Readmission after lung cancer resection is associated with a 6-fold increase in 90-day postoperative mortality

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Objectives: Postoperative readmission affects patient care and healthcare costs. There is a paucity of nationwide data describing the clinical significance of readmission after thoracic operations. The purpose of this study was to evaluate the relationship between postoperative readmission and mortality after lung cancer resection.

Methods: Data were extracted for patients undergoing lung cancer resection from the linked Surveillance Epidemiology and End Results–Medicare registry (2006-2011), including demographics, comorbidities, socioeconomic factors, readmission within 30 days from discharge, and 90-day mortality. Readmitting facility and diagnoses were identified. A hierarchical regression model clustered at the hospital level identified predictors of readmission.

Results: We identified 11,432 patients undergoing lung cancer resection discharged alive from 677 hospitals. The median age was 74.5 years, and 52% of patients received an open lobectomy. Thirty-day readmission rate was 12.8%, and 28.3% of readmissions were to facilities that did not perform the original operation. Readmission was associated with a 6-fold increase in 90-day mortality (14.4% vs 2.5%, $P < .001$). The most common readmitting diagnoses were respiratory insufficiency, pneumonia, pneumothorax, and cardiac complications. Patient factors associated with readmission included resection type; age; prior induction chemoradiation; preoperative comorbidities, including congestive heart failure and chronic obstructive pulmonary disease; and low regional population density.

Conclusions: Factors associated with early readmission after lung cancer resection include patient comorbidities, type of operation, and socioeconomic factors. Metrics that only report readmissions to the operative provider miss one-fourth of all cases. Readmitted patients have an increased risk of death and demand maximum attention and optimal care. (J Thorac Cardiovasc Surg 2014;148:2261-7)

See related commentary on pages 2267-8.

Supplemental material is available online.

Lung cancer is the leading cause of cancer death in the United States,[1] and resection remains the treatment of choice for appropriate surgical candidates with early-stage disease.[2] Early postoperative readmission is not only clinically relevant[3] but also an important predictor of increased resource use.[4] Beginning in October of 2012, the Affordable Care Act established the Hospital Readmissions Reduction Program, reducing Medicare payments for excess readmissions for acute myocardial infarction, pneumonia, and heart failure.[5] Because most early postoperative readmissions are perceived as preventable, incentives to reduce their occurrence are likely forthcoming in the future.

Currently, there is a paucity of national data describing the frequency of postoperative readmissions after lung cancer resection. Data from the American College of Surgeons National Surgical Quality Improvement Program report 30-day readmission after all thoracic operations to be 11.9%,[6] but further granularity is necessary to elaborate a pragmatic quality metric. Although the development of a risk-adjusted readmission metric for coronary artery bypass surgery is under way through the Society of Thoracic Surgeons (STS),[7] such a process is nonexistent for pulmonary resections. The STS General Thoracic Surgery Database includes postoperative outcomes up to 30 days for member providers, but because the STS is composed primarily of thoracic surgery specialists,[8] the Surveillance Epidemiology and End Results (SEER)-Medicare database may better represent operative experiences nationwide.[9]

The primary objectives of this study were to determine the frequency and associated risk factors of early readmission after lung cancer resection and to assess the impact

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Funded by the Agency for Healthcare Research and Quality: K080HS18049.
Disclosures: Authors have nothing to disclose with regard to commercial support.
Received for publication Jan 29, 2014; revisions received March 25, 2014; accepted for publication April 11, 2014; available ahead of print May 10, 2014.

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0022-5223/$36.00

http://dx.doi.org/10.1016/j.jtcvs.2014.04.026

Abbreviations and Acronyms
OR = odds ratio
SEER = Surveillance Epidemiology and End Results
STS = Society of Thoracic Surgeons
VATS = video-assisted thoracoscopic surgery

of readmission on 90-day outcomes. We hypothesized that readmission within 30 days of discharge is associated with an increased risk of subsequent mortality.

METHODS

Surveillance Epidemiology and End Results–Medicare Database

The SEER registry is a population-based collection of incident cases and includes cancer diagnostic, descriptive, and therapeutic information relevant to the time of diagnosis. The National Cancer Institute links the SEER registry to Medicare data for eligible patients to provide comprehensive information on survival, inpatient admissions, outpatient events, and other healthcare claims for 93% of patients aged 65 years or more.[10] These data accurately account for postoperative readmissions and are not limited to readmissions taking place at the facilities providing the index operation. The combined SEER-Medicare database encompasses approximately 26% of the population and provides an opportunity for longitudinal studies broadly generalizable to the Medicare population.

Patient Selection

The 2006 to 2010 SEER-Medicare database was used to identify records for all patients aged 66 years or more with non–small cell lung cancer of any stage by American Joint Committee on Cancer criteria who received surgical resection.[11] Exclusionary criteria included enrollment in a Medicare Health Maintenance Organization, lung cancer diagnoses made at autopsy, prior lung cancer diagnoses within 1 year of index diagnosis, missing date of diagnosis, wedge resection for stage IV disease, and death before discharge from the operative admission. To ensure that all patients had adequate presurgical records to identify comorbid diseases present at the time of surgery, we also excluded patients who were not eligible for Medicare during the 3 months before surgery or who were diagnosed in 2006.

Demographic information available in the SEER-Medicare data included age, gender, race, and the operative and readmitting facilities. Clinical data included year of operation, final pathologic stage, procedure type and approach, preoperative comorbidities, and readmission diagnoses. To differentiate between readmissions for operative complications and unrelated readmissions, a panel of International Classification of Diseases, Ninth Revision codes composed of respiratory, infectious, cardiac, wound, and renal diagnoses were matched to readmission diagnoses recorded in the SEER-Medicare database (Table E1). Comorbidities were identified using the Deyo modification of the Charlson index[12] and were defined using criteria provided by the National Cancer Institute for use with diagnoses reported within inpatient files (Medicare Provider Analysis and Review), outpatient files (Outpatient Statistical Analysis File), and physician claims data (National Claims History).[13,14] Mortality measures were based on Medicare death certificate records within the SEER-Medicare database. The primary outcomes were readmission within 30 days of discharge from the operative admission and mortality within 90 days of surgery.

Statistical Analyses

The mortality rate within 90 days of surgery was compared between the readmitted and nonreadmitted patient groups. Subgroup analyses included mortality rate comparisons based on the readmitting facility (operative vs nonoperative) and readmitting diagnosis (operative complication vs unrelated). To compare mortality rates between patients who were readmitted and patients who were not, a hierarchical generalized linear model for 90-day mortality using previously reported model predictors in addition to 30-day readmission and restricted to patients who were discharged alive was created.[15] A single hierarchical generalized linear model was used to estimate risk of readmission, with adjustments for data clustered by treatment provider. Model predictors were selected a priori on the basis of literature review and frequency of occurrence within our dataset, and included both clinical and socioeconomic risk factors. The statistical significance of each predictor of readmission included in the models was assessed using the F test statistic. A test for provider covariance was performed to determine whether risk-adjusted readmission rates varied significantly between operative providers. All outcomes data were analyzed using SAS version 9.3 (SAS Institute, Inc, Cary, NC) and R version 3.0.2 statistical software.[16] The University of Virginia Institutional Review Board for Health Sciences Research approved this study.

RESULTS

For patients diagnosed with non–small cell lung cancer between 2007 and 2009, SEER-Medicare captured 11,432 patients who were discharged alive after resection and who met all inclusion criteria. The median age was 74.5 years at the time of surgery, and most patients presented with stage I disease (70.4%). Approximately half of patients were female (51.5%), and the predominant race was white (89.7%). The most common procedure performed was an open lobectomy (51.6%), and thoracoscopic approaches accounted for 26.8% of resections (Table 1). The most common preoperative comorbidities were chronic pulmonary disease, diabetes, and peripheral vascular disease. Patients included within the final study population were treated at 677 hospitals.

The overall readmission rate within 30 days of discharge was 12.8% (1461/11,432), and 28.3% (414/1461) of readmissions were to facilities that did not perform the index operation. The median length of stay during postoperative readmissions was 4 days (interquartile range, 2-7 days). Readmissions were more frequent within the first 2 weeks after discharge (Figure 1). The mortality rate within 90 days of surgery was approximately 6 times higher among patients who experienced at least 1 early readmission (odds ratio [OR], 6.6; 14.4% [210/1461] vs 2.5% [249/9971], $P < .001$). Among readmitted patients, those who underwent 2 or more readmissions within 60 days of discharge did not have a significantly higher 90-day mortality rate than those readmitted only once (16.2%, 58/358 vs 13.8%, 152/1103, $P = .295$). In a hierarchical generalized linear model for 90-day mortality, postoperative readmission within 30 days had the largest contribution to predicting mortality risk (OR, 5.79; $P < .001$, F-test statistic 291). The model C-statistic was 0.80 (Table 2).

Ninety-day mortality did not differ between patients who were readmitted to the operative facility and patients who were readmitted to an alternate facility (13.6% vs 16.4%, $P = .16$). However, of patients initially readmitted to a