Gender, Race, and Socioeconomic Status Affects Outcomes After Lung Cancer Resections in the United States

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Background. The effect of gender, race, and socioeconomic status on contemporary outcomes after lung cancer resections has not been comprehensively evaluated across the United States. We hypothesized that risk-adjusted outcomes for lung cancer resections would not be influenced by these factors.

Methods. From 2003 to 2007, 129,207 patients undergoing lung cancer resections were evaluated using the Nationwide Inpatient Sample (NIS) database. Multiple regression analysis was used to estimate the effects of gender, race, and socioeconomic status on risk-adjusted outcomes.

Results. Average patient age was 66.8 ± 10.5 years. Women accounted for 5.0% of the total study population. Among racial groups, whites underwent the largest majority of operations (86.2%), followed by black (6.9%) and Hispanic (2.8%) races. Overall the incidence of mortality was 2.9%, postoperative complications were 30.4%, and pulmonary complications were 22.0%. Female gender, race, and mean income were all multivariate correlates of adjusted mortality and morbidity. Black patients incurred decreased risk-adjusted morbidity and mortality compared with white patients. Hispanics and Asians demonstrated decreased risk-adjusted complication rates. Importantly low income status independently increased the adjusted odds of mortality.

Conclusions. Female gender is associated with decreased mortality and morbidity after lung cancer resections. Complication rates are lower for black, Hispanic, and Asian patients. Low socioeconomic status increases the risk of in-hospital death. These factors should be considered during patient risk stratification for lung cancer resection.

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In the United States, lung cancer is the leading cause of cancer-related deaths among both men and women [1]. Despite recent advances in oncologic therapy, surgical resection for early-stage lung cancer remains the predominant treatment strategy. As a result continued emphasis on improving postoperative outcomes is critical. Operative mortality rates for lung cancer resections currently approach 2%, and complication rates are approximately 8% [2, 3]. In an effort to further improve patient outcomes and quality of care, continued examination of potential risk factors for morbidity and mortality is warranted at a nationwide level.

Disparities in medical and surgical outcomes are often influenced by several patient- and health system–related factors. Patient outcomes after surgical lung cancer resection may be related to inherent differences in gender, race, or socioeconomic status. Although other reported series have identified these factors as potential determinants of patient outcomes and survival [3–13], many of these reports are limited by single institutional experiences or statewide databases. In addition many published analyses lack critical social- and hospital-related data required for rigorous risk adjustment and are subject to biases that limit their generalizability to patients nationwide.

The present study used a nationwide administrative database to examine the influence of gender, race, and socioeconomic status on risk-adjusted morbidity and mortality after appropriate adjustment for various demographic, social, operation, and institutional factors. Understanding the independent influence of these variables is critical to reducing disparities in lung cancer care and identifying methods to improve patient outcomes.

Material and Methods

Data Source

Data was obtained from the 2002 to 2007 Nationwide Inpatient Sample (NIS) datasets. NIS data represents the largest, all-payer, publicly available inpatient care data-

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base in the United States, providing a 20% random sample of US hospital discharges. The hospitals represented within these datasets are designated as "community hospitals" within the American Hospital Association annual survey. Data reported herein represents inpatient admissions for patients of all ages, races, income levels, and sources of insurance.

The University of Virginia Institutional Review Board (IRB) exempted this study from formal review because it failed to meet the regulatory definition of human subject research because of the lack of controlled patient identifiers and because the data is not collected for research purposes only.

Patients and Hospitals

A total of 26,189 discharge records representing a weighted estimate of 129,207 patients undergoing lung cancer resections was identified by querying the first 5 diagnosis and procedure categories with the NIS using the following International Classification of Diseases—Ninth Revision, Clinical Modifications (ICD-9-CM) procedure and diagnostic codes: lung resection (ICD-9-CM codes 323, 3230, 3239, 324, 3241, 3249, 325, 3250, 3259) and primary diagnosis of lung cancer (ICD-9-CM codes 162, 1622, 1623, 1624, 1625, 1628, 1629). The presence of patient admission-level comorbid disease was assessed using available Agency for Health Research and Quality comorbidity categories within the NIS datasets developed by Elixhauser and colleagues [14]. Hospital-related details were available within the NIS database. Thoracic surgery teaching hospital status was determined by linking the American Hospital Association identification numbers of all hospitals within the NIS study dataset with hospital reports from the Association of American Medical College's Graduate Medical Education tracking system. Hospital operative volume was categorized into quartiles: low ($<$ 25th percentile), medium (26th to 49th percentile), high (50th to 74th percentile], and very high ($>$ 75th percentile].

Outcomes Measured

All measured outcomes were established a priori. The primary outcomes in this study were the effects of gender, race, and socioeconomic status on risk-adjusted mortality and morbidity after lung cancer resections. Secondary outcomes of interest included observed differences in the overall incidence of mortality and postoperative complication rates. The incidence of postoperative and pulmonary complications was determined using previously described methodology [15, 16].

Statistical Analysis

All statistical methodology used in this study was designed to test the null hypothesis that risk-adjusted outcomes after lung cancer resections in the United States are not significantly different with respect to gender, race, and socioeconomic status. Statistical significance for all analyses was defined by an alpha of less than 0.05. Because of the complex sampling methods used by the NIS, all data analyses were performed using Predictive Analytics SoftWare (PASW) Statistics version 18.0.0 complex samples module (IBM Corporation, Somers, NY).

Descriptive Statistics and Univariate Analyses

Descriptive and inferential statistics were used to compare observed differences in the incidence of mortality, composite postoperative complication rate, and pulmonary complication rate as a function of gender, race, and mean income. Continuous variables with normal distributions are reported as means $\pm$ standard deviation, whereas the median (interquartile range) is used to express nonnormally distributed data. Continuous variables were compared using either the Student's t test or the Mann-Whitney U test. Comparisons of categorical variables used the Pearson's χ^2 or Fisher's exact test where appropriate. All categorical variables are expressed as a percentage of the total study population or respective study group. Independent sample group comparisons were unpaired. All calculated test statistics were used to derive reported 2-tailed p values. Two additional effect size statistics were calculated to provide an estimate of the strength of the relationship between 2 variables within a given population and to provide a clinically practical interpretation of the reported results The phi coefficient was calculated for all univariate comparisons with 1 degree of freedom, and the Cramer's V statistic was computed for comparisons of categorical ordinal variables with greater than 1 degree of freedom.

Multivariable Analysis

Because of the complex structure of this study dataset, hierarchical multiple logistic regression was used to estimate risk-adjusted associations between female gender, race, and mean income quartile and the outcomes of in-hospital death, composite incidence of postoperative complications, and pulmonary complications for patients undergoing lung cancer resections. Three separate logistic regression models were used for each outcome. Missing data for individual covariates accounted for less than 5% of the total study dataset. All covariates considered potential confounders for model outcomes were selected a priori and were retained in each final model. The predictive strength and relative contribution of each model covariate was assessed by the Wald χ^2 statistic. Results of each logistic regression model are reported as confounder adjusted odds ratio (AOR) with 95% confidence interval (CI). Model performance was assessed by the area under the receiver operating characteristics curve (AUC) and the Nagelkerke Pseudo R^2 statistic. Sensitivity analyses were performed by reestimating each model after removing the strongest individual predictor as determined by the Wald statistic [17]. Using this technique, model performance is validated if the observed effects remain statistically significant and are not substantially attenuated ($>$ 10%) after reestimation.