The effect of surgeon volume on procedure selection in non–small cell lung cancer surgeries

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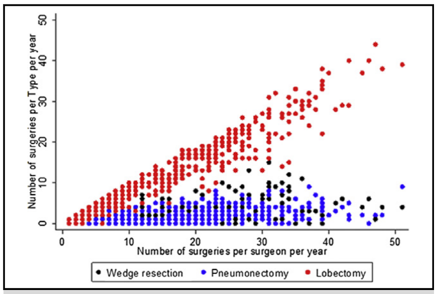
ABSTRACT

Objectives: Procedure selection by the surgeon can greatly affect patients' operative and long-term survival. This selection potentially reflects comfort with technically challenging surgeries. This study aims to examine surgeon choices for non–small cell lung cancer and whether surgeon volume predicts the type of procedure chosen, controlling for patient demographics, comorbidity, year of surgery, and institutional factors.

Methods: Data were abstracted from an Ontario population-based linked database from 2004 to 2011. Patient demographics, comorbidities, year of surgery, and institutional and surgical factors were evaluated. Three-level, random-effect, multilevel regression analyses were performed to examine factors influencing operative selection.

Results: Over the interval, 8070 patients (50.4% were male) underwent surgical resection, including pneumonectomy (n = 842), lobectomy (n = 6212), and wedge resection (n = 1002). Resections were performed by 124 unique physicians in 45 institutions. The proportion of patients undergoing pneumonectomy decreased from 14.8% in 2004 to 7.6% in 2011. Multilevel regression analysis showed physician volume, age, year of procedure, gender, and comorbidities were predictive of performing a pneumonectomy. By adjusting for these variables, the results indicated that for each 10-unit increase in physician volume, the relative risk of performing a pneumonectomy decreased by 9.1% (95% confidence interval, 8.2-10.0, $P = .04$).

Conclusions: Although patient and temporal factors influence the type of resection a patient receives for non–small cell lung cancer, surgeon volume also is a strong predictor. This study may be limited by minimal stage data, but the suggestion that a surgeon's total procedural volume for non–small cell lung cancer significantly influences procedure selection has implications on how we deliver care to this patient population. (J Thorac Cardiovasc Surg 2015;150:507-13)



Observed relationship between surgeon volume and procedure type.

Central Message

Surgeon volume is a predictor of procedure selection along with within-patient factors and has implications on the delivery of care.

Perspective

The type of resection selected significantly affects a patient's operative and long-term survival. If a surgeon with high surgical volumes is less likely to perform higher-risk pneumonectomy procedures than one with lower volumes, this may translate to a significant reduction in adverse events. Surgeon volume should be considered an important component in how care is delivered in this population.

See Editorial page 458.

GTS

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Lung cancer represents a large burden of disease affecting health care systems worldwide.[1-3] In Canada, it is the second most common cancer in both male and female individuals, and the fourth most prevalent cancer overall.[4] It is estimated that 25,500 new cases of lung cancer were diagnosed in 2013.[4] Despite the significant decrease in the lung cancer mortality rate over the past 20 years, it remains the leading cause of cancer-related death in Canada, accounting for the deaths of 20,200 Canadians in 2013.[4]

Surgical resection is associated with optimal outcomes for early-stage lung cancer.[3-8] Approximately 20% to 25% of patients undergo resection because it provides the best long-term survival for those with non–small cell lung cancer (NSCLC).[9-11] Surgically resectable patients undergo anatomic resections, pneumonectomy and lobectomy, or

Abbreviations and Acronyms

CCI = Charlson Comorbidity Index
NSCLC = non–small cell lung cancer

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sublobar resections, including segmentectomy and wedge resection.[2-4,12] Lobectomy is noted as the most common and recommended resection choice for patients with early-stage NSCLC.[1-5] Lobectomy is ideal because of its parenchyma-sparing technique and a decreased rate of cancer recurrence compared with lesser resections,[1-3,13] although sublobar resections also can result in reasonable outcomes in appropriately selected patients.[1,3,11,14] Pneumonectomy is less desirable with a significantly higher morbidity and mortality rate, reported to be approximately 10%, whereas lobectomy and subanatomic resections have reported rates of 4% and less than 4%, respectively.[15-18] This indicates that pneumonectomy cases carry a 3-fold greater mortality than the other resection types. A pneumonectomy is often avoidable with the use of advanced techniques, although this procedure is occasionally necessary because of tumor location.[1,2]

Procedure selection by the surgeon has one of the greatest effects on patients' operative and long-term survival. Well-established pathologic and physiologic factors influence a surgeon's choice of surgery, including tumor biology and location, extent of disease (stage), and patient-specific factors, such as age, pulmonary function, and comorbidity.[1-3,12,14] Only over the past decade have surgeon-specific factors, such as experience, training, and volume, been identified and examined as other important determinants of outcomes in patients with lung cancer.[3,19-21] Resections performed by dedicated thoracic surgeons are reported to be advantageous, resulting in lower mortality and improved survival.[1,3,19-21] Likewise, hospital volume is associated with improved surgical outcome after lung cancer resection.[18,19]

It is intuitive that surgeon-specific factors, such as experience, influence a surgeon's procedure selection. It is hypothesized that choice of surgery may reflect the surgeon's comfort level with technically challenging procedures. That is, a surgeon with less expertise may be more inclined to perform a pneumonectomy or sublobar resections, which can be less challenging than a guideline-recommended standard or sleeve lobectomy. This potential relationship has not been addressed in the current literature. Therefore, the aim of this study is to examine the choice of procedure that surgeons make for NSCLC and whether a surgeon's volume is predictive of the type of procedure, controlling for patient demographics, comorbidity, year of surgery, and institutional factors.

MATERIALS AND METHODS

The dataset was constructed from the population-based linked databases accessed via the Institute for Clinical Evaluate Sciences. These databases included data from the Ontario Cancer Registry, Ontario Health Insurance Plan claims, Canadian Institutes for Health Information Discharge Abstract Database, and the National Ambulatory Care Reporting Service database. All patients in Ontario who underwent any pulmonary resection for primary NSCLC during 2004 to 2011 were included. The Canadian enhancement of the International Classification of Diseases 10th revision was used to describe diagnosis and morphology. Inclusion of code C34.XX, referring to neoplasm located within the lung, with the attendant morphology codes for primary squamous cell carcinoma not otherwise specified, primary adenocarcinoma, primary bronchioalveolar adenocarcinoma, and primary alveolar adenocarcinoma, ensured that all types of patients with NSCLC were included. All surgeons are trained as general thoracic surgeons, who have completed a 2-year residency after qualifying as a general or cardiac surgeon, as per Ontario thoracic surgery practice standards.

To reduce the confounding effect of cancer reoccurrence, all Z85 codes, indicating a personal history of other malignant neoplasms, were excluded. Synchronous tumors were excluded because of the varied nature of their occurrence. Secondary or extended resections were not analyzed. Only pneumonectomy, lobectomy, and wedge resection procedures were examined. Both thoracotomy and thoracoscopic procedures were included in the analysis. Laterality of surgery, physical performance test results (eg, physical fitness testing, maximum value of oxygen, and exercise tolerance tests), Eastern Cooperative Oncology Group score, histology of tumor, and causes of mortality were not analyzed because these variables were not available in the dataset.

De-identified information on gender, age, year of procedure, income quintile, location of residence (rural vs urban), institution volume (total number of surgeries performed per institution per year), surgeon volume (total number of surgeries performed per surgeon per year), length of stay, in-hospital mortality, and postdischarge mortality was collected. Comorbidities were recorded using the Charlson Comorbidity Index (CCI) both as individual conditions and as an aggregate index score. To adjust for risk factors, the CCI was calculated using prehospitalization Canadian enhancement of the International Classification of Diseases 10th revision codes, following a previously validated method.[22-24] The study was approved by the Hamilton Integrated Research Ethics Board with a waiver of patient consent.

Patient characteristics were summarized, and descriptive and graphic assessments of outcome trends over time were performed. Age data were available only as grouped intervals. Thus, to estimate average age, the products of the midpoint of each class interval and the frequency for that interval were summed and divided by the total of all frequencies. The lowest and highest intervals were excluded from this calculation because a midpoint could not be determined for the "low to 35" or "91-high" intervals.

The 90-day mortality for each procedure was calculated. Multilevel logistic regression analyses were performed to examine factors that influence a surgeon's choice of surgery. A 3-level random effects model was used to control for the cluster effect of physician nested within institution. Patient age, gender, year of surgery, location of residence (urban, rural), income quintile, and risk factors as determined by the CCI were adjusted for in the analyses. Variables with a significant effect on each outcome variable were reported.

Because of limited availability, stage data could not be included as a predictor variable in the regression model. However, accurate stage data were available for the last 2 years of study, 2010 and 2011. These were added to the multilevel regression model to examine trends that could be attributed to stage of disease. Because of small sample sizes, stage I and substages IA and IB were grouped into a single class variable with no difference to final outcomes, and substages of stage II, III, and IV were grouped in the same manner. Stages 0, X, NS, NA, or otherwise unknown were excluded for clarity of analysis. Stage I was used as the reference variable.

By using the available stage data from 2010 and 2011, the relationship between stage and surgeon volume was also analyzed. Low-, medium-, and high-volume surgeons were distinguished by dividing the variable into tertiles. STATA/SE software version 12.1 (StataCorp LP, College Station, Tex) was used to complete the statistical analyses.