ORIGINAL CONTRIBUTION

Disparities in Surgical Treatment of Early-Stage Non-Small-Cell Lung Cancer

Anthony P. Polednak

Connecticut Department of Public Health, Hartford Connecticut

This study involved 1,564 black or white patients diagnosed in 1992 to 1997 with non-small-cell lung cancer, reported to the population-based Connecticut Tumor Registry, who were linked with a statewide hospital discharge database that provided information on comorbid conditions. While only 11.4 percent of patients did not receive surgical treatment (lung resection), this proportion increased with rising age and was higher among patients who resided in a census tract in the highest poverty-rate quintile, were black, not married and had one or more selected comorbid conditions. These associations persisted in logistic regression models that included all of the variables as predictors of surgery. Studies are needed to explain these disparities.

Non-small-cell lung cancer (NSCLC)\(^a\) comprises 75 to 80 percent of all lung cancers, and about 30 percent of patients are candidates for curative surgical resection [1, 2]. Using data from three population-based registries in the National Cancer Institute's Surveillance, Epidemiology and End Results (SEER) Program, surgical treatment among black or white early-stage NSCLC patients diagnosed in 1978 to 1982 (age less than 75 years) was positively associated with median family income of census tract of residence [3]. In another SEER study, surgery rates among elderly patients were lower in the lowest quartile (vs. the highest three quartiles) of median income of ZIP code of residence, and for black than white patients (independent of various characteristics) [4]. In the latter study, comorbidity was examined only for the small subsample with a hospitalization in the previous year [4], raising concerns about the degree of control for confounding due to comorbidity [5]. However, versions of the Charlson comorbidity index [6] adapted for use with administrative databases include most conditions coded for the index hospital discharge as well as a prior discharge [7, 8].

This study used a population-based statewide cancer registry and a statewide cancer registry, reported to the population-based Connecticut Tumor Registry, who were linked with a statewide hospital discharge database that provided information on comorbid conditions. While only 11.4 percent of patients did not receive surgical treatment (lung resection), this proportion increased with rising age and was higher among patients who resided in a census tract in the highest poverty-rate quintile, were black, not married and had one or more selected comorbid conditions. These associations persisted in logistic regression models that included all of the variables as predictors of surgery. Studies are needed to explain these disparities.
inpatient hospital discharge database (HDD) to examine socioeconomic status (SES), age and comorbidity in relation to surgical resection among early-stage NSCLC patients of any age at diagnosis. HDDs are being used increasingly in medical outcome studies [9], and analyses of inpatient hospital admissions can be useful as a first step [10, 11] in adjusting for comorbidity.

MATERIALS AND METHODS

In Connecticut, a statewide HDD, maintained by the Office of Health Care Access, has covered (since 1992) all acute-care hospitals in Connecticut; for a given hospital, the medical record number is unique for each patient. The latest HDD file available included complete data for admissions from January, 1992, through August, 1997. The population-based Connecticut Tumor Registry (CTR), located in the Connecticut Department of Public Health since its inception in 1941 [12], has been part of the SEER Program since its inception in 1973 [13]. SEER registries have high rates of completeness of reporting of data from hospitals [14]. In Connecticut, state public-health legislation requires reporting of cancers to the CTR by all licensed hospitals and clinical laboratories in the state, and the CTR has reciprocal reporting agreements with cancer registries in all adjacent states and other states (including Connecticut residents diagnosed in Florida).

The original CTR data file included 9,044 Connecticut residents diagnosed from January, 1992, through August, 1997, with invasive NSCLC, International Classification of Diseases for Oncology (ICD-O-2) site codes 18.0-20.9, and morphology codes 8010-8040, 8050-8076, 8140, 8250-8260, 8310, 8320, 8323, 8550-8573, or 8980-8981, as the only or first-diagnosed reportable cancer, after excluding a small number ascertained solely by autopsy or death certificate.

Almost all patients (i.e., 8,994 or 99.4 percent of 9,044) were coded as white or black race; the 50 patients of other or unknown race were excluded from further analysis. While Hispanic ethnicity is coded in the CTR as a separate data item, the number of Hispanic patients is small (i.e., about 2.5 percent of NSCL patients) and the reporting of Hispanic ethnicity by hospitals is of uncertain validity, so that separate analyses of patients of Hispanic ethnicity were not done.

Of the 8,994 black or white patients, the 319 for whom census tract of residence at the time of diagnosis was not coded in the CTR were excluded from further analysis. Because cancer registries do not include indicators of SES reported directly from patients, an ecologic indicator(s) of patient SES is assigned to each patient [15]. In this study the ecologic or geopolitical unit was the census tract. The ecologic indicator of patient SES was the census tract’s poverty rate from the 1990 Census, which is the proportion of the entire population with incomes below the federal poverty threshold. Poverty rate, rather than household income or other indicators for census tracts, was used because household size is taken into account in defining poverty status.

Of the remaining 8,675 patients, only those with early-stage cancer, for whom surgery is recommended, were appropriate for analysis of surgery. SEER site-specific surgery codes were used to define early stages (similar to American Joint Commission on Cancer or AJCC): I (T1 or T2, no lymph node involvement) and II (T1 or T2 with involvement of intrapulmonary, hilar, or peribronchial lymph nodes; or T3 with no lymph node involvement). Of the 1,822 early-stage black or white patients (19.3 percent of all 8,675), 1,627 (89.3 percent) had at least one hospital admission in the CTR database that
linked (i.e., on hospital, hospital medical record number, and gender) with the HDD, which was necessary for assessment of comorbidity. Some non-linkage was anticipated, due to the absence of an inpatient hospital admission for some patients, an out-of-state hospital (not covered by the HDD) and/or erroneous or missing medical record numbers.

Of the 1,627 patients, 63 were excluded because the first HDD admission more than two months after diagnosis of NSCLC, and comorbidity would be uncertain, or survival after diagnosis was less than two months, so that there was limited opportunity to schedule and receive surgical resection. Of the 1,564 remaining patients, 90 percent had a first admission within two months before the diagnosis of NSCLC.

Surgical resection was defined by using SEER site-specific surgery codes 20 to 70 (i.e., partial or wedge resection, lobectomy or pneumonectomy). This definition does not include local surgical excision or destruction of lesion (SEER code 10), which is not considered standard (non-palliative) therapy [2].

The principal diagnosis and up to nine other diagnoses are coded in the HDD, using the International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM). For the first admission that linked between the two databases, all codes were searched for clinically important comorbid conditions, or those conditions having some effect on short-term survival, derived from the Charlson comorbidity index [6] adapted for administrative databases that use ICD-9-CM codes [7, 8]. After combining subgroups such as mild and moderate or severe liver disease, the conditions (and their ICD-9-CM codes) selected were: cancer other than lung cancer (codes 140-161, 163-200-208); diabetes (250); peripheral vascular disease (441, 443.9, 785.4); myocardial infarction (410, 412); cerebrovascular (430-8); congestive heart failure and related conditions (428, 402.0-402.1, 425); hemiplegia, paraplegia (342, 344.1); chronic pulmonary (490-6, 500-5, 506.4); renal disease (582-583, 585, 586, 588); rheumatologic (710, 714, 725); ulcer (531-4); chronic liver (571-2); dementia (290); and HIV (042). “Metastatic solid tumor” (codes 196-199) [7, 8] was excluded as a comorbid condition in this study of cancer patients.

In multiple logistic regression models [16], the dependent variable was non-receipt vs. receipt of surgical resection. The independent variables were categorical or "dummy" variables that included age at diagnosis (less than 55, 55 to 69, 60 to 64, 65 to 69, 70 to 74, 75 to 79, and 80 or more years), sex (female vs. male) stage (I or II), the SES indicator (quintiles), marital status (married or other), race (black vs. white), and number of comorbid conditions (0, 1, or 2 or more). Using the frequency distribution of census-tract poverty rates (from lowest to highest), patients were divided into five groups with approximately equal sample sizes (i.e., quintiles) for the SES variable.

All odds ratios (ORs) tabulated were adjusted ORs from the full model, with all of the variables included. Confidence limits (95 percent CLs) on adjusted odds ratios or ORs were based on the Normal approximation. Interactions were tested by the Wald statistic (with chi-square distribution) [16].

RESULTS

Of the 1,564 early-stage (I or II) patients, 179 (11.4 percent) did not have surgical resection. This figure was higher for patients in the highest-poverty quintile, older patients, black (vs. white) patients, patients with one or 2+ (vs. 0) comorbid conditions, and for non-married (vs. married) patients, but differed little by gender or stage (Table 1). In a multiple logistic
Table 1. Adjusted odds ratios from a multiple logistic regression model for non-receipt of surgical resection among 1,564 early-stage NSCLC patients (Connecticut residents) diagnosed in 1992 to 1997.

| Characteristic                  | Total no. | No resection (%)<sup>a</sup> | Adjusted OR<sup>b</sup> (95% CL)<sup>a</sup> |
|--------------------------------|-----------|------------------------------|-----------------------------------------------|
| Comorbid conditions:<sup>c</sup> |           |                              |                                               |
| 0                              | 984       | 8.8                          | Referent group                                |
| 1                              | 436       | 13.8                         | 1.51 (1.05, 2.19)*                            |
| 2+                             | 144       | 22.2                         | 2.59 (1.60, 4.18)*                            |
| Age:                           |           |                              |                                               |
| <55                            | 181       | 1.7                          | Referent group                                |
| 55-59                          | 145       | 7.6                          | 4.55 (1.23, 16.81)*                            |
| 60-64                          | 224       | 8.9                          | 6.13 (1.77, 21.18)*                            |
| 65-69                          | 301       | 8.3                          | 5.36 (1.58, 18.20)                            |
| 70-74                          | 322       | 10.6                         | 6.68 (2.00, 22.35)*                            |
| 75-79                          | 261       | 15.3                         | 10.06 (3.02, 33.54)*                           |
| 80+                            | 130       | 35.4                         | 29.05 (6.65, 97.62)*                           |
| Marital status:                |           |                              |                                               |
| Married                        | 971       | 8.7                          | Referent group                                |
| Other                          | 593       | 16.0                         | 1.58 (1.10, 2.26)*                            |
| Poverty rate of census tract:  |           |                              |                                               |
| 0.0-1.8%                       | 340       | 8.5                          | Referent group                                |
| 1.9-2.9%                       | 321       | 11.2                         | 1.27 (0.74, 2.18)                             |
| 3.0-4.2%                       | 278       | 10.1                         | 1.15 (0.65, 2.03)                             |
| 4.3-7.2%                       | 302       | 10.3                         | 1.17 (0.67, 2.04)                             |
| 7.3%+                          | 323       | 17.0                         | 1.78 (1.05, 3.01)*                            |
| Race:                          |           |                              |                                               |
| White                          | 1478      | 11.0                         | Referent group                                |
| Black                          | 86        | 19.8                         | 2.10 (1.10, 4.02)*                            |
| Sex:                           |           |                              |                                               |
| Male                           | 803       | 12.3                         | Referent group                                |
| Female                         | 761       | 10.5                         | 0.83 (0.58, 1.18)                             |
| Stage:                         |           |                              |                                               |
| I                              | 1298      | 12.0                         | Referent group                                |
| II                             | 266       | 8.6                          | 0.72 (0.44, 1.16)                             |

<sup>a</sup>The proportion of patients without resection; there is no adjustment for the effects of the other variables included in the model (see adjusted odds ratio).

<sup>b</sup>Adjusted odds ratios (ORs) are from a multiple logistic regression model that included all of the variables shown in the table.

<sup>c</sup>Selected diseases or conditions (see text).

<sup>*</sup>P < .05

CL: Confidence limits (95%) (see text)

regression model with non-receipt (vs. receipt) of surgical resection as the dependent variable, adjusted ORs were statistically significantly elevated for all six age categories (vs. the reference category of less than 55 years), the 5th vs. first quintile of SES, 1 vs. 0 and 2+ vs. 0 comorbid conditions, black vs. white race and not mar-
ried vs. married, but were close to 1.00 for sex and stage (Table 1). While ORs are difficult to interpret in the presence of interactions, there were few statistically significant interactions (Wald statistic, not shown); most involved age and SES and were limited to the oldest age group; in a separate model (not shown) limited to age less than 80 years at diagnosis, results were similar to those shown in Table 1.

DISCUSSION

The finding of an association between non-receipt of surgery and black vs. white race, independent of the effect of the association between race and SES, supports the results of previous studies using different age groups of NSCLC patients [3, 4]. The adjusted OR in Table 1 adjusts for confounding due to the association between race and SES, in examining the association between race and surgical resection. This finding should be interpreted with caution, however, because of the small sample of blacks (Table 1) and "residual confounding" or inadequate control for SES in comparisons of health-related outcomes in blacks and whites [17]. The higher proportion without resection among unmarried than married patients, consistent with findings from a study of elderly NSCLC patients [18], could reflect residual confounding with SES and/or a direct role of the spouse in decision-making, as well as differing perceptions of providers regarding availability of post-operative convalescent care for patients who differ in marital status.

A study limitation is underestimation of comorbidity from hospital discharge databases in comparison with medical record abstraction [10, 11], and the degree of underestimation could vary by age, SES and/or race. The strong association between comorbidity and receipt of surgical resection (Table 1) suggests that meaningful comorbidity was captured. However, residual confounding with comorbidity may have occurred in the analyses of associations between surgery and other variables such as age, SES and race. The actual role of specific comorbid conditions in treatment decisions could not be determined.

Another study limitation is the use of an ecologic rather than an individual indicator of SES. However, the ecologic indicator was available for almost all patients, whereas income of individual patients in interview studies is often unknown (e.g., 40 percent of patients in one report) [19]. The unit used in this study was the census tract, which is the same as that in one previous study [3] and smaller than the zip code unit used in another study [4]. Use of even smaller units such as census block group was not feasible but would be of uncertain benefit in estimating the SES of individual patients [20]. In addition, living in high-poverty areas may affect healthcare quality and outcomes through mechanisms independent of those involving individual SES [21].

Studies of NSCLC are needed in other geographic areas, and should include larger numbers of patients in high-poverty areas, more-detailed assessment of patient comorbidity, and both individual and ecologic indicators of SES. Both patient preferences and physicians' perceptions of patients based on patient characteristics [22, 23] should be explored as possible explanations for disparities found in this study.

ACKNOWLEDGEMENTS: Funded in part by Contract N01-CN-67005 between the National Cancer Institute and the Connecticut Department of Public Health. The author thanks Heping Li for conducting a computerized record linkage.

REFERENCES

1. Carney, D.N. and Hansen, H.H. Non-small-cell lung cancer — Stalemate or progress? N. Engl. J. Med. 343:1261-1263, 2000.
2. Alpard, S.K. and Zwischenberger, J.B. Staging and surgery for non-small cell lung cancer (NSCLC). Surg Oncol 7:25-43, 1999.
3. Greenwald, H.P., Polissar, N.L., Borgatta, E.F., McCorkle, R., and Goodman, G. Social factors, treatment, and survival in early-stage non-small cell lung cancer. Am. J. Public Health 88:1681-1684, 1998.
4. Bach, P.B., Cramer, L.D., Warren, J.L., and Begg, C.B. Racial differences in the treatment of early-stage lung cancer. N. Engl. J. Med. 341:1198-1205, 1999.
5. Campbell, D.E. and Greenberg, E.R. Racial differences in the treatment of early-stage lung cancer. N. Engl. J. Med. 342:517, 2000.
6. Charison, M.E., Pompei, P., Ales, K.L., and Mackenzie, C.R. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation. J. Chron. Dis. 40:373-383, 1987.
7. Deyo, R.A., Cherkin, D.C., and Ciol, M.A. Adapting a clinical comorbidity index for use with ICD-9-CM administrative databases. J. Clin. Epidemiol. 45:613-619, 1992.
8. Romano, P.S., Roos, L.L., and Jollis, J.G. Adapting a clinical comorbidity index for use with ICD-9-CM administrative data: differing perspectives. J. Clin. Epidemiol. 46:1075-1079, 1993.
9. Ray, W.A. Policy and program analysis using administrative databases. Ann. Intern. Med. 127:712-718, 1997.
10. Malenka, D.J., McLerran, D., Roos, N., Fisher, E.S., and Wennberg, J.E. Using administrative data to describe casemix: A comparison with the medical record. J. Clin. Epidemiol. 47:1027-1032, 1994.
11. Kieszak, S.M., Flanders, W.D., Kosinski, A.S., Ship, C.C., and Karp, H. A comparison of the Charlson comorbidity index derived from medical record data and administrative billing data. J. Clin. Epidemiol. 52:137-142, 1999.
12. Haenszel, W. and Curnen, M.G.M. The first fifty years of the Connecticut Tumor Registry: reminiscences and prospects. Yale J. Biol. Med. 59:475-484, 1986.
13. Ries, L.A.G., Kosary, C.L., Hankey, B.F., Miller, B.A., Harras, A., and Edwards, B.K. SEER Cancer Statistics Review, 1973-1994. National Cancer Institute. NIH Publication No. 97-2789. Bethesda, MD, 1997.
14. Zippin, C., Lum, D., and Hankey, B.F. Completeness of hospital cancer case reporting from the SEER program of the NCI. Cancer 76:2343-2350, 1995.
15. 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.
16. Norusis, M.J. SPSS Advanced Statistics, 6.1. Chicago: SPSS, Inc; 1994.
17. Kaufman, J.S., Cooper, R.S., and McGee, D.L. Socioeconomic status and health in blacks and whites: the problem of residual confounding and the resiliency of race. Epidemiology 8:621-628, 1997.
18. Bach, P.B., Cramer, L.D., Begg, C.B., and Warren J.L. Racial differences in the treatment of early-stage lung cancer. N. Engl. J. Med. 342:518-519, 2000.
19. Mayberry, R.M., Coates, R.J., Hill, H.A., Click L.A., Chen., W.W., Austin, D.F., Redmond, C.K., Femoglio-Preiser, C.M., Hunter, C.P., Haynes, M.A., Muss, H.B., Wesley, M.N., Greenberg R.S, and Edwards, B.K. Determinants of black/white differences in colon cancer survival. J. Natl. Cancer Inst. 87:1686-1693, 1995.
20. Geronimus, A.T. and Bound, J. Use of census-based aggregate variables to proxy for socioeconomic group: Evidence from national samples. Am. J. Epidemiol. 148:475-486, 1998.
21. Yen, I.H. and Kaplan, G.A. Neighborhood social environment and risk of death: multilevel evidence from the Alameda County study. Am. J. Epidemiol. 148:989-907, 1999.
22. Mandelblatt, J.S., Yabroff, K.R., and Kern, J.F. Equitable access to cancer services: a review of barriers to quality care. Cancer 86:2378-2390, 1999.
23. Van Ryn, M. and Burke, J. The effect of patient race and socioeconomic status on physicians' perceptions of patients. Soc. Sci. Med. 50:813-828, 2000.