Pulmonary resections performed at hospitals with thoracic surgery residency programs have superior outcomes

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Objective: Pulmonary resections are performed at thoracic residency (TR), general surgery residency (GSR), no surgery residency, and no residency hospitals. We hypothesize that morbidity and mortality for these procedures are different between hospitals and that operations performed at TR teaching hospitals have superior results.

Methods: Records of adults who underwent pneumonectomy, lobar, segmentectomy, and nonanatomic wedge resections (N = 498,099) were evaluated in an all-payer inpatient database between 2003 and 2009. Hospital teaching status was determined by linkage to Association of American Medical College's Graduate Medical Education Tracking System. Multiple hierarchical regression models examined the in-hospital mortality, occurrence of any complication, and failure to rescue.

Results: The mean annual pulmonary resection volume among hospitals was TR (16%), GSR (17%), no surgery residency (28%), and no residency (39%). Unadjusted mortality for all procedures was lowest at TR hospitals ($P < .001$). Likewise, any complication was least likely to occur at TR hospitals ($P < .001$). After case-mix adjustment, the risk of any complication after segmentectomy or nonanatomic wedge resection was lower at TR hospitals than in GSR hospitals ($P < .001$). Among pneumonectomy recipients, TR hospitals reduced the adjusted odds ratio of failure to rescue by more than 25% compared with no surgery residency ($P < .001$). Likewise, in patients who underwent pneumonectomy, TR centers were associated with reducing the odds ratio of death by more than 30% compared with GSR hospitals ($P < .001$).

Conclusions: In comparison with other hospitals, including GSR hospitals, TR hospitals have lower morbidity and mortality. These results support using hospitals with a TR as an independent prognostic indicator of outcomes in pulmonary resections. (J Thorac Cardiovasc Surg 2013;145:60-7)

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The regulatory climate in the United States has led to increased scrutiny of postsurgical quality and outcomes, including those after pulmonary resections, and as such, center and surgeon performance data are being made readily accessible.[1-3] As a quality indicator, the Center for Medicare and Medicaid Services intends to expand public reporting of procedure-related outcomes.[3-6] It is anticipated that similar to coronary artery bypass grafting, other procedures, such as pulmonary resections, will be included in such reports. Pulmonary resections, such as pneumonectomy, lobar, segmentectomy, and nonanatomic wedge resections, are performed in a variety of hospitals, including those with thoracic surgery residency (TSR), general surgery residency (GSR), no surgery residency (NSR), and no residency (NR).

Pay-for-performance incentive programs for such specialty surgeons have expanded over the last decade and shifted their reimbursement strategies from process measures to outcome effectiveness measures.[7-9] Establishing assessable and computable metrics among surgical subspecialties is important for effective comparisons.[9] Furthermore, failure to discriminate the outcomes between thoracic surgery and general surgery teaching hospitals may falsely suggest similar outcomes at these centers.

On the basis of volume-to-outcome associations,[10,11] currently considered one of the benchmarks for various outcome and quality programs,[12] the systematic channeling of patients to disease-specific specialists at teaching hospitals has grown.[13,14] Clinical outcomes ultimately will drive referral patterns, costs, and access to care as interpreted by patients, providers, and payers. On the basis of these characteristics, we hypothesized that pulmonary resections performed at teaching and nonteaching hospitals have different outcomes. Although this question has been partly

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Abbreviations and Acronyms

ACGME = Accreditation Council for Graduate Medical Education
AHRQ = Agency for Healthcare Research and Quality
AUC = area under the receiver operating characteristic curve
GSR = general surgery residency
ICD-9-CM = International Classification of Diseases, 9th Revision, Clinical Modification
NIS = Nationwide Inpatient Sample
NR = no residency
NSR = no surgery residency
TSR = thoracic surgery residency

studied in the context of lung cancer–related resections,[15,16] a contemporary series evaluating the impact of all-cause pulmonary resections performed at any type of hospital in the United States remains unknown. In addition, we postulated that even among surgery teaching hospitals, TSR and GSR programs would have differences in outcomes.

MATERIALS AND METHODS

Data Sources

Data were abstracted from the 2003 to 2009 Nationwide Inpatient Sample (NIS). The NIS is the largest Healthcare Cost and Utilization Project all-payer inpatient database, sponsored by the Agency for Healthcare Research and Quality (AHRQ).[17] No data imputations were performed, datasets were reviewed for any systematically missing values, and records accordingly were excluded from evaluation.

Hospital identifiers were abstracted from the American Hospital Association 2009 database. The NIS and American Hospital Association databases contain deidentified administrative-level data and were not considered human subjects research; thus, they were exempted from review by the University of Virginia's Human Investigation Committee.

Patients and Groups

Patients were selected (N = 498,099) if they underwent a pneumonectomy, lobar, segmentectomy, or a nonanatomic wedge resection using International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9-CM) codes—pneumonectomy: 32.5, 32.50, and 32.59; lobar: 32.4, 32.41, and 32.49; segmentectomy: 32.3, 32.30, and 32.39; and nonanatomic wedge resection: 32.29. All procedure codes (PR1-PR15) were queried to identify patients as having undergone either of these procedures regardless of indication. Cases in which multiple pulmonary resections occurred were assigned to a group on the basis of the first resection code to avoid double counting any record. Patient risk factors were assessed using the AHRQ comorbidities developed by Elixhauser and colleagues,[18] which provide effective adjustments for mortality risk among surgical populations.[19]

Hospital Educational Status Assignment

Hospital educational status was determined by identifying all Thoracic Surgery or General Surgery residency training programs accredited by the Accreditation Council for Graduate Medical Education (ACGME), as identified by the American Medical Association Fellowship and Residency Electronic Interactive Database Access Online System.[20] On the basis of these strata, hospitals were differentiated into TSR (N = 73), GSR (N = 244), NSR (N = 1135), and NR (N = 4133) hospitals. ACGME training programs where a Thoracic Surgery and General Surgery residency coexist were coded as TSR hospitals. The American Hospital Association, American Medical Association Fellowship and Residency Electronic Interactive Database Access Online System, and NIS databases were then cross-linked by an identifier key, while maintaining the integrity of the deidentified data among NIS records for assigning teaching status.

Outcomes of Interest

In-hospital mortality, risk of complication, and failure to rescue, defined as mortality after a complication, were the primary outcomes of interest. Risk of complication included any complication that was identified and limited to the hospital admission recorded ICD-9-CM codes. Because the NIS contains inpatient data, only complications occurring after hospital discharge cannot be evaluated. Several ICD-9-CM codes were adapted from previously described work to identify the occurrence of a complication.[21]

Statistical Analysis

Descriptive statistics were computed as described.[21] Hospital educational status annual mean case volume, unadjusted mortality, complication rate, and failure to rescue were calculated. Hierarchical generalized linear equations calculated the adjusted odds of the dependent variable (by controlling for differences in case-mix, hospitalization, and administrative features, ie, [1] patient characteristics such as risk factors, gender, and age; and [2] hospital and administrative characteristics such as admission month, year, center bed size, and region of the United States where the center is located). Model covariates were selected a priori on the basis of decisions about their likely contribution toward the prediction of the outcome.[22-25] All covariates selected for inclusion were retained in the final models. The models' predictive capacity to discriminate was measured by computing the area under the receiver operating characteristic curve (AUC).

We present the results from mixed-effects models. There was no discernible difference in model performance characteristics or parameter estimates between these 2 approaches. To confirm model validation, we created randomly resampled equal split-samples from the original annual dataset(s), using the derivation dataset(s) to develop our models, and the confirmatory dataset(s) for validation. These 2 sets of models had minimal decrement (did not change by > 10%). All data were analyzed using IBM SPSS Complex Samples 20 (SPSS Inc, An IBM Co, Armonk, NY). Adjustments for the stratification structure in the NIS datasets were made using appropriate discharge weights.

RESULTS

Annual case volumes are lowest at hospitals with TSR programs. TSR hospitals performed the fewest pulmonary resections annually (16%) (Tables 1 and 2). NR hospitals (N = 4133) performed the highest proportion of pulmonary resections annually (39%), and GSR teaching hospitals (N = 707) performed approximately more than half the proportion of pulmonary resections versus NSR teaching hospitals (N = 1135) (GSR: 17%, NSR: 28%). There was a 34% decrease in association with pulmonary resection volume at TSR hospitals (N = 331) between 2003 and 2009. These data confirm that NR hospitals perform more pulmonary resections than hospitals with surgery residencies.