Postoperative Mortality Is an Inadequate Quality Indicator for Lung Cancer Resection

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Background. **Postoperative mortality is the most commonly reported surgical quality measure. However, such metrics may be incapable of identifying performance outliers. The purpose of this study was to compare different measures of postoperative mortality after lung cancer resection using a large multiinstitutional database.**

Methods. **Data were extracted for lung cancer resection patients from the linked Surveillance Epidemiology and End Results–Medicare Registry (2006 to 2010), which provides detailed and longitudinal information about Medicare beneficiaries with cancer. Four definitions of postoperative mortality were evaluated: in-hospital, 30-day, perioperative, and 90-day. Hierarchical regression models were used to estimate mortality risk at 30 and 90 days, and provider quality was assessed by comparing observed versus expected mortality.**

Results. **We identified 11,787 lung cancer resection patients from 686 hospitals. The median age was 74 years, and 52% of patients were treated with open lobectomy. Although 30-day, perioperative, and in-hospital mortality rates were between 3% and 4%, 90-day mortality was almost double (6.89%). Clinical variables associated with 90-day mortality included sex, preexisting comorbidities, and procedure type. There were no statistically significant differences in 30-day or 90-day mortality rates among providers.**

Conclusions. **Currently reported measures of in-hospital and 30-day postoperative mortality do not adequately represent a patient's true mortality risk as mortality almost doubles by 90 days. Because of low occurrence rate and variable provider volumes, neither 30-day nor 90-day mortality is a suitable quality indicator for lung resection.**

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Lung cancer remains the leading cause of cancer death in the United States [1]. Over the past decade, The Society of Thoracic Surgeons (STS) general thoracic surgery database (GTSD) has provided data reflecting predictors of morbidity and mortality after surgical interventions for lung and esophageal cancer [2–6]. Within this database composed primarily of board-certified thoracic surgeons at high-volume centers, 30-day postoperative mortality has been estimated at 2.2% [7], and thoracoscopic techniques have been associated with reduced postoperative morbidity [8, 9]. Although the STS-GTSD data consist primarily of general thoracic surgery specialists [6], the Surveillance Epidemiology and End Results (SEER)–Medicare database may better represent operative experiences nationwide [10].

The Center for Medicare and Medicaid Services derives its surgical quality indictors from the Agency for Healthcare Research and Quality, with heavy focus on in-hospital and 30-day mortality. These quality indicators possess inherent appeal: they are clinically relevant and accurately measured through claims records. However, as critical care capabilities improve and thoracic specialists pursue more aggressive resections, 30-day mortality may underestimate surgery-related mortality and morbidity [11–13]. Although 90-day mortality is a clinically relevant outcome measure, this metric is rarely reported as most databases do not track patients after 30 days. Furthermore, there is little evidence that postoperative mortality is able to differentiate between good and poor performers given its low occurrence rate and variable provider volumes.

The objectives of this study were to compare in-hospital, 30-day, perioperative, and 90-day mortality measures after lung cancer resection and to assess the capacity of these mortality metrics to differentiate between good and poor performers.

Material and Methods

SEER-Medicare Database

The SEER registry is a population-based collection of incident cases, and includes cancer diagnostic, descriptive, and therapeutic information linked to survival data. The National Cancer Institute links the SEER registry to

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Medicare data for eligible patients to provide comprehensive information on survival, inpatient admissions, outpatient events, and other healthcare claims for 93% of patients 65 years old or older [14]. Although there are differences between SEER registry patients and the Medicare population as a whole, 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 age 66 years or greater with non-small cell lung cancer (NSCLC) of any stage by American Joint Committee on Cancer criteria who received surgical resection [15]. Exclusionary criteria included enrollment in a Medicare Health Maintenance Organization, lung cancer diagnoses made at autopsy, prior lung cancer diagnosis within 1 year of index diagnosis, missing date of diagnosis, and wedge resection for stage IV disease as this was more likely to be a diagnostic procedure. To ensure that all patients had at least 1 year of presurgical records to identify comorbid diseases present at the time of surgery, we additionally excluded patients who did not meet insurance criteria during the 3 months before surgery or who were diagnosed in 2006.

Demographic information included age, sex, race, and treating facility. Clinical data included year of operation, final pathologic stage, procedure type and approach, and comorbidities. Comorbidities were identified using the Deyo modification of the Charlson index [16], and were collected using SAS search code provided by the National Cancer Institute based on inpatient files (MEDPAR), outpatient files (OUTSAF), and physician claims data (NCH) [17, 18]. The primary objectives were to estimate patient risk and compare providers across four postoperative outcomes measures, namely, in-hospital, 30-day, perioperative, and 90-day mortality. In-hospital mortality was defined as death before discharge after surgery, and perioperative mortality included any death occurring in hospital or within 30 days of surgery. All mortality measures were based on Medicare death certificate records within the SEER-Medicare database.

Statistical Analyses

To compare 30-day and 90-day mortality, we calculated the 95% confidence interval for proportion of deaths occurring in the second and third months postoperatively. Hierarchical generalized logistic regression models were used to estimate 30-day and 90-day mortality risk, with adjustments for data clustered by treatment provider. Model predictors were selected a priori based on literature review and frequency of occurrence within our dataset. Modeling was first performed with individual comorbidity variables, and then repeated using the composite Charlson-Deyo comorbidity index score. The statistical significance of each predictor of mortality included in the models was assessed using the F test statistic.

To test the utility of mortality rate as a quality measure, we removed the hospital clustering effect to calculate an expected mortality rate for each hospital based on patient characteristics, and then compared this to each provider's observed mortality. A Bonferroni correction was used to adjust for multiple comparisons at the alpha = 0.05 level. All outcomes data were analyzed using SAS statistical software (version 9.3; SAS Institute, Cary, NC). Provider volume data are represented using R statistical software together with the ggplot package [19, 20]. The University of Virginia Institutional Review Board for Health Sciences Research approved this study.

Results

Between 2007 and 2010, SEER-Medicare captured data of 11,787 patients who underwent surgical resection for NSCLC and met all inclusion criteria (Fig 1). The median age was 74 years at the time of surgery, and most patients presented with stage I disease (70%; 8,103 of 11,787). Roughly half of patients were female (51%; 6,012 of 11,787), and the predominant race was white (89.6%; 10,599 of 11,787). The most common procedure performed was an open lobectomy (51.9%; 6,119 of 11,787), and thoracoscopic approaches accounted for 26.4% of resections (3,110 of 11,787; Table 1). Patients included within the final study population were treated at 686 hospitals. Hospital case volume ranged between 1 and 383 cases, and one third of hospitals (32.9%; 226 of 686) treated 2 or fewer patients during the study period (Fig 2). Postoperative mortality rates are shown in Table 2. Whereas 30-day, perioperative, and in-hospital mortality rates

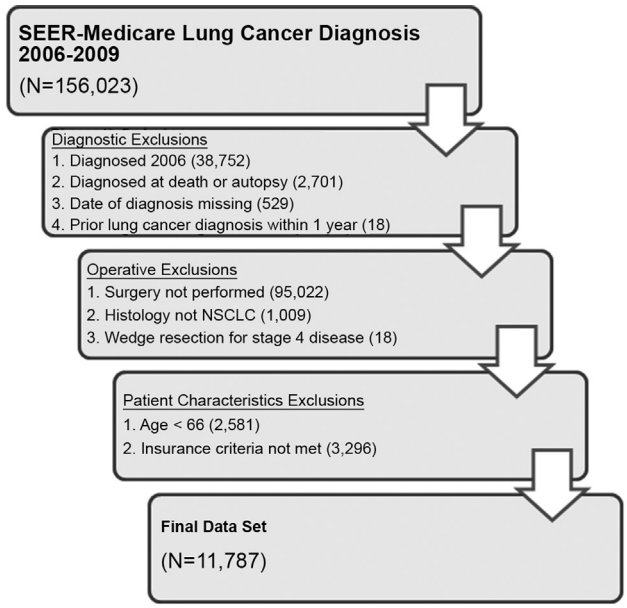

Fig 1. Inclusion and exclusion criteria for lung cancer resection dataset, based on the 2006 to 2010 SEER-Medicare registry. Patients diagnosed in 2006 were excluded to ensure availability of 1 year of preoperative comorbidity records. (NSCLC = non-small cell lung cancer; SEER = Surveillance Epidemiology and End Results.)