients who live 5 years have undergone surgical resection.[17] Neither postoperative radiation nor adjuvant chemotherapy has been shown to increase

At the time of the study, Howard P. Greenwald was with the School of Public Administration, University of Southern California, Sacramento. Nayak L. Polissar is with Mountain-Whisper-Light Statistical Consulting, Seattle, Wash. Edgar F. Borgatta is with the Department of Sociology, University of Washington, Seattle. Ruth McCorkle was with the School of Nursing, University of Pennsylvania, Philadelphia. Gary Goodman is with the Swedish Hospital Tumor Institute, Seattle.

Requests for reprints should be sent to Howard P. Greenwald, PhD, School of Policy, Planning, and Development, University of Southern California, Sacramento Center, 1201 J St, Sacramento, CA 95814-2919 (e-mail: greenwa@usc.edu).

This article was accepted April 9, 1998.

survival among non–small cell lung cancer patients without nodal involvement.[18–20]

Within these restricted clinical parameters, the study reported here used observations more broadly representative and larger in number than most earlier investigations. Large numbers were required because nearly all studies of social factors in cancer survival, including the present investigation, estimate patients' SES based on their area of residence (e.g., census tract or zip code). The degree of error resulting from this procedure may cause researchers to miss substantively important relationships between SES and survival unless the numbers of observations are, as in the present study, large enough to compensate by adequately increasing statistical power.[21]

Methods

Variables

The present study focused on 2 outcome variables (surgical treatment and survival time) and 4 independent variables (age, sex, income, and race). Survival time was computed from date of diagnosis to date of death or last follow-up. Age was coded as age at time of diagnosis. For reasons explained later, race was coded Black or White. Income was used as the indicator of SES in this research and was coded as median family income in the subject's census tract. In the analysis summarized here, this variable was coded in deciles of the median family income distribution within the study sample.

Data

We used data collected by the National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program, identifying pertinent cases from the SEER public use tape released in 1992. Operated since 1973, the SEER system draws data from 9 regional registries. It is the most comprehensive database on cancer in the United States. Several detailed descriptions of SEER's operation and summary reports on its findings have been published.[22–25]

We selected cases diagnosed between 1978 and 1982 from 3 SEER sites (Detroit, San Francisco, and Seattle–Puget Sound). For each patient, SEER records included age, race, cancer site, stage, histology, date of diagnosis, initial treatment, vital status, date of death (if applicable), and census tract number. Only patients who were found to have a non–small cell histology, were classified as stage I by SEER, were 75 years of age or younger at the time of diagnosis, and were classified as either Black or White were selected for analysis. Data on SES in the form of median family income for each patient's census tract were added to his or her record based on information from the 1980 United States Census. Data in the 1992 SEER public use file allowed us to follow all patients for at least 10 years.

Cases were restricted to those accrued in Detroit, San Francisco, and Seattle because these sites had the most complete data of all SEER locations on the variables of interest here. Cases diagnosed between 1978 and 1982 were selected because these years clustered around the 1980 census (from which individual SES data were inferred). Individuals more than 75 years of age were omitted because of the likelihood that a significant percentage of these patients would be considered poor candidates for surgery. Persons of racial descriptions other than Black or White were omitted because of the great variation encompassed by other racial groups and nonuniform relationships to cancer survival. Individuals residing in areas not assigned to tracts by the 1980 census (about 3.3%) or whose records did not contain census tract information (about 2.3%) were omitted from the analysis. A total of 5189 case patients from the 3 SEER sites met selection criteria (2510 from Detroit, 1772 from San Francisco, and 907 from Seattle). Among these patients, data were missing in 32 records for surgical treatment and in 57 records for vital status.

Statistical Analysis

Receipt of surgical treatment was modeled via logistic multiple regression, as appropriate for dichotomous dependent variables. Relative mortality risk was assessed via the Cox proportional hazards model. When exponentiated, coefficients in the logistic regression and Cox proportional hazards models measure odds ratios or relative risks. Coefficients were estimated only for patients with complete data on all pertinent variables.

Results

Tables 1 and 2 present directly observable relationships between income and race, the independent variables in this study, and both surgery and 5-year survival. Table 1 indicates strong relationships between median family income in the patient's census tract (deciles) and both surgical treatment and survival. Patients in the highest income decile were 45% more likely to receive surgical treatment and 102% more likely to attain 5-year survival than those in the lowest income decile. Table 2 indicates weaker (but statistically significant) relationships between race and both surgery and survival. Whites were 20% more likely to receive surgery than Blacks and 31% more likely to survive 5 years. It is noteworthy that, within the sample as a whole, 50.6% of those undergoing surgery and 5.2% of those not undergoing surgery survived 5 years.

Table 3 summarizes a logistic regression analysis of race and income as predictors of surgical treatment. The model including race, age, and sex as predictors (Table 3, top) indicates a strong statistical relationship between race and surgical treatment, Blacks appearing less likely than Whites to receive such treatment. In a similar model with the addition of median family income (deciles) as a predictor (Table 3, bottom), median family income was a statistically significant predictor of surgery. Race remained statistically significant, but the magnitude of the coefficient was approximately half that observed in the previous model.

Table 4 summarizes Cox proportional hazards models involving the same predictor variables shown in Table 3. The race variable (Table 4, top) was associated with greater mortality risk. Blacks had a risk ratio (RR) of 1.278 relative to Whites, equivalent to a nearly 30% greater chance of dying in any given month following diagnosis. A model including median family income (Table 4, bottom) indicates a statistically significant relationship of income with mortality risk, each decile increase being associated with a 4% drop. Race remained statistically significant, although it was again weaker than in the model omitting income.

As a means of exploring the role of treatment as a mediating variable between race, income, and survival, Table 5 presents equations similar to those shown in Table 4 with the addition of a dichotomous variable representing receipt of surgical treatment. In the model with only race, age, sex, and treatment as predictor variables (Table 5, top), race was no longer a statistically significant predictor of survival (RR = 1.06, 95% confidence interval [CI] = 0.98, 1.15). In the second model (Table 5, bottom), the coefficient for median family income was about half as large as the coefficient in an equation omitting surgery (see Table 4, bottom). The coefficient for income remained statistically significant, however, the likelihood of dying in any month following diagnosis falling about 2% with each decile increase.

The relationships of income to surgical treatment and survival were consistent across both racial categories and SEER sites. Com-

TABLE 1—Median Family Income, Surgical Treatment, and 5-Year Survival Among Study Patients

Median Household Income (decile)	Surgical Treatment,[a] % (n = 5157)	5-Year Survival,[b] % (n = 5132)
1	49.6	22.4
2	47.4	25.0
3	56.5	32.3
4	56.1	30.9
5	63.3	33.3
6	58.8	34.1
7	58.9	30.4
8	67.7	37.4
9	61.4	32.2
10	71.9	45.3
Total	59.2	32.3

[a]Chi-square value on table of median family income deciles by surgery: 110.881 (*df* = 9, *P* < .0001).
[b]Chi-square value on table of median family income deciles by 5-year survival: 86.990 (*df* = 9, *P* < .0001).

TABLE 2—Race, Surgical Treatment, and 5-Year Survival Among Study Patients

Race	Surgical Treatment,[a] % (n = 5157)	5-Year Survival,[b] % (n = 5132)
Black	50.6	25.7
White	60.9	33.6
Total	59.2	32.3

[a]Chi-square value on table of race by surgery: 30.968 (*df* = 1, *P* < .0001).
[b]Chi-square value on table of race by 5-year survival: 20.581 (*df* = 1, *P* < .0001).

TABLE 3—Race, Socioeconomic Status, and Surgical Treatment Among Study Patients: Logistic Regression Analysis

	Coefficient	SE	Odds Ratio	*P*
Model including race				
Race (White = 0, Black = 1)	–0.506	0.079	0.603	<.0001
Age	–0.063	0.004	0.939	<.0001
Sex (male = 0, female = 1)	0.492	0.064	1.636	<.0001
Intercept	4.283	0.252	71.429	<.0001
Model including race and income				
Median income	0.073	0.011	1.076	<.0001
Race (White = 0, Black = 1)	–0.260	0.088	0.771	<.01
Age	–0.062	0.004	0.085	<.0001
Sex (male = 0, female = 1)	0.502	0.064	1.652	<.0001
Intercept	3.742	0.265	41.667	<.0001

Note. Equations are based on 5157 observations owing to deletion of patients (n = 32) with missing data on surgical treatment.

puted on the basis of an equation predicting surgical treatment with income–race interaction terms (products of the dichotomous race variable and 3 categories of median family income), odds ratios among Whites for medium vs low and high vs low income were 1.14 (95% CI = 0.96, 1.34) and 1.53 (95% CI = 1.31, 1.80), respectively. Among Blacks, the corresponding odds ratios were 1.81 (95% CI = 1.23, 2.66) and 1.86 (95% CI = 0.92, 3.72). Separate equations estimated on the basis of observations in individual SEER locations indicated that income was a statistically significant predictor of both surgery and survival.

Race proved a less consistent predictor of treatment and survival across SEER sites. Coefficients for race in equations predicting surgical treatment and including income among the independent variables were statistically significant only for patients from San Francisco. The Black–White odds ratio for undergoing surgery in San Francisco was 0.65 (95% CI = 0.47, 0.90). In Detroit and Seattle, the odds ratios were 1.08 (95% CI = 0.85, 1.36) and 1.48 (95% CI = 0.66, 3.36), respectively. In equations predicting mortality risk on the basis of both race and income, the coefficient for race approached statistical significance only for the San Francisco site (RR = 1.13, 95% CI = 0.96, 1.34). The Black–White risk ratios in Detroit and Seattle were 0.99 (95% CI = 0.87, 1.12) and 0.77 (95% CI = 0.51, 1.17), respectively. Still, addition of variables representing individual SEER sites to the equations presented in Tables 3 through 5 produced coefficients for race highly similar to those shown. This observation indicates that tendencies of Blacks to undergo surgery less often and to experience higher mortality rates than Whites, and for Black–White survival differences to be explained by receipt of surgery, were general within the sample as a whole.

Discussion

The key findings of this study include statistically significant relationships between indicators of social disadvantage and both treatment and mortality risk. Relatively low income predicts a diminished tendency to receive surgical treatment and a poorer likelihood of survival. Lack of surgical treatment apparently explains a large part of the increased mortality risk experienced by individuals in lower income census tracts. Our results indicate that Black patients experience greater mortality risk than Whites even after adjustment for income differences. In at least one location, Blacks undergo surgery less often than Whites, a relationship not explained by Black–White income differentials. Across the sample as a whole, lack of surgical treatment statistically explained a tendency for Blacks to experience lower survival rates than Whites.

These findings are consistent with the disturbing possibility that low SES and Black patients die needlessly because they do not receive a widely available treatment of significant potential benefit. Alternative explanations are plausible. Biological host factors linked to income or race may affect the aggressiveness of non–small cell lung cancer. Poor general health and adverse health behavior (such as smoking), which often coincide with low income and membership in minority groups,[26] may lead to lower rates of surgery as providers judge disadvantaged patients to be relatively poor surgical risks.

Biological host factors appear unlikely to explain the findings reported here, especially relationships of income to treatment and survival.

TABLE 4—Race, Socioeconomic Status, and Relative Mortality Risk Among Study Patients

	Coefficient	SE	Risk Ratio	*P*
Model including race only				
Race	0.245	0.042	1.278	<.0001
Age	0.036	0.002	1.037	<.0001
Sex	–0.350	0.034	0.709	<.0001
Model including race and income				
Median income	–0.040	0.006	0.961	<.0001
Race	0.109	0.046	1.115	<.02
Age	0.035	0.002	1.036	<.0001
Sex	–0.350	0.034	0.705	<.0001

Note. Equations are based on 5132 observations owing to deletion of patients (n = 57) with missing data on vital status.

TABLE 5—Race, Socioeconomic Status, Treatment, and Relative Mortality Risk Among Study Patients

	Coefficient	SE	Risk Ratio	*P*
Model including race only				
Race	0.060	0.042	1.062	.1509
Age	0.022	0.002	1.022	<.0001
Sex	–0.241	0.035	0.786	<.0001
Surgery	–1.388	0.035	0.250	<.0001
Model including race and income				
Median income	–0.022	0.006	0.978	<.0003
Race	–0.016	0.047	0.984	.7311
Age	0.021	0.002	1.021	<.0001
Sex	–0.244	0.035	0.783	<.0001
Surgery	–1.378	0.035	0.252	<.0001

Note. Equations are based on 5100 observations owing to deletion of patients with missing data on surgical treatment (n = 32) or vital status (n = 57).

Social mobility in the United States has been too pervasive and rapid over recent generations to support the belief that low income earners constitute a biologically stable pool.

The differences reported here in effects of race across geographic regions are more consistent with a social than a biological explanation. It appears unlikely that Black Americans differ biologically from city to city. Factors such as migration history and industrial base, however, do differ geographically. The history and culture of individual Black communities may predispose their residents to differential lifestyle risks or discourage them from using health services. Access to and quality of health care institutions serving the disadvantaged also vary among metropolitan areas.[27]

Observations reported here underscore the importance of closely monitoring changes taking place today in delivery of health services for the disadvantaged. Evidence that disadvantaged patients with early non–small cell lung cancer receive less aggressive care than the advantaged and experience less favorable outcomes suggests that similar relationships may occur in other treatable diseases. Researchers must definitively determine the degree to which lack of access explains differences such as those observed here. Furthermore, the apparently independent impact of race on receipt of surgery noted here raises concern that parts of the health care system may treat members of some minority groups differently from nonminorities. This possibility requires continuing discussion and analysis. □

Acknowledgments

We are grateful to the American Cancer Society for helping to support this research (grant PDT-393).

References

1. Boring CC, Squires TS, Tong T. Cancer statistics, 1992. *CA Cancer J Clin.* 1992;42:19–36.
2. *Cancer Facts and Figures—1995.* Atlanta, Ga: American Cancer Society; 1995.
3. Linden G. The influence of social class in the survival of cancer patients. *Am J Public Health.* 1969;59:267–274.
4. Lipworth L, Abelin T, Connelly RR. Socioeconomic factors in the prognosis of cancer patients. *J Chronic Dis.* 1970;23:105–115.
5. Berg JW, Ross R, Latourette HB. Economic status and survival of cancer patients. *Cancer.* 1977;39:467–477.
6. Chirikos TN, Reiches NA, Moeschberger ML. Economic differentials in cancer survival. *J Chronic Dis.* 1984;37:183–193.
7. Chirikos TN, Horner RD. Economic status and survivorship in digestive system cancers. *Cancer.* 1985;56:210–217.
8. *Special Report on Cancer in the Economically Disadvantaged.* New York, NY: American Cancer Society; 1986.
9. Page WF, Kuntz AJ. Racial and socioeconomic factors in cancer survival. *Cancer.* 1980;45:1029–1040.
10. Wegner EL, Kolonel LN, Nomura AMY, Lee J. Racial and socioeconomic status differences in survival of colorectal cancer patients in Hawaii. *Cancer.* 1982;9:2208–2216.
11. Dayal HH, Polissar L, Dahlberg S. Race, socioeconomic status, and other prognostic factors for survival from prostate cancer. *J Natl Cancer Inst.* 1985;74:1001–1006.
12. Freeman HP. Cancer in the economically disadvantaged. *Cancer.* 1989;64(suppl):324–334.
13. Diehr P, Yergan J, Chu J, et al. Treatment modality and quality differences for black and white breast cancer patients treated in community hospitals. *Med Care.* 1989;27:942–958.
14. Polednak AP, Flannery JT. Black versus white racial differences in clinical stage at diagnosis and treatment of prostatic cancer in Connecticut. *Cancer.* 1992;70:2152–2158.
15. McWhorter WP, Mayer WJ. Black/white differences in type of initial breast cancer treatment and implications for survival. *Am J Public Health.* 1987;77:1515–1517.
16. Greenberg ER, Chute CG, Stukel T, et al. Social and economic factors in the choice of lung cancer treatment. *N Engl J Med.* 1988;318:612–617.
17. Lin AY, Ihde DC. Recent developments in the treatment of lung cancer. *JAMA.* 1992;267:1661–1664.
18. Sarna GP, Holmes EC, Petrovich Z, Figlin RA. Lung cancer. In: Haskell CM, ed. *Cancer Treatment.* Philadelphia, Pa: WB Saunders Co; 1985:180–211.
19. Hansen HH, Rorth M. Lung cancer. In: Pinedo HM, Chabner BA, eds. *Cancer Chemotherapy.* Vol 8. New York, NY: Elsevier, 1986:348–369.
20. Green N, Kurohara SS, George FW, et al. Postresection irradiation for primary lung cancer. *Radiology.* 1975;116:405–407.
21. Greenwald HP, Polissar NL, Borgatta EF, McCorkle R: Detecting survival effects of socioeconomic status: problems in the use of aggregate measures. *J Clin Epidemiol.* 1994;47:903–909.
22. Young JL Jr, Percy CL, Asire AJ. Cancer incidence and mortality in the United States, 1973–1977. *J Natl Cancer Inst Monogr.* 1981;57:1–187.
23. Horm JW, Asire AJ, Young JL Jr. *SEER Program: Cancer Incidence and Mortality in the United States, 1973–1981.* Bethesda, Md: National Cancer Institute; 1984. DHHS publication NIH 85-1837.
24. Ries LG, Pollack ES, Young JL Jr. Cancer patient survival: Surveillance, Epidemiology, and End Results program, 1973–79. *J Natl Cancer Inst.* 1983;70:693–707.
25. Shambaugh E. Stat bite: accuracy of SEER data. *J Natl Cancer Inst.* 1991;83:1369.
26. House JS, Kessler RC, Herzog AR. Age, socioeconomic status, and health. *Milbank Q.* 1990;68:383–411.
27. Ginzberg E. Improving health care for the poor: lessons from the 1980s. *JAMA.* 1994;271:464–467.