Failure to rescue and pulmonary resection for lung cancer

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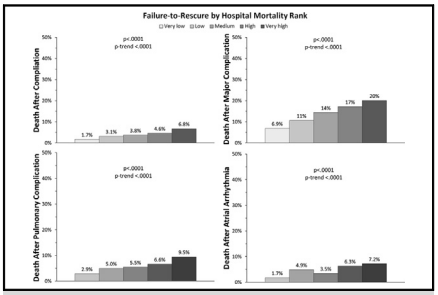
ABSTRACT

Objective: Failure to rescue is defined as death after an acute inpatient event and has been observed among hospitals that perform general, vascular, and cardiac surgery. This study aims to evaluate variation in complication and failure to rescue rates among hospitals that perform pulmonary resection for lung cancer.

Methods: By using the Society of Thoracic Surgeons General Thoracic Surgery Database, a retrospective, multicenter cohort study was performed of adult patients with lung cancer who underwent pulmonary resection. Hospitals participating in the Society of Thoracic Surgeons General Thoracic Surgery Database were ranked by their risk-adjusted, standardized mortality ratio (using random effects logistic regression) and grouped into quintiles. Complication and failure to rescue rates were evaluated across 5 groups (very low, low, medium, high, and very high mortality hospitals).

Results: Between 2009 and 2012, there were 30,000 patients cared for at 208 institutions participating in the Society of Thoracic Surgeons General Thoracic Surgery Database (median age, 68 years; 53% were women, 87% were white, 71% underwent lobectomy, 65% had stage I). Mortality rates varied over 4-fold across hospitals (3.2% vs 0.7%). Complication rates occurred more frequently at hospitals with higher mortality (42% vs 34%, $P < .001$). However, the magnitude of variation (22%) in complication rates dwarfed the 4-fold magnitude of variation in failure to rescue rates (6.8% vs 1.7%, $P < .001$) across hospitals.

Conclusions: Variation in hospital mortality seems to be more strongly related to rescuing patients from complications than to the occurrence of complications. This observation is significant because it redirects quality improvement and health policy initiatives to more closely examine and support system-level changes in care delivery that facilitate early detection and treatment of complications. (J Thorac Cardiovasc Surg 2015;149:1365-73)



Failure-to-rescue rates by risk-adjusted hospital mortality rankings for lung resection.

Central Message

Hospital mortality rankings appear to be more strongly related to rescuing patients from complications than preventing complications.

Perspective

Preventing complications is unarguably the best way to curb early deaths after pulmonary resection. However, the data show that variability in rescuing patients from complications is the dominant driver of variability in mortality. This observation suggests that system-level interventions that optimize the early detection and treatment of postoperative complications are needed to improve outcomes.

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GTS

Supplemental material is available online.

Variability in operative mortality is well documented for many operations and is an indicator of poor-quality surgical care.[1] Conventional wisdom suggests that the best way to avoid an early death is to avoid complications. For many types of major operations, complication rates do not vary across hospitals ranked by risk-adjusted mortality.[2-4] One explanation for this observation is that some systems of care fail to identify or intervene on complications early. Failure to rescue is a metric commonly used to evaluate this concept and is defined by the number of deaths among hospitalized patients experiencing an acute event, such as a postoperative complication.

Lung cancer is the second most common malignancy in the United States and the number one cause of death from cancer.[5] Billions of dollars are spent yearly to care for these patients.[6] National quality improvement initiatives attempt to mitigate the burden of this deadly and costly disease. Such efforts would likely be enhanced by a better understanding of mechanisms underlying early adverse outcomes. A first step toward achieving this goal is to better understand whether variation in operative mortality appears to be explained by complications, failure to rescue, or both.

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Abbreviations and Acronyms

ASA = American Society of Anesthesiologists
SMR = standardized mortality ratio
STS-GTSD = Society of Thoracic Surgeons-General Thoracic Surgery Database

We used the Society of Thoracic Surgeons-General Thoracic Surgery Database (STS-GTSD) to describe variation in complication and failure to rescue rates across hospitals ranked and grouped by risk-adjusted operative mortality.

MATERIALS AND METHODS

A retrospective, multicenter cohort study was performed of adults with primary lung cancer who underwent pulmonary resection between January 2, 2009, and December 31, 2012. Potentially eligible study subjects included those with an International Classification of Disease, 9th Revision diagnostic code for lung cancer and a Common Procedure Terminology code for pulmonary resection as indicated on the STS data-collection form (versions 2.081-2.2) by the STS-GTSD participant. Sequential exclusion criteria included reoperations for synchronous or metachronous lung cancer (n = 891), children (n = 66), missing gender information (n = 1), emergency or "palliative" resections (n = 1474), an erroneous American Society of Anesthesiologists (ASA) classification of "VI" (n = 1), missing discharge mortality (n = 19), or in situ carcinoma or an inability to identify cancer in the pathologic specimen (n = 245). A total of 35,620 patients from 213 institutions were considered eligible for study. The University of Washington Institutional Review Board considered this work exempt from review.

Outcomes assessed in this study were complication and failure to rescue rates. A complication was defined by the occurrence of any reportable adverse outcome as defined on the STS data-collection form (versions 2.081-2.2). Major complications were based on a prior definition and include tracheostomy, reintubation, initial ventilatory support greater than 48 hours, adult respiratory distress syndrome, bronchopleural fistula, pulmonary embolus, pneumonia, bleeding requiring reoperation, or myocardial infarction.[7] Pulmonary complications were based on the occurrence of any 1 of the following events: air leak for more than 5 days, pneumonia, atelectasis requiring bronchoscopy, reintubation, other pulmonary event, adult respiratory distress syndrome, tracheostomy, initial ventilator support for more than 48 hours, bronchopleural fistula, pulmonary embolus, pneumothorax, respiratory failure, or pneumothorax requiring drainage. Because atrial arrhythmias occur commonly after pulmonary resection,[8] this event was also evaluated. Failure to rescue was primarily defined by early death among patients who experienced any complication, but was also calculated among patients with major or pulmonary complications or atrial arrhythmia. Early death is universally defined throughout this study as a patient who died during the index hospitalization or within 30 days of resection. The cause of death is not recorded by the STS-GTSD. Because causes of death not attributable to a complication (eg, inpatient suicide) are extraordinarily rare, we assumed that all deaths were a result of a complication.

Variation in complication and failure to rescue rates was assessed across hospitals ranked by their risk-adjusted standardized mortality ratio (SMR). An SMR greater than 1.0 indicates that the hospital had a higher than average operative mortality rate. The SMR was calculated for each hospital as the ratio of the hospital's risk-adjusted operative mortality rate divided by the risk-adjusted operative mortality rate of a hypothetical "average" hospital using a hierarchical (random effects) logistic regression model with nesting of patients within hospitals. Covariate selection and parameterization were based on a previously published model[7] and included both hospital-specific random effects and 23 patient-level covariates: age, gender, calendar year, body mass index, urgency, hypertension, steroid use, congestive heart failure, coronary artery disease, peripheral vascular disease, cerebrovascular disease, diabetes, renal insufficiency, smoking status, forced expiratory volume, ASA classification, Zubrod, prior thoracic surgery, preoperative chemotherapy or radiation therapy, extent and approach to resection, and pathologic stage. Because the risk-adjustment model requires complete data on all covariates, an additional 5620 patients were excluded from the study because of missing covariate data. Some of these 5620 patients account for all contributed cases at 5 centers, resulting in the exclusion of these 5 centers. A comparison of patients with and without missing covariate data is provided in Table E1. Hospitals were ranked according to SMR and then grouped into quintiles similar to a prior study.[2] These groups serve as the primary exposure variable for the analysis.

The Kruskal–Wallis test was used to test for differences in the median of continuous variables across groups. A comparison of categoric variables was initially made using a chi-square test to avoid assumptions of linearity. A test for ordinal trends is also reported. An adjusted analysis of variation in failure to rescue rates across hospital rank groups was performed using general estimating equations to account for clustering of patients within hospitals. All analyses were performed using SAS version 9.3 (SAS Institute, Inc, Cary, NC), WinBUGS version 3.2.2 (Freeware, http://www.mrc-bsu.cam.ac.uk/bugs/welcome.shtml and Imperial College of Science, Technology and Medicine at St Mary's, London, UK), and R version 2.14.1.

RESULTS

A total of 30,000 patients at 208 hospitals underwent pulmonary resection for lung cancer between 2009 and 2012. Patients were grouped according to their hospital's quintile of risk-adjusted hospital-specific mortality. Mortality rates varied by at least 4-fold between very high versus very low mortality hospitals (3.2% vs 0.7%). The 5 groups had statistically significant differences in nearly all demographic, risk factor, treatment, and stage variables. However, an overwhelming majority of absolute differences were no greater than 5% in magnitude (Table 1). The prevalence of chronic obstructive pulmonary disease varied by 8% across groups, but forced expiratory volume in 1 second and the diffusion capacity of carbon monoxide did not vary in a clinically meaningful way. Both ASA and Zubrod scores differed by more than 5% across groups, but the low mortality hospitals did not necessarily have the lowest (best) ASA and Zubrod scores. The pattern of variation in ASA and Zubrod score did not demonstrate a discernable relationship with risk-adjusted hospital performance. In terms of clinically meaningful differences (>5%), the groups appeared balanced overall in terms of the distribution of patient-level factors that influence outcomes.

Figure 1, *A* shows significant variation in the frequency of overall, major, and pulmonary complications, as well as atrial arrhythmias across hospitals. In general, but not always, complication rates were higher at hospitals with higher mortality rates. However, very high mortality