CHEST

# Patient Safety and Comparative Effectiveness of Anesthetic Technique in Open Lung Resections

*Umut Özbek, PhD; Jashvant Poeran, MD, PhD; Madhu Mazumdar, PhD; and Stavros G. Memtsoudis, MD, PhD, FCCP*

**BACKGROUND:** Despite literature suggesting benefits of using regional anesthesia, the impact of neuraxial anesthesia on perioperative outcomes in patients undergoing lung surgery remains unstudied. We studied the effect of combined neuraxial/general anesthesia (vs general anesthesia) on perioperative outcome in a large national sample of patients who underwent open lung resection.

**METHODS:** We extracted data from the Premier Perspective database on patients who underwent open lung resection. The main effect of interest was anesthesia type: general and combined neuraxial/general anesthesia. Patient and health-care variables, complications, and resource use were compared between groups. Multivariable analyses assessed the independent impact of choice of anesthetic technique on outcomes.

**RESULTS:** For 18,943 patients, anesthesia type was known: 79% (n = 14,912) were administered general anesthesia, and 21% (n = 4,031) received neuraxial/general anesthesia. Comparing general vs neuraxial/general anesthesia, unadjusted incidences for the latter were lower for acute myocardial infarction (1.09% vs 0.67%, $P = .018$), pulmonary complications (20.96% vs 18.98%, $P = .006$), blood transfusion (14.15% vs 9.80%, $P < .0001$), and mechanical ventilation (11.60% vs 8.81%, $P < .0001$). Neuraxial/general anesthesia was associated with lower adjusted odds of blood transfusion (OR, 0.82; 95% CI, 0.69-0.98) and mechanical ventilation (OR, 0.81; 95% CI , 0.67-0.98), while higher odds were seen for DVT (OR, 1.50; 95% CI, 1.01-2.23) and pulmonary embolism (OR, 1.56; 95% CI, 1.02-2.38).

**CONCLUSIONS:** This study illustrates the association between adding neuraxial to general anesthesia in open lung resections among patients with cancer and perioperative outcomes. Neuraxial anesthesia use was associated with decreased risk for blood transfusion but increased thromboembolic risks. Additional studies are needed to elucidate mechanisms by which neuraxial anesthesia may affect these outcomes. CHEST 2015; 148(3):722-730

Manuscript received December 4, 2014; revision accepted March 2, 2015; originally published Online First March 26, 2015.

**ABBREVIATIONS:** ICD-9-CM = *International Classification of Diseases, Ninth Revision, Clinical Modification*

**AFFILIATIONS:** From the Institute for Healthcare Delivery Science, Department of Population Health Science & Policy (Drs Özbek, Poeran, and Mazumdar), Tisch Cancer Institute (Drs Özbek and Mazumdar), and Department of Medicine (Dr Poeran), Icahn School of Medicine at Mount Sinai, New York, NY; Department of Healthcare Policy and Research (Dr Memtsoudis), Weill Cornell Medical College, and Department of Anesthesiology (Dr Memtsoudis), Hospital for Special Surgery, New York, NY; and Department of Anesthesiology, Perioperative Medicine and Intensive Care Medicine (Dr Memtsoudis), Paracelsus Medical University, Salzburg, Austria.

**FUNDING/SUPPORT:** Drs Özbek and Mazumdar were partially supported by Tisch Cancer Institute, Icahn School of Medicine at Mount Sinai, New York, NY.

**CORRESPONDENCE TO:** Stavros G. Memtsoudis, MD, PhD, FCCP, Department of Anesthesiology, Hospital for Special Surgery, 535 E 70th St, New York, NY 10021; e-mail: memtsoudiss@hss.edu



**DOI:** 10.1378/chest.14-3040

Approximately 400,000 Americans suffer from lung cancer, the leading cause of cancer death in the United States.[1,2] To date, surgical resection represents the main curative approach and is performed approximately 40,000 times per year in the United States alone.[3-5] Despite improvements in surgical techniques and medical management, morbidity and mortality remain relatively high.[6] In this context, many practitioners consider the use of neuraxial anesthetic techniques in an attempt to reduce complication rates.[7,8]

Current evidence is derived from small, single-institution studies suggesting better clinical outcomes with the use of neuraxial anesthesia (combined with general anesthesia), including less intraoperative bleeding, better control of postoperative pain, early mobilization, and oral intake tolerance.[7,9-13] However, large-scale data on anesthesia practices and outcomes, in particular for the United States, are lacking.

Such data are important, given that much of the estimated $12.1 billion per year spent on lung cancer treatment in the United States[14] is related to the high use of resources (ie, critical care services, mechanical ventilation, prolonged hospital stay) and potentially high rates of perioperative complications.

In view of the available evidence suggesting benefits of neuraxial anesthesia in this and other patient populations,[15] we aimed to (1) determine the extent of the use of neuraxial anesthesia among patients undergoing open resection surgery for lung cancer, and (2) quantify the impact of anesthetic technique on patient perioperative outcomes and resource utilization. We used data from a large, claims-based national database and hypothesized that the addition of neuraxial anesthesia to general anesthesia would positively affect various perioperative outcomes.

## Materials and Methods

### Data Source

Data collected between 2006 and 2013 were obtained from Premier Perspective Inc, which is an administrative database containing information on all discharges from approximately 20% to 25% of hospitals located in the United States.[16] This project was exempt from requirements for consent by our institutional review board (project HS No. 14-00647), as the data are compliant with the Health Insurance Portability and Accountability Act.

### Study Sample

All patient records with an *International Classification of Diseases, Ninth Revision, Clinical Modification* (ICD-9-CM) procedure code for open lung resection performed between 2006 and 2013 were identified using codes for segmentectomy (32.39), lobectomy (32.49), and pneumonectomy (32.59). To keep the sample as homogenous as possible, we chose to study only open lung resections. This sample was further restricted to entries with ICD-9-CM codes for malignant neoplasm of main bronchus (162.2), malignant neoplasm of upper lobe bronchus or lung (162.3), malignant neoplasm of middle lobe bronchus or lung (162.4), malignant neoplasm of lower lobe bronchus or lung (162.5), malignant neoplasm of other parts of bronchus or lung (162.8), and malignant neoplasm of bronchus and lung unspecified (162.9). Elective, urgent, and emergent admissions were included. Using billing data as previously described,[17] we separated entries into groups of patients, who underwent their procedure under general or combined neuraxial/general anesthesia. Those without indication of type of anesthesia were categorized as missing. To ensure that this step would not skew results, a sensitivity analysis was performed by including and by excluding patients with missing entry for all analyses.

### Demographic Variables

We compared the characteristics of patients with lung cancer undergoing lung resection under the different types of anesthesia (general and neuraxial/general). Patient-related characteristics included age, sex, race (white, black, Hispanic, other), admission type (emergent, elective, urgent, and others), and insurance type (commercial, Medicaid, Medicare, uninsured). Health care-related characteristics included hospital size ($<299$, 300-499, $>500$ beds), geographic location (rural, urban), and teaching status (teaching, nonteaching). Comorbidity prevalence and overall comorbidity burden was assessed using the method described by Deyo et al.[18] In addition, the extent of surgery (pneumonectomy, lobectomy, or segmentectomy) was taken into account.

### Outcome Variables

Outcome variables were almost all identified by ICD-9-CM codes (e-Table 1) and incidence (or median) was shown by anesthesia group. Complications included acute renal failure, DVT, GI complications, cardiac complications (including conduction disorders, functional disturbances, ventricular fibrillation and flutter, atrial fibrillation and flutter, cardiac arrest, cardiac insufficiency, cardiorespiratory failure, and heart failure resulting from the procedure), acute myocardial infarction, cerebrovascular events, pulmonary complications overall, pulmonary embolism, pneumonia, mortality, and wound complications. Need for blood transfusion, admission to an ICU, need for mechanical ventilation, length of hospital stay, and cost of hospitalization were classified as resource utilization variables.

### Statistical Analysis

Patient demographics, health care- and procedure-related variables, and comorbidities were assessed and compared by anesthesia type. Categorical variables were compared using $\chi^2$ tests. Due to their skewed distribution, the difference between groups in continuous variables was tested using the Mann-Whitney *U* test. We used multilevel logistic regression modeling to assess the association between anesthesia types on outcomes. Correlation of patients within each hospital was accounted for by including a random intercept in the models. To meet the minimum recommended sample size cluster, only hospitals having $\geq 30$ patients were included.[19] Models were adjusted using all variables that were clinically important and found significant in the univariable analysis ($P \leq .15$). The Deyo-Charlson Comorbidity Index was used to adjust for comorbidity status. ORs, 95% CIs, and *P* values are reported and are to be used together as a measure of overall significance. All analyses were performed in SAS version 9.3 statistical software (SAS Institute Inc); the GLIMMIX procedure was used for multilevel regression analyses.