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

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Abstract

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

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

Results—Average patient age was 66.8 ± 10.5 years. Females accounted for 5.0% of the total study population. Among racial groups, whites underwent the large 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 30.4%, and pulmonary complications 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 to 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 following 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.

Keywords

Gender; Race; Income; Lung Cancer; Surgery; Outcomes

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INTRODUCTION

Within the United States (U.S.), 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%, while 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 following surgical lung cancer resection may be related to inherent differences in gender, race or socioeconomic status (SES). 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 utilized 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 2002–2007 Nationwide Inpatient Sample (NIS) datasets. NIS data represents the largest, all-payer, publicly available inpatient care database in the United States, providing a 20% random sample of United States hospital discharges. The hospitals represented within these datasets are designated as “community hospitals” within the American Hospital Association (AHA) 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 as it failed to meet the regulatory definition of human subjects research due to 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 were identified by querying the first five 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 co-morbid disease was assessed using available AHRQ comorbidity categories within the NIS datasets developed by Elixhauser et al [14].

Hospital related details were available within the NIS database. Thoracic surgery teaching hospital (TSTH) status was determined by linking the AHA 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 [$<25^{\text{th}}$ percentile], Medium [26–49th percentile], High [50–74th percentile], and Very High [$>75^{\text{th}}$ 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 following 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 utilized in this study was designed to test the null hypothesis that risk adjusted outcomes following lung cancer resections within 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 <0.05 . Due to the complex sampling methods utilized 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 (SD), while the median [interquartile range] is used to express non-normally distributed data. Continuous variables were compared using either the Student's *t* test or the Mann Whitney *U* test. Comparisons of categorical variables utilized 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 two-tailed *p*-values. Two additional effect size statistics were calculated to provide an estimate of the strength of the relationship between two variables within a given population and to provide a clinically practical interpretation of the reported results. The phi (ϕ) 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 >1 degree of freedom.

Multivariable Analysis

Due to the complex structure of this study dataset, hierarchical multiple logistic regression was utilized 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 utilized for each outcome. Missing data for individual covariates accounted for $<5\%$ 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 ratios (AOR) with 95% confidence intervals (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 re-

estimating 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 re-estimation.

RESULTS

Patient, Hospital, and Operative Characteristics

Descriptive statistics for select model covariates are presented in Table 1. Average patient age was 66.8 ± 10.5 years. Females accounted for 5.0% of the total study population. Among racial groups, whites underwent the large majority of operations (86.2%) followed by Black (6.9%) and Hispanic (2.8%) races. The most frequent mean income quartile represented those earning >\$63,000 per year (mean income quartile IV). With respect to lung cancer resections, lobectomy was the most common operation performed, and the large majority of operations were elective. Resections were performed at TSTH 16.5% of the time, and the large majority of operations were performed at hospitals with very high (>75th percentile) operative volume (73.9%). The overall incidence of in-hospital mortality was 2.9%, the composite incidence of any postoperative complication was 30.4%, and pulmonary complications occurred following 22.0% of lung cancer resections.

Univariate Analyses for Mortality and Morbidity

Univariate associations for the outcomes of hospital mortality, composite postoperative complication rate, and pulmonary complications as a function of gender, race and income following lung cancer resections are detailed in Table 2. For the outcome of mortality, female gender (46.2% vs. 32.0%, $p < 0.001$), Black race (8.3% vs. 4.1%, $p = 0.03$), and higher income (34.9% vs. 25.9%, $p = 0.01$) were more commonly observed among survivors compared to decedents. Alternatively, low income status (24.5% vs. 18.85, $p = 0.04$) was more commonly associated with mortality compared to survivors. For the composite incidence of any postoperative complication, female gender (42.3% vs. 47.0%, $p = 0.002$) and Hispanic race (2.8% vs. 4.0%, $p = 0.04$) were less commonly associated with postoperative complications, while white (86.1% vs. 83.3%, $p = 0.02$) or Native American (0.5% vs. 0.2%, $p = 0.04$) race was more commonly associated with complications. Regarding the incidence of pulmonary complications, white race was more frequent among those with pulmonary complications (87.2% vs. 83.5%, $p = 0.01$), while Hispanics less commonly encountered pulmonary complications (2.5% vs. 3.9%, $p = 0.03$).

Adjusted Effects of Gender, Race, and Income on Mortality and Morbidity

The adjusted odds ratios for the effects of female gender, race, and mean income on mortality and postoperative complications appear in Table 3. Within the mortality model, female gender was associated with a 24% ($p < 0.001$) reduction in the odds of mortality compared to men. Among racial groups, Black race was the only multivariate correlate of mortality. Mean income was a significant predictor of mortality ($p < 0.001$), and lower income categories were associated with significantly increased odds of death compared to mean income quartile IV. Importantly, female gender and mean income proved to be stronger predictors in this model with higher Wald χ^2 statistics compared to the effect of race. With respect to postoperative complications, female gender was a significant positive predictor of any postoperative complication (AOR=0.83) as well as pulmonary complications (AOR=0.93) following lung cancer resection. Among racial groups, Black, Hispanic and Asian patients incurred decreased risk-adjusted complication rates compared to white patients. No significant associations were observed for the effect of income on the odds of postoperative complications.

COMMENT

The present study reports upon contemporary, nationwide lung cancer resection outcomes as they relate to differences in gender, race and socioeconomic status. These results suggest that after accounting for the potential confounding influence of over 50 different variables, female gender was a significant, independent correlate of postoperative morbidity and mortality and was associated with reduced odds of death and postoperative complications compared to males. Race was also a significant predictor of postoperative complications. Moreover, risk-adjusted mortality was significantly influenced by socioeconomic status, and the odds of death increased with declining mean income. Importantly, among these factors, gender proved to be the strongest predictor of postoperative death and morbidity. To our knowledge, these findings represent the most comprehensive report of current nationwide outcomes following lung cancer resections to address the contribution of important demographic factors that have been implicated in health disparities within the United States. Thus, these data provide an analysis of valuable patient related factors to be considered by thoracic surgeons and patients in the preoperative setting.

In this report, the effect of gender was a significant correlate of postoperative mortality and morbidity and is in agreement with other reported series [3, 4, 8, 10, 11]. In one recent series reporting on outcomes from the national Society of Thoracic Surgeons (STS) General Thoracic Surgery Database, male gender was associated with elevated odds of mortality (OR=1.37, $p=0.013$) as well as the composite outcome of mortality and major morbidity (OR=1.12, $p=0.031$) following lung cancer resections [3]. Furthermore, the beneficial effects of female gender on 5-year survival rates for women with stage I–III tumors were noted in another prospective series of 1,085 patients with non-small cell lung carcinoma [8]. Important to consider in the results of the present study is the relative disproportion of females to males within this NIS dataset as well as the relative strength of female gender as an independent risk factor for the primary outcomes of interest. Considering the estimated associations between female gender and outcomes, we would expect that the effect of female gender on risk-adjusted outcomes may be even more dramatic in datasets with more equal distribution of gender. Moreover, although not directly assessed in the present study, the influences of tumor type and disease stage must be considered as contributing to the improved perioperative outcomes for females undergoing lung cancer resections.

The present results provide a valuable extension to accumulated data regarding the influence of race and socioeconomic status on lung cancer treatment and outcomes [5–7, 13, 22]. In a recent population-based study of 76,086 lung cancer resection patients (1998–2002) within a Florida cancer registry, African American patients were diagnosed with lung cancer at an earlier age, with more advanced disease, comprised the largest proportion of low income patients, and were less likely to undergo surgical resection, which resulted in reduced median survival times compared to Caucasians (7.5 years vs. 8.8 years, $p<0.001$) [13]. However, after risk-factor adjustment, race failed to be a multivariate correlate of survival in this series, while severe poverty was an independent predictor of worse survival (HR=1.05, $p=0.001$). Importantly, in this series no significant differences were observed for patient undergoing surgical resections, and the study is limited by the fact that only 22% of their cohort underwent surgical resection, their analysis failed to address postoperative morbidity, and the results reflect trends that may not be current. Other series, however, corroborate these findings among single institutional experiences and various cancer registries and are complementary to those of the present analysis [5, 22].

The potential explanations for disparities in outcomes related to gender, race and socioeconomic status in this study are complex and multifactorial. Substantial evidence exists describing the interaction of various factors on patient outcomes, including ethnicity,

education level, language barriers, socioeconomic status, cultural values, poor physician-patient communication, provider bias, disparities in hospital resource utilization, and access to specialized care [16, 23–28]. In this large observational analysis, we also demonstrate the independent influence of several of these factors. Specifically, these results indicate that many of the racial and socioeconomic influences that have been documented as potential culprits for disparities in patient outcomes appear related. When individually accounted for through regression analysis, various modifiable social, health system and economic factors largely account for the observed differences. In fact, these data, as well as those presented elsewhere [5, 22], demonstrate that many ethnic disparities in lung cancer outcomes could be reduced, and even improved, with appropriate utilization of operative intervention and adjuvant therapy.

The presented results are subject to select limitations. Due to the retrospective study design, selection bias must be considered. In addition, we are unable to account for certain data, including tumor type, pathologic or clinical stage, preoperative performance status or predicted pulmonary function. Use of community-level income status, such as mean income by ZIP code, is admittedly imperfect, and this definition of socioeconomic status may differ compared to other studies. However, previous research has supported the use of such definitions as a valid proxy for socioeconomic status [18–21]. The use of de-identified data and the lack of long-term follow-up within the NIS limits the ability to scrutinize the data further, and this study also did not directly examine the effects of insurance or primary payer status on risk-adjusted outcomes. The impact of varying insurance types on risk-adjusted outcomes, however, has been documented in other recent surgical series [16, 29]. Despite these limitations, use of the NIS provides important benefits as the data represented herein is broadly applicable to patients nationwide and allows for the effective adjustment for certain social and economic influences that are often poorly captured or unavailable in other institutional or registry datasets.

Conclusions

The results reported herein demonstrate important differences in lung cancer resection outcomes as they relate to disparate differences in gender, race and socioeconomic status. Based upon these analyses, female gender is associated with decreased risk-adjusted mortality and morbidity following lung cancer resections, while the odds of postoperative complications are lower for Black, Hispanic and Asian patients. Low socioeconomic status increases the risk of in-hospital death. These factors should be considered during individual patient risk stratification for lung cancer resection, and optimization of modifiable patient-, provider-, and system-related factors may help to reduce health disparities and outcomes for this patient population.

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REFERENCES

1. Jemal A, Siegel R, Ward E, Hao Y, Xu J, Murray T, Thun MJ. Cancer statistics, 2008. *CA Cancer J Clin.* 2008; 58(2):71–96. [PubMed: 18287387]
2. Ginsberg RJ. Lung cancer surgery: acceptable morbidity and mortality, expected results and quality control. *Surg Oncol.* 2002; 11(4):263–6. [PubMed: 12450562]
3. Kozower BD, Sheng S, O'Brien SM, Liptay MJ, Lau CL, Jones DR, Shahian DM, Wright CD. STS database risk models: predictors of mortality and major morbidity for lung cancer resection. *Ann Thorac Surg.* 2010; 90(3):875–81. discussion 81–3. [PubMed: 20732512]

4. Agudo A, Ahrens W, Benhamou E, Benhamou S, Boffetta P, Darby SC, Forastiere F, Fortes C, Gaborieau V, Gonzalez CA, Jockel KH, Kreuzer M, Merletti F, Pohlman H, Richiardi L, Whitley E, Wichmann HE, Zambon P, Simonato L. Lung cancer and cigarette smoking in women: a multicenter case-control study in Europe. *Int J Cancer*. 2000; 88(5):820–7. [PubMed: 11072254]
5. Bach PB, Cramer LD, Warren JL, Begg CB. Racial differences in the treatment of early-stage lung cancer. *N Engl J Med*. 1999; 341(16):1198–205. [PubMed: 10519898]
6. Blackstock AW, Herndon JE 2nd, Paskett ED, Miller AA, Lathan C, Niell HB, Socinski MA, Vokes EE, Green MR. Similar outcomes between African American and non-African American patients with extensive-stage small-cell lung carcinoma: report from the Cancer and Leukemia Group B. *J Clin Oncol*. 2006; 24(3):407–12. [PubMed: 16365181]
7. Blackstock AW, Herndon JE 2nd, Paskett ED, Perry MC, Graziano SL, Muscato JJ, Kosty MP, Akerley WL, Holland J, Fleishman S, Green MR. Outcomes among African-American/non-African-American patients with advanced non-small-cell lung carcinoma: report from the Cancer and Leukemia Group B. *J Natl Cancer Inst*. 2002; 94(4):284–90. [PubMed: 11854390]
8. Cerfolio RJ, Bryant AS, Scott E, Sharma M, Robert F, Spencer SA, Garver RI. Women with pathologic stage I, II, and III non-small cell lung cancer have better survival than men. *Chest*. 2006; 130(6):1796–802. [PubMed: 17166999]
9. Chang JW, Asamura H, Kawachi R, Watanabe S. Gender difference in survival of resected non-small cell lung cancer: histology-related phenomenon? *J Thorac Cardiovasc Surg*. 2009; 137(4):807–12. [PubMed: 19327500]
10. Ferguson MK, Skosey C, Hoffman PC, Golomb HM. Sex-associated differences in presentation and survival in patients with lung cancer. *J Clin Oncol*. 1990; 8(8):1402–7. [PubMed: 2166143]
11. Ferguson MK, Wang J, Hoffman PC, Haraf DJ, Olak J, Masters GA, Vokes EE. Sex-associated differences in survival of patients undergoing resection for lung cancer. *Ann Thorac Surg*. 2000; 69(1):245–9. discussion 49–50. [PubMed: 10654523]
12. Radzikowska E, Glaz P, Roszkowski K. Lung cancer in women: age, smoking, histology, performance status, stage, initial treatment and survival. Population-based study of 20 561 cases. *Ann Oncol*. 2002; 13(7):1087–93. [PubMed: 12176788]
13. Yang R, Cheung MC, Byrne MM, Huang Y, Nguyen D, Lally BE, Koniaris LG. Do racial or socioeconomic disparities exist in lung cancer treatment? *Cancer*. 2010; 116(10):2437–47. [PubMed: 20209616]
14. Elixhauser A, Steiner C, Harris DR, Coffey RM. Comorbidity measures for use with administrative data. *Med Care*. 1998; 36(1):8–27. [PubMed: 9431328]
15. Guller U, Hervey S, Purves H, Muhlbaier LH, Peterson ED, Eubanks S, Pietrobon R. Laparoscopic versus open appendectomy: outcomes comparison based on a large administrative database. *Ann Surg*. 2004; 239(1):43–52. [PubMed: 14685099]
16. LaPar DJ, Bhamidipati CM, Mery CM, Stukenborg GJ, Jones DR, Schirmer BD, Kron IL, Ailawadi G. Primary payer status affects mortality for major surgical operations. *Ann Surg*. 2010; 252(3):544–50. discussion 50–1. [PubMed: 20647910]
17. Lin DY, Psaty BM, Kronmal RA. Assessing the sensitivity of regression results to unmeasured confounders in observational studies. *Biometrics*. 1998; 54(3):948–63. [PubMed: 9750244]
18. Cheung MC, Perez EA, Molina MA, Jin X, Gutierrez JC, Franceschi D, Livingstone AS, Koniaris LG. Defining the role of surgery for primary gastrointestinal tract melanoma. *J Gastrointest Surg*. 2008; 12(4):731–8. [PubMed: 18058185]
19. Hodgson N, Koniaris LG, Livingstone AS, Franceschi D. Gastric carcinoids: a temporal increase with proton pump introduction. *Surg Endosc*. 2005; 19(12):1610–2. [PubMed: 16211437]
20. Perez EA, Koniaris LG, Snell SE, Gutierrez JC, Sumner WE 3rd, Lee DJ, Hodgson NC, Livingstone AS, Franceschi D. 7201 carcinoids: increasing incidence overall and disproportionate mortality in the elderly. *World J Surg*. 2007; 31(5):1022–30. [PubMed: 17429568]
21. Perez EA, Livingstone AS, Franceschi D, Rocha-Lima C, Lee DJ, Hodgson N, Jorda M, Koniaris LG. Current incidence and outcomes of gastrointestinal mesenchymal tumors including gastrointestinal stromal tumors. *J Am Coll Surg*. 2006; 202(4):623–9. [PubMed: 16571433]
22. Bryant AS, Cerfolio RJ. Impact of race on outcomes of patients with non-small cell lung cancer. *J Thorac Oncol*. 2008; 3(7):711–5. [PubMed: 18594315]

23. Ayanian JZ, Zaslavsky AM, Guadagnoli E, Fuchs CS, Yost KJ, Creech CM, Cress RD, O'Connor LC, West DW, Wright WE. Patients' perceptions of quality of care for colorectal cancer by race, ethnicity, and language. *J Clin Oncol*. 2005; 23(27):6576–86. [PubMed: 16116149]
24. Breitkopf CR, Catero J, Jaccard J, Berenson AB. Psychological and sociocultural perspectives on follow-up of abnormal Papanicolaou results. *Obstet Gynecol*. 2004; 104(6):1347–54. [PubMed: 15572501]
25. Johnson RL, Roter D, Powe NR, Cooper LA. Patient race/ethnicity and quality of patient-physician communication during medical visits. *Am J Public Health*. 2004; 94(12):2084–90. [PubMed: 15569958]
26. Johnson RL, Saha S, Arbelaez JJ, Beach MC, Cooper LA. Racial and ethnic differences in patient perceptions of bias and cultural competence in health care. *J Gen Intern Med*. 2004; 19(2):101–10. [PubMed: 15009789]
27. Liu JH, Zingmond DS, McGory ML, SooHoo NF, Ettner SL, Brook RH, Ko CY. Disparities in the utilization of high-volume hospitals for complex surgery. *JAMA*. 2006; 296(16):1973–80. [PubMed: 17062860]
28. Schulman KA, Berlin JA, Harless W, Kerner JF, Sistrunk S, Gersh BJ, Dube R, Taleghani CK, Burke JE, Williams S, Eisenberg JM, Escarce JJ. The effect of race and sex on physicians' recommendations for cardiac catheterization. *N Engl J Med*. 1999; 340(8):618–26. [PubMed: 10029647]
29. Lapar DJ, Bhamidipati CM, Walters DM, Stukenborg GJ, Lau CL, Kron IL, Ailawadi G. Primary Payer Status Affects Outcomes for Cardiac Valve Operations. *J Am Coll Surg*. In Press, published ahead of print March 12, 2011.

Table 1

Descriptive statistics of select patient risk factors entered as model covariates.

Variable	Weighted Frequency (n=129,207)	% of Total Sample
Mortality	3,700	2.9%
Any Complication	39,253	30.4%
Pulmonary Complications	28,376	22.0%
Age (years)^a	129,207	66.8±10.5
Female	64,560	5.0%
Elective Operation	114,873	88.9%
Lung Cancer Resection		
Sublobar Resection	15,799	12.2%
Lobectomy	104,402	80.8%
Pneumonectomy	9,005	7.0%
Select Elixhauser Comorbid Disease Categories^b		
Congestive Heart Failure	6,093	4.8%
Diabetes (uncomplicated)	16,478	13.1%
Chronic Pulmonary Disease	61,820	49.1%
Pulmonary Circulatory Disease	1,150	0.9%
Renal Failure	2,741	2.2%
Thoracic Surgery Teaching Hospital	21,281	16.5%
Race		
White	111,341	86.2%
Black	8,909	6.9%
Hispanic	3,517	2.8%
Asian or Pacific Islander	2,918	2.3%
Native American	211	0.2%
Other	2,311	1.8%
Mean Income Quartile		
I (< \$39,000)	23,847	18.9%
II (\$39,000–47,999)	27,816	22.0%
III (\$48,000–62,999)	31,896	25.2%
IV (> \$63,000)	42,806	33.9%
Primary Payer		
Medicare	78216	60.5%
Medicaid	5278	4.1%
Uninsured	2017	1.6%
Private	43696	33.8%

Rheumatoid Arthritis (RA)

^a Means ± Standard Error of Mean (SEM)^b Elixhauser comorbid disease category details available online (<http://www.hcupus.ahrq.gov/db/nation/nis/nisdde.jsp>)

Table 2

Univariate associations of gender, race and income on the unadjusted odds of in-hospital mortality, composite incidence of postoperative complications, and pulmonary complications.

Variable	Mortality		Postoperative Complications		Pulmonary Complications	
	Unadjusted Odds Ratio (95% C.I.)	Effect Size	Unadjusted Odds Ratio (95% C.I.)	Effect Size	Unadjusted Odds Ratio (95% C.I.)	Effect Size
Female	0.55 (0.41–0.73) *	0.059	0.83 (0.73–0.94) *	0.043	1.04 (0.90–1.20)	0.007
Race						
White	1.48 (0.97–2.27)	0.026	1.24 (1.04–1.47) *	0.034	1.35 (1.10–1.67) *	0.040
Black	0.48 (0.24–0.94) *	0.031	0.85 (0.67–1.07)	0.020	0.88 (0.67–1.15)	0.013
Hispanic	1.56 (0.86–2.86)	0.021	0.69 (0.48–0.98) *	0.030	0.62 (0.40–0.97) *	0.030
Asian or Pacific Islander	0.46 (0.11–1.86)	0.016	0.66 (0.41–1.08)	0.024	0.56 (0.30–1.04)	0.026
Native American	-	-	3.28 (1.12–9.32) *	0.032	2.44 (0.82–7.30)	0.023
Other	0.47 (0.11–1.89)	0.015	1.01 (0.65–1.57)	<0.001	0.63 (0.34–1.16)	0.021
Mean Income						
I (< \$39,000)	1.41 (1.02–1.94) *	0.030	0.95 (0.81–1.12)	0.008	0.96 (0.79–1.15)	0.007
II (\$39,000–47,999)	0.99 (0.85–1.15)	1.02	0.99 (0.85–1.15)	1.02	1.02 (0.85–1.21)	0.003
III (\$48,000–62,999)	1.09 (0.95–1.25)	0.017	1.09 (0.95–1.25)	0.017	1.16 (0.98–1.36)	0.025
IV (> \$63,000)	0.65 (0.48–0.89) *	0.039	0.97 (0.85–1.11)	0.006	0.90 (0.77–1.05)	0.173

* $p < 0.05$

Table 3

Hierarchical Logistic Regression Models: Effect of gender, race and income.

	Mortality Model [†]		Morbidity Model [‡]		Pulmonary Complication Model [§]	
	Wald χ^2 (p-value)	Adjusted Odds Ratio	Wald χ^2 (p-value)	Adjusted Odds Ratio	Wald χ^2 (p-value)	Adjusted Odds Ratio
Female	49.23 (<0.001)	0.76 (0.71–0.82)*	201.37 (<0.001)	0.83 (0.81–0.85)*	28.34 (<0.001)	0.93 (0.90–0.95)*
Race	9.27 (0.10)		53.36 (0.03)		43.41 (<0.001)	
White		1.00		1.00		1.00
Black		0.83 (0.71–0.97)*		0.94 (0.89–0.99)*		0.93 (0.87–0.98)*
Hispanic		0.93 (0.75–1.17)		0.82 (0.76–0.89)*		0.77 (0.70–0.85)*
Asian or Pacific Islander		0.84 (0.63–1.11)		0.80 (0.73–0.87)*		0.85 (0.77–0.95)*
Native American		0.00 (N/A)		1.04 (0.76–1.41)		0.93 (0.65–1.33)
Other		1.21 (0.93–1.58)		1.11 (1.01–1.22)		1.06 (0.95–1.18)
Mean Income	35.79 (<0.001)		71.14 (0.07)		6.32 (0.10)	
I (< \$39,000)		1.37 (1.23–1.54)*		0.98 (0.95–1.03)		0.98 (0.93–1.02)
II (\$39,000–47,999)		1.14 (1.03–1.27)*		1.00 (0.97–1.04)		0.99 (0.95–1.03)
III (\$48,000–62,999)		1.24 (1.13–1.37)*		1.04 (1.00–1.07)		1.03 (0.99–1.07)
IV (> \$63,000)		1.00		1.00		0.93 (0.90–0.95)*

Model Performance

Models adjusted for all covariates: age, gender, race, mean income, primary payer status, elective operative status, operative year, hospital category, hospital region, hospital operative volume, lung cancer resection type, Elixhauser comorbid disease categories. Reference Groups: Gender (Male), Race (White), Mean Income (IV: > \$63,000).

* $p < 0.05$.

[†] Area Under Receiver Operator Curve (AUC)=0.84, Nagelkerke Pseudo R^2 =0.22 with 57 degrees of freedom

[‡] AUC=0.62, Nagelkerke Pseudo R^2 =0.06 with 57 degrees of freedom

[§] AUC=0.63, Nagelkerke Pseudo R^2 =0.05 with 57 degrees of freedom.