Published in final edited form as:
J Thorac Cardiovasc Surg. 2014 July ; 148(1): 13–18. doi:10.1016/j.jtcvs.2014.03.012.

Sex differences in early outcomes after lung cancer resection: Analysis of the Society of Thoracic Surgeons' General Thoracic Database

Betty C. Tong, MD, MHS[1], **Andrzej S. Kosinski, PhD**[2], **William R. Burfeind Jr., MD**[3], **Mark W. Onaitis, MD**[1], **Mark F. Berry, MD**[1], **David H. Harpole Jr., MD**[1], and **Thomas A. D'Amico, MD**[1]

[1]Section of Thoracic Surgery, Department of Surgery, Duke University Medical Center, Durham, North Carolina

[2]Department of Biostatistics and Bioinformatics, Duke University, Durham, North Carolina

[3]St. Luke's Health Network, Bethlehem, PA

Abstract

Objectives—Women with lung cancer have superior long-term survival outcomes compared to men, independent of stage. The etiology of this disparity is unknown. For patients undergoing lung cancer resection, these survival differences could be due, in part, to relatively better perioperative outcomes for women. This study was undertaken to determine differences in perioperative outcomes after lung cancer surgery based on sex.

Methods—The STS General Thoracic Database was queried for all patients undergoing resection of lung cancer between 2002 and 2010. Postoperative complications were analyzed with respect to sex. Univariable analysis was performed, then multivariable modeling to determine significant risk factors for postoperative morbidity and mortality.

Results—A total of 34,188 patients (16,643 men and 17,545 women) were considered. Univariable analysis demonstrated statistically significant differences in postoperative complications favoring women in all categories of postoperative complications. Women also had lower in-hospital and 30-day mortality (O.R. 0.56, 95% CI 0.44-0.71; $p<0.001$).

Multivariable analysis demonstrated that several pre-operative conditions independently predicted 30-day mortality: male sex, increasing age, lower diffusion capacity, renal insufficiency, preoperative radiation therapy, cancer stage, extent of resection and thoracotomy as surgical approach.

Coronary artery disease was an independent predictor of mortality in women but not men. Thoracotomy as surgical approach and preoperative radiation therapy were predictive of mortality for men but not women. Post-operative prolonged air leak and empyema predicted mortality in men but not women.

Corresponding author: Betty C. Tong, MD, MHS DUMC 3531 Durham, NC 27710 (919) 613-4690 phone (919) 684-8508 fax betty.tong@duke.edu.

Conclusions—Women have lower postoperative morbidity and mortality after lung cancer surgery. Some risk factors are sex-specific with regard to mortality. Further study is warranted to determine the etiology of these differences and to determine their effect on survival.

OBJECTIVES

Lung cancer is the leading cause of cancer mortality for both men and women [1]. Several studies have demonstrated sex differences in the epidemiology, clinical presentation, tumor biology and survival from lung cancer. Compared to men, women are more likely to be diagnosed with lung cancer at a younger age [2]. Women also appear to be more susceptible to the carcinogenic effects of cigarette smoke [3]. In addition, women are more likely to be diagnosed with advanced stage disease, and nonsmokers diagnosed with lung cancer are also more likely to be women [4].

Many studies have shown a survival advantage for women regarding lung cancer prognosis and survival. These differences persist regardless of stage or treatment modality [5-7]. For patients with early stage disease undergoing surgical resection, there is a relative paucity of data describing any association between perioperative outcomes and long-term survival with NSCLC. It is possible that patients with better perioperative outcomes may have improved long-term survival outcomes, due to factors such as increased adherence to adjuvant therapy regimens.

Several studies have consistently identified male sex as a poor prognostic factor in predicting prolonged length of hospital stay and perioperative mortality, as well as long-term survival [8-11]. Using the Society of Thoracic Surgeons' (STS) General Thoracic Database, we sought to further examine sex differences in perioperative outcomes following lung cancer resection in a large cohort, and to identify whether preoperative predictors of surgical mortality differed between men and women.

METHODS

Data Source and Study Cohort

The STS Database Access and Publications Committee and the Institutional Review Board of the Duke University Medical Center approved this study. The STS General Thoracic Database was queried for all patients undergoing resection for lung cancer between 2002 and 2010. Patients younger than 18 years of age or undergoing lung resection for non-lung cancer diagnoses were excluded from the analysis.

Variables

Demographic information (age, sex), pulmonary function, preoperative comorbid conditions, extent of resection, surgical approach and pathologic stage were examined. Comorbid conditions included coronary artery disease, diabetes, prior history of chemotherapy or radiation, renal insufficiency. Procedures examined included wedge resection (single or multiple), segmentectomy, lobectomy, bilobectomy, sleeve lobectomy and pneumonectomy. For purposes of the analysis, procedures were grouped into sublobar (wedge, segmentectomy), lobar (lobectomy, sleeve lobectomy, thoracoscopic lobectomy) and greater-than-lobar resections (bilobectomy, completion pneumonectomy, standard and carinal pneumonectomy). Postoperative events considered were those identified on the Data Collection Form of the STS General Thoracic Surgery Database (http://www.sts.org/quality-research-patient-safety/national-database/database-managers/general-thoracic-surgery-databa-1).

Statistical Analysis

Fisher exact test was used to determine whether sex was predictive of postoperative complications in the selected population. Association with sex for continuous variables was tested with two-sample Wilcoxon test and for categorical variables with the Fisher exact test. In addition to 30-day or discharge mortality, individual postoperative events as defined on the database data collection form were used in the univariable model.

A logistic regression model was used to identify predictors of mortality after surgery, as defined by the STS General Thoracic Database form: immediately postoperatively until discharge, if discharge occurred > 30 days after procedure, or immediately postoperatively, up to 30 days, if discharged prior to that time. This model was then applied to the male and female portions of the cohort separately, to identify sex-specific risk factors for perioperative mortality. Only patients with complete data were considered for the multivariable model; if at least one covariate or outcome was missing, the patient was excluded from the analysis. For the multivariable model, the individual events were grouped into categories for ease of the analysis. The following categories were considered: 30-day or discharge mortality; pulmonary complications (postoperative air leak greater than 5 days, atelectasis requiring bronchoscopy, pneumonia, evidence of adult respiratory distress syndrome, bronchopleural fistula, reintubation, pulmonary embolus or deep venous thrombosis requiring treatment, initial ventilator support greater than 48 hours, tracheostomy or other pulmonary event); cardiovascular complications (atrial or ventricular arrhythmia, myocardial infarction, other cardiovascular event); gastrointestinal complications; hematologic complications (bleeding requiring reoperation, postoperative blood transfusion); infectious complications (UTI, empyema, wound infection, septicemia or other infection requiring treatment); neurologic complications (new central neurologic event, recurrent laryngeal nerve paresis, delirium tremens or other neurologic event); and miscellaneous complications (new or worsening renal failure, chylothorax, other events requiring medical treatment or other events requiring OR with general anesthesia or unexpected admission to ICU). The analysis was conducted using SAS statistical package version 9.2 (SAS Institute, Cary, NC) and R version 2.8.1 package (http://www.R-project.org).

RESULTS

Between 2002 and 2010, a total of 34,188 patients (17,545 female and 16,643 male) underwent resection for lung cancer in the STS General Thoracic Surgery Database. Women and men differed with regard to baseline characteristics and comorbid conditions (Table 1). Women were younger at the time of surgery with a mean age of 65.8 years, compared to 67.0 years for men ($p<0.001$). While the mean forced expiratory volume in 1 second (FEV_1)

was significantly higher for women as compared to men (80.4% predicted vs. 75.4% predicted, respectively, p<0.001), the diffusion capacity of carbon monoxide (DLCO) was significantly lower (69.7% predicted for women vs. 72.7% for men, p<0.001). With regard to preoperative comorbid conditions, a significantly higher proportion of men had a history of diabetes, coronary artery disease and renal insufficiency as compared to women. In contrast, significantly more women than men had undergone chemotherapy and/or radiation prior to surgery. There was a difference in pathologic stage distribution between genders (p < 0.001) with a higher proportion of women having pathologic stage I disease, relative to higher stages, as compared to men. While the majority of both groups underwent lobectomy for lung cancer resection, women had a relatively higher proportion of sublobar resection and relatively lower proportion of greater-than-lobar resection for surgery, as compared to men (p<0.001).

Of the 34,188 patients in the study cohort, there were 751 total deaths within 30 days or at discharge (2.2%). However, the mortality rates differed between men and women (Table 2). There were 259/17545 (1.5%) deaths in females; in males, there were 492/16643 (3.0%) deaths (p<0.001).

In univariable models of individual postoperative complications, sex was a significant predictor in nearly all events examined. This included each of the individual events within the pulmonary, cardiac, neurologic, hematologic, infectious and gastrointestinal categories. Female sex was not significant in predicting postoperative chylothorax, either managed medically or requiring surgical intervention (p=0.41 and 0.11, respectively). Despite the increased frequency of postoperative complications in men, there was no difference in the proportions of patients who discharged to a site other than home (i.e. nursing home).

Within the initial cohort examined, 15,529 (7823 female and 7706 male) had no missing data for variables considered in the final multivariable model of discharge or 30-day mortality. Among all patients, significant predictors of mortality included male sex, increasing age, decreasing DLCO, preoperative radiation therapy, renal insufficiency, higher pathologic stage, greater extent of resection, open thoracotomy and postoperative empyema requiring treatment (Table 3). When the groups were separated by sex, the independent predictors of mortality differed. Age, DLCO, renal insufficiency and pathologic stage were predictive in the separated groups. However, coronary artery disease was predictive of mortality in women but not men (p<0.001). Similarly, pre-operative radiation therapy (p<0.001), thoracotomy as surgical approach (p<0.001), postoperative prolonged air leak (p=0.02) and empyema (p=0.004) all were predictive of mortality in men but not women.

DISCUSSION

This study demonstrates that women and men undergoing surgery for lung cancer differ with regard to preoperative characteristics and comorbidities. At baseline, women are younger and seem to be healthier than their male counterparts, as a significantly smaller proportion of female patients reported a history of coronary artery disease, renal insufficiency and diabetes. In addition, there are sex-specific predictors of perioperative mortality for patients undergoing lung cancer resection. To our knowledge, this is the first study to identify such predictors for the female and male patient populations.

More men than women in the study cohort underwent bilobectomy, sleeve resection or pneumonectomy. There is relatively higher morbidity and mortality associated with these procedures compared to standard lobectomy and sublobar resection. The relatively higher proportion of these procedures in men may contribute to the increased perioperative mortality seen in the study. Also, a relatively higher proportion of females had stage I disease. Patients with stage I disease have a better overall prognosis, and those who avoid adjuvant therapy also avoid the toxicities associated with chemotherapy and radiation.

Interestingly, despite the fact that women had more stage I disease than men, a higher proportion of women had a history of preoperative radiation and chemotherapy. While the STS General Thoracic Database form delineates both the time course and indication for preoperative chemotherapy and radiation therapy, we did not separate these factors in the analysis. Since more women had stage I disease, and thus would be less likely to have undergone preoperative chemotherapy and radiation therapy for their lung cancer. We can only conclude, then, that the women reporting a history of preoperative chemotherapy and radiation therapy received it for a different indication, such as breast cancer.

These data also confirm that women undergoing lung cancer resection have decreased rates of postoperative morbidity and mortality following lung cancer resection. In nearly every category of postoperative complication as defined in the STS database, women had lower morbidity compared to men. Furthermore, some predictors of perioperative morbidity and mortality differ among men and women.

In general, our results are consistent with several other studies of patients undergoing surgery for lung cancer. In a study of patients undergoing lobectomy for lung cancer in the STS Database, Wright *et al*. demonstrated that male sex was an independent predictor of prolonged length of stay following surgery [11]. Rueth *et al.*, in an analysis of 4171 patients from the national Surveillance Epidemiology and End Results (SEER) database, also reported that male sex was an independent predictor of postoperative pulmonary and cardiac complications [10]. However, in contrast to the findings reported by Rueth *et al*., we found that male sex was also predictive of non-cardiopulmonary complications as well. Some possible explanations for this could be the fact that this study included patients with Stage II, III and IV disease, or that the classification of non-cardiopulmonary complications included more variables.

Having coronary artery disease was predictive of surgical mortality in women but not men. This may reflect differences in the pathophysiology, disease spectrum, clinical presentation and management of coronary artery disease in women [12]. In addition to these differences, it has been shown that the medical management and evaluation of women with cardiovascular disease differs from that of men [13, 14]. As a whole, women are referred for cardiovascular diagnostic tests less often than men, which may contribute to an underappreciation of disease extent at the time of surgery [15]. In addition, women with known cardiovascular disease treated with aspirin prophylaxis derive less protection against myocardial infarction than men [16]. While the perioperative medical management of thoracic surgery patients with known coronary disease has yet to be studied, it is also possible that practice patterns for thoracic surgeons with regard to perioperative aspirin and beta blockade differ among women and men undergoing lung resection. In light of these findings, it is important for the thoracic surgeon to optimize medical management for all patients with known coronary artery disease in the perioperative period in order to decrease the risk of mortality. Current specialty guidelines, such as those published by the American College of Cardiology, can be helpful in this setting [17].

For men but not women, thoracotomy as surgical approach and postoperative complications of prolonged air leak and empyema were predictive of mortality. It is possible that these sex-based differences are due to immunologic differences between men and women in response to surgery and physiologic stress. In studies of sepsis, women older than 50 years of age had significantly lower hospital mortality than their male counterparts [18]. It has been postulated that these differences can be attributed to increased levels of sex hormones and anti-inflammatory mediators [19]. Furthermore, it has been shown that patients undergoing thoracoscopic lobectomy have decreased immune suppression following surgery than those undergoing thoracotomy [20-22]. Since women have relatively less immune suppression following surgery as compared to men, it is possible that the immunologic benefits of VATS may be less significant for women. Also, as immunosuppression is associated with prolonged air leaks following thoracic surgery, it is conceivable that women have relatively decreased immune suppression after surgery compared to men, and thus may benefit in terms of fewer postoperative air leaks [23, 24]. Certainly this represents an area of possible future study.

In this study, pathologic stage, resection greater than lobectomy and postoperative empyema were also independent predictors of surgical mortality. This is consistent with other authors' findings [25-27]. However, in the current study, decreasing FEV_1 did not predict mortality. This is in contrast to other studies, in which FEV_1 has been associated with surgical mortality [9, 25].

Our study is potentially limited by missing data in the STS General Thoracic Database. The initial study cohort had 34,188 patients; however, due to missing data, only 15,529 were included in the multivariable model. While the data remain quite robust, including the other 18,659 patients from the initial analysis might strengthen the findings and conclusions in this study. In addition, the STS Database is a voluntary database of thoracic surgeons and may not accurately reflect procedures performed by non-participants or non-cardiothoracic surgeons.

It has been previously demonstrated that women undergoing lung cancer resection have improved long-term survival relative to men [5, 6, 8]. There are several points along the lung cancer treatment continuum that can affect outcomes and survival, including surgery and its postoperative complications. Patients with increased morbidity from surgery and prolonged hospital stays may take longer to fully recover from the operation. As such, these patients may be less likely to begin adjuvant therapy in a timely manner, and therefore may not receive the optimum benefit from this treatment. As we, and others, have demonstrated that female sex is predictive of superior postoperative outcomes, it is possible that these differences contribute to the sex-related differences in long-term survival. While several factors such as age, sex, stage, histology and performance status are known to influence long-term survival for patients with non-small cell lung cancer (NSCLC), there is relatively little information regarding the effect of perioperative outcomes on long-term survival [28, 29]. Whether the sex differences in perioperative outcomes influence the long-term survival for patients with lung cancer remains to be seen. Additional longitudinal studies of these sex differences, with particular emphasis on completion and adherence to adjuvant therapy regimens, would be helpful in this regard. Also, studies of tumor biology and response to therapy, as related to the respective female and male physiologic states, might also help to provide answers to these important questions.

Acknowledgments

Funding sources: None. Dr. Tong is an NHLBI Clinical Research Scholar of the Cardiothoracic Surgical Trials Network.

REFERENCES

1. Siegel R, Naishadham D, Jemal A. Cancer statistics, 2012. CA Cancer J Clin. 2012; 62(1):10–29. [PubMed: 22237781]
2. Harichand-Herdt S, Ramalingam SS. Gender-associated differences in lung cancer: clinical characteristics and treatment outcomes in women. Semin Oncol. 2009; 36(6):572–80. [PubMed: 19995649]
3. Ramchandran K, Patel JD. Sex differences in susceptibility to carcinogens. Semin Oncol. 2009; 36(6):516–23. [PubMed: 19995643]
4. Wakelee HA, et al. Lung cancer incidence in never smokers. J Clin Oncol. 2007; 25(5):472–8. [PubMed: 17290054]
5. Fu JB, et al. Lung cancer in women: analysis of the national Surveillance, Epidemiology, and End Results database. Chest. 2005; 127(3):768–77. [PubMed: 15764756]
6. Wisnivesky JP, Halm EA. Sex differences in lung cancer survival: do tumors behave differently in elderly women? J Clin Oncol. 2007; 25(13):1705–12. [PubMed: 17470862]
7. Sagerup CM, et al. Sex-specific trends in lung cancer incidence and survival: a population study of 40,118 cases. Thorax. 2011; 66(4):301–7. [PubMed: 21199818]
8. Chang MY, et al. Factors predicting poor survival after resection of stage IA non-small cell lung cancer. J Thorac Cardiovasc Surg. 2007; 134(4):850–6. [PubMed: 17903494]
9. Kozower BD, et al. STS database risk models: predictors of mortality and major morbidity for lung cancer resection. Ann Thorac Surg. 2010; 90(3):875–81. discussion 881-3. [PubMed: 20732512]
10. Rueth NM, et al. Surgical treatment of lung cancer: Predicting postoperative morbidity in the elderly population. J Thorac Cardiovasc Surg. 2012; 143(6):1314–23. [PubMed: 22341420]
11. Wright CD, et al. Predictors of prolonged length of stay after lobectomy for lung cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database risk-adjustment model. Ann Thorac Surg. 2008; 85(6):1857–65. discussion 1865. [PubMed: 18498784]
12. Berger JS, et al. Sex differences in mortality following acute coronary syndromes. JAMA. 2009; 302(8):874–82. [PubMed: 19706861]
13. Mosca L, et al. Evidence-based guidelines for cardiovascular disease prevention in women: 2007 update. Circulation. 2007; 115(11):1481–501. [PubMed: 17309915]
14. Lansky AJ, et al. Percutaneous coronary intervention and adjunctive pharmacotherapy in women: a statement for healthcare professionals from the American Heart Association. Circulation. 2005; 111(7):940–53. [PubMed: 15687113]

15. Tobin JN, et al. Sex bias in considering coronary bypass surgery. Ann Intern Med. 1987; 107(1): 19–25. [PubMed: 3496029]
16. Berger JS, et al. Aspirin for the primary prevention of cardiovascular events in women and men: a sex-specific meta-analysis of randomized controlled trials. JAMA. 2006; 295(3):306–13. [PubMed: 16418466]
17. Fleisher LA, et al. ACC/AHA 2007 guidelines on perioperative cardiovascular evaluation and care for noncardiac surgery: a report of the American College of Cardiology/American Heart Association Task Force on Practice Guidelines (Writing Committee to Revise the 2002 Guidelines on Perioperative Cardiovascular Evaluation for Noncardiac Surgery): developed in collaboration with the American Society of Echocardiography, American Society of Nuclear Cardiology, Heart Rhythm Society, Society of Cardiovascular Anesthesiologists, Society for Cardiovascular Angiography and Interventions, Society for Vascular Medicine and Biology, and Society for Vascular Surgery. Circulation. 2007; 116(17):e418–99. [PubMed: 17901357]
18. Adrie C, et al. Influence of gender on the outcome of severe sepsis: a reappraisal. Chest. 2007; 132(6):1786–93. [PubMed: 17890473]
19. Schroder J, et al. Gender differences in human sepsis. Arch Surg. 1998; 133(11):1200–5. [PubMed: 9820351]
20. Whitson BA, et al. Thoracoscopic versus thoracotomy approaches to lobectomy: differential impairment of cellular immunity. Ann Thorac Surg. 2008; 86(6):1735–44. [PubMed: 19021967]
21. Leaver HA, et al. Lymphocyte responses following open and minimally invasive thoracic surgery. Eur J Clin Invest. 2000; 30(3):230–8. [PubMed: 10692000]
22. Ng CS, et al. Thoracotomy is associated with significantly more profound suppression in lymphocytes and natural killer cells than video-assisted thoracic surgery following major lung resections for cancer. J Invest Surg. 2005; 18(2):81–8. [PubMed: 16036776]
23. Cerfolio RJ, et al. Predictors and treatment of persistent air leaks. Ann Thorac Surg. 2002; 73(6): 1727–30. discussion 1730-1. [PubMed: 12078760]
24. Hazelrigg SR, Nunchuck SK, LoCicero J 3rd. Video Assisted Thoracic Surgery Study Group data. Ann Thorac Surg. 1993; 56(5):1039–43. discussion 1043-4. [PubMed: 8239797]
25. Myrdal G, et al. Outcome after lung cancer surgery. Factors predicting early mortality and major morbidity. European Journal of Cardio-Thoracic Surgery : official journal of the European Association for Cardio-Thoracic Surgery. 2001; 20(4):694–9. [PubMed: 11574210]
26. Pastorino U, et al. Lung cancer stage is an independent risk factor for surgical mortality. Tumori. 2008; 94(3):362–9. [PubMed: 18705405]
27. Watanabe S, et al. Recent results of postoperative mortality for surgical resections in lung cancer. Ann Thorac Surg. 2004; 78(3):999–1002. discussion 1002-3. [PubMed: 15337036]
28. Chiang TA, et al. Important prognostic factors for the long-term survival of lung cancer subjects in Taiwan. BMC Cancer. 2008; 8:324. [PubMed: 18992131]
29. Vansteenkiste JF, et al. Survival and prognostic factors in resected N2 non-small cell lung cancer: a study of 140 cases. Leuven Lung Cancer Group. Ann Thorac Surg. 1997; 63(5):1441–50. [PubMed: 9146340]

Table 1

Sex differences in baseline and operative characteristics.

Characteristic	Female (%) N=17545 (51.3)	Male (%) N=16643 (48.7)	Total (%)	P value
Age (yrs), mean (SD)	65.8 (11.2)	67.0 (10.7)	66.4 (10.9)	< 0.001
FEV1 Predicted, mean (SD)	80.4 (23.1)	75.4 (22.7)	78.0 (23.0)	< 0.001
DLCO Predicted, mean (SD)	69.7 (22.8)	72.7 (24.0)	71.2 (23.4)	< 0.001
Diabetes Mellitus	2258 (13.2)	3003 (18.5)	5261 (15.8)	< 0.001
Coronary Artery Disease	2271 (15.4)	4786 (32.9)	7057 (24.0)	< 0.001
Preoperative Chemotherapy	2174 (14.7)	1986 (13.7)	4160 (14.2)	0.013
Preoperative Radiation Therapy	1637 (11.1)	1426 (9.8)	3063 (10.5)	< 0.001
Renal Insufficiency	262 (1.6)	518 (3.3)	780 (2.4)	< 0.001
Pathologic Stage				< 0.001
I	9648 (69.5)	8610 (65.1)	18258 (67.3)	
II	1886 (13.6)	2264 (17.1)	4150 (15.3)	
III	1893 (13.6)	1885 (14.2)	3778 (13.9)	
IV	454 (3.3)	475 (3.6)	929 (3.4)	
Extent of Resection				< 0.001
Sublobar	3713 (21.2)	3226 (19.4)	6939 (20.3)	
Lobar	12682 (72.3)	11718 (70.4)	24400 (71.4)	
> Lobar	1150 (6.6)	1699 (10.2)	2849 (8.3)	
Surgical Approach				< 0.001
Open	11309 (66.2)	11622 (72.0)	22931 (69.0)	
VATS	5772 (33.8)	4517 (28.0)	10289 (31.0)	

Table 2

Sex differences in postoperative complications

Postoperative event	Female (%) N = 17545	Male (%) N = 16643	P value
Discharge or 30-day mortality	259 (1.5)	492 (3.0)	<0.001
Air leak with duration > 5 days	1387 (7.9)	1660 (10.0)	<0.001
Atelectasis requiring bronchoscopy	522 (3.0)	686 (4.1)	<0.001
Pneumonia	537 (3.1)	800 (4.8)	<0.001
Evidence of Adult Respiratory Distress Syndrome	153 (0.9)	227 (1.4)	<0.001
Bronchopleural fistula	46 (0.3)	93 (0.6)	<0.001
Reintubation	512 (2.9)	742 (4.5)	<0.001
Pulmonary embolus or DVT requiring treatment	129 (0.7)	164 (1.0)	0.012
Initial ventilator support > 48 hours, tracheostomy, or other pulmonary event	948 (5.4)	1039 (6.2)	<0.001
Atrial arrhythmia requiring treatment	1571 (9.0)	2287 (13.7)	<0.001
Ventricular arrhythmia requiring treatment	105 (0.6)	157 (0.9)	<0.001
Myocardial infarct	44 (0.3)	94 (0.6)	<0.001
Other cardiovascular event	260 (1.5)	360 (2.2)	<0.001
Gastrointestinal complications	288 (1.6)	447 (2.7)	<0.001
Postoperative blood transfusion	965 (5.5)	1127 (6.8)	<0.001
Bleeding requiring reoperation	109 (0.6)	158 (0.9)	<0.001
Urinary tract infection	390 (2.2)	225 (1.4)	<0.001
Empyema requiring treatment	45 (0.3)	98 (0.6)	<0.001
Wound infection	59 (0.3)	81 (0.5)	0.030
Sepsis or other infection requiring treatment	163 (0.9)	254 (1.5)	<0.001
New central neurological event	90 (0.5)	112 (0.7)	0.045
Recurrent laryngeal nerve paresis or delirium tremens or other neurological event	341 (1.9)	494 (3.0)	<0.001
New renal failure requiring treatment or worsening renal function (> 2x preop value)	171 (1.0)	343 (2.1)	<0.001
Chylothorax requiring drainage or medical treatment only	64 (0.4)	52 (0.3)	0.41
Chylothorax requiring surgical intervention	40 (0.2)	053 (0.3)	0.11
Other events requiring medical treatment or other events requiring OR with general anesthesia or unexpected admission to ICU	758 (4.3)	1021 (6.1)	<0.001

NIH-PA Author Manuscript

NIH-PA Author Manuscript

Table 3

Predictors of mortality after lung cancer resection

Variable	All Patients OR [95% CI]	P value	Males OR [95% CI]	P value	Females OR [95% CI]	P value
Female sex	0.56 [0.44, 0.71]	<0.001				
Age	1.06 [1.04, 1.07]	<0.001	1.07 [1.08, 1.09]	<0.001	1.04 [1.02, 1.06]	<0.001
DLCO	0.98 [0.97, 0.98]	<0.001	0.98 [0.97, 0.99]	<0.001	0.97 [0.96, 0.98]	<0.001
Coronary Artery Disease	1.23 [0.97, 1.56]	0.095	1.09 [0.82, 1.45]	0.54	1.64 [1.05, 2.56]	0.035
Pre-operative Radiation Therapy	1.60 [1.05, 2.46]	0.033	1.86 [1.07, 3.25]	0.03	1.24 [0.64, 2.42]	0.53
Renal Insufficiency	3.13 [2.09, 4.68]	<0.001	2.80 [1.75, 4.49]	<0.001	4.68 [2.19, 10.04]	<0.001
Pathologic Stage		<0.001		0.007		0.048
I	1.00		1.00		1.00	
II	1.05 [0.76, 1.44]		1.19 [0.82, 1.73]		0.79 [0.42, 1.49]	
III	1.65 [1.24, 2.21]		1.65 [1.14, 2.38]		1.69 [1.04, 2.74]	
IV	2.43 [1.46, 4.05]		2.53 [1.23, 4.77]		2.19 [0.91, 5.25]	
Extent of Resection		<0.001		<0.001		<0.001
Sublobar	1.00		1.00		1.00	
Lobar	1.53 [1.07, 2.19]		1.63 [1.03, 2.60]		1.41 [0.80, 2.48]	
> Lobar	4.51 [2.95, 6.89]		4.81 [2.82,8.22]		4.44 [2.18, 9.05]	
Approach		0.008				0.65
Thoracotomy	1.00		1.00	0.003	1.00	
VATS	0.69 [0.52, 0.91]		0.58 [0.40, 0.85]		0.90 [0.58, 1.41]	
Postoperative Air Leak > 5 days	1.33 [0.96, 1.84]	0.096	1.58 [1.08, 2.30]	0.023	0.88 [0.45, 1.71]	0.69
Postoperative Empyema	3.99 [1.88, 8.45]	0.002	3.82 [1.68, 8.65]	0.005	4.38 [0.55, 34.72]	0.25