Variation in Pulmonary Resection Practices Between The Society of Thoracic Surgeons and the European Society of Thoracic Surgeons General Thoracic Surgery Databases

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Background. **Clinical guidelines are created to reduce variation in care practices, with the goal of improving patient outcomes. There is currently no international consensus on best practices for pulmonary resection. Our aim was to evaluate variation in treatment patterns and outcomes for pulmonary resection by comparing The Society of Thoracic Surgeons (STS) and the European Society of Thoracic Surgery (ESTS) general thoracic surgery databases (GTSDs).**

Methods. **An international collaboration was established between the STS and ESTS GTSD task forces. Patients who underwent pulmonary resection between 2010 and 2013 were identified from the 2 databases. Data on patient demographics, disease characteristics, treatment strategies, morbidity, and mortality were compared.**

Results. **There were 78,212 lung resections captured in the STS (n = 47,539) and ESTS databases (n = 30,673). Patients from the STS database were more likely to be of the female sex, have no pathologic N2 disease, have had previous cardiothoracic operations, and have received preoperative thoracic irradiation compared with patients from the ESTS database. In addition, patients from the STS database were more likely to have undergone a thoracoscopic operation and have received a sublobar resection. Although there was an increased risk of reintubation, atrial arrhythmias, and return to the operating room in the STS patients, the mean hospital length of stay was shorter than in patients from the ESTS database, regardless of operation performed. Thirty-day mortality was higher in the STS patients for wedge resection ($p < 0.001$) but lower for lobectomy ($p < 0.001$) and pneumonectomy ($p < 0.001$) compared with the ESTS patients.**

Conclusions. **Differences exists in patient population, procedures performed, and outcomes for pulmonary resections between the STS and ESTS databases, suggesting an opportunity for quality improvement initiatives.**

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Lung cancer is the leading cause of cancer death worldwide [1]. The abundance of research published in the field of lung cancer often makes it difficult for clinicians to remain abreast of best practices. For this reason, societal guidelines are useful to help clinicians make patient care decisions based on the best available evidence. These guidelines are meant to reduce variation in patient care practices, with the goal of uniformly improving patient outcomes.

In North America, the American College of Chest Physicians and the National Comprehensive Cancer Network have published guidelines for the diagnosis and management of lung cancer [2, 3]. Similarly, the European Society of Thoracic Surgeons (ESTS) has developed clinical guidelines for the preoperative staging of lung cancer and patient fitness for radical therapy in lung cancer [4, 5]. Although the health care system in which patients are treated certainly affects treatment decisions, an international consensus on best practices for pulmonary resection may lead to improved patient outcomes. Precedence for the development of an international consensus statement in thoracic surgery exists in the publication of definitions to promote an evidence-based approach to management of the pleural space [6].

With the goal of international sharing of information and developing consensus in treatment algorithms, The Society of Thoracic Surgeons (STS) and the ESTS general thoracic surgery database (GTSD) task forces

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have engaged in a database collaboration. Members of the 2 task forces have met over the past 3 years, with the primary goal of harmonizing definitions and terminology in the databases to allow for more efficient and accurate collaborations [7]. As an initial step in building consensus in pulmonary resection care algorithms, this study aims to identify variation in treatment patterns and outcomes of patients who underwent pulmonary resection by comparing the STS and ESTS databases.

Patients and Methods

STS and ESTS Databases

Participating institutions voluntarily contribute unselected data to the STS-GTSD. The STS-GTSD is a highly accurate, complete, and externally audited database that has been shown to have an overall accuracy of nearly 95% [8]. Detailed examination of unreported data has demonstrated no purposeful omission or gaming of data. Twice-yearly reports are returned to the institutions comparing their outcomes with other database participants to be used for quality improvement purposes. Details of the STS-GTSD collection instrument can be found on the STS website [9].

Similarly, the ESTS-GTSD is an international voluntary prospectively maintained online registry, which collects data on general thoracic surgical procedures from participating European centers. In contrast to the STS-GTSD, only general thoracic surgical units eligible for institutional accreditation currently undergo data auditing in Europe. The most recent “Silver Book” report contains data from 205 participating general thoracic surgical units [10]. The ESTS-GTSD has been used to create risk-adjusted instruments for assessing the center-specific performance and is able to be queried for investigative purposes [11, 12].

Patient Population

Patients who underwent pulmonary resection between 2010 and 2013 were identified by querying the STS and ESTS databases. The STS-GTSD was examined from July 2010 through June 2013, whereas the ESTS-GTSD was queried from May 2010 through June 2013. The date ranges varied slightly between databases to align with the STS biannual reporting cycle. Inclusion criteria included adult patients who underwent open or thoracoscopic pulmonary wedge resection, segmentectomy, lobectomy, bilobectomy, sleeve resection, or pneumonectomy. Lobectomy, sleeve lobectomy, and bilobectomy were grouped together as “lobectomy.” Patients were excluded if they underwent extrapleural or carinal pneumonectomy.

Outcome Definitions and Data Analysis

Demographic variables, disease characteristics, and outcome measures were defined by the STS or ESTS database guidelines [9, 10]. Aggregate data from the 17th data analysis of STS was used as the STS source data and matching data were queried from the ESTS. These data were examined to identify variation between societal databases using χ^2 or Fisher’s exact test for binary variables and 2-sample t tests for continuous variables.

Results

During the study period, 78,212 patients underwent pulmonary resection and were captured in the STS (n = 47,539) or ESTS databases (n = 30,673). More patients in the STS database underwent video-assisted thoracoscopic surgery (VATS) compared with those in the ESTS database (62.5% versus 21.8%; $p < 0.001$) (Table 1). Additionally, more patients in the STS database underwent sublobar resection compared with those in the ESTS database (43.3% versus 31.1%; $p < 0.001$). This included 39.4% wedge resections and 3.9% segmentectomies in the STS compared with 23.7% wedge resections and 7.4% segmentectomies in the ESTS.

Examining patient demographics between societal databases, a higher percentage of pulmonary resections were performed on female patients in the STS (Table 2). This was observed uniformly, regardless of operation performed. Similarly, more pulmonary resections were performed after previous cardiothoracic operations and after preoperative thoracic irradiation in the patients from the STS database. However, the rates of preoperative chemotherapy were not substantially different between groups. Overall, patients in the STS database tended to have a higher American Society of Anesthesiologists classification and Zubrod score compared with those from the ESTS database. This is consistent with generally higher rates of obesity, hypertension, congestive heart failure, and coronary artery disease in the STS population.

Table 3 demonstrates that a greater percentage of wedge resections were performed for benign disease in the STS database. For cases of primary lung cancer, the distribution of pathologic T staging was generally similar

Table 1. Distribution of Pulmonary Resections Between 2010 and 2013

Type of Resection	STS (n = 47,539)	ESTS (n = 30,673)	p Value
VATS, wedge resection	15,557 (32.5)	3,493 (11.3)	<0.05
VATS, lobectomy	13,147 (27.5)	2,557 (8.3)	<0.05
VATS, segmentectomy	923 (1.9)	605 (2)	<0.05
VATS, bilobectomy	180 (0.4)	47 (0.1)	<0.05
VATS, pneumonectomy	72 (0.2)	27 (0.1)	<0.05
Wedge resection	3,301 (6.9)	3,836 (12.4)	<0.05
Segmentectomy	954 (2)	1,657 (5.4)	<0.05
Lobectomy	10,735 (22.5)	14,175 (46)	<0.05
Sleeve lobectomy	515 (1.1)	638 (2.1)	<0.05
Bilobectomy	889 (1.9)	1407 (4.6)	<0.05
Pneumonectomy	1,266 (2.6)	2,249 (7.3)	<0.05

Data presented as n (%).

ESTS = European Society of Thoracic Surgeons; STS = The Society of Thoracic Surgeons; VATS = video-assisted thoracoscopic surgery.

Table 2. Demographics of Patients Who Underwent Pulmonary Resections Between 2010 and 2013

	Wedge Resection		Segmentectomy		Lobectomy		Pneumonectomy		
Variable	STS (n = 18,858)	ESTS (n = 7,329)	STS (n = 1,877)	ESTS (n = 2,262)	STS (n = 25,466)	ESTS (n = 18,963)	STS (n = 1,338)	ESTS (n = 2,276)	*p* Value
Age, y, median (IQR)	63 (19)	62 (18)	67 (6)	63 (16)	67 (15)	63 (15)	62 (15)[a]	62 (13)[a]	<0.05
Female sex	51.2	38.1	54.8	35.5	53.3	31.5	40.8	21	<0.05
Comorbidities									
Underweight (BMI < 18.5)	3.7	2.9	3.6[a]	4.7[a]	3.1	4.2	3.2	5.3	<0.05
Obesity (BMI ≥ 30)	16.1[a]	16.8[a]	28.7	15.3	27.1	15.8	24.8	13.3	<0.05
HTN	50.5	24.2	55.4	28.4	57.2	31.2	47.2	29.2	<0.05
CHF	3.1	0.6	4.2	1.1	2.5	0.9	1.8	0.7	<0.05
CAD	15.5	5.5	20.2	6.8	19.3	9.3	14.2	7.7	<0.05
PVD	5.6	15	8.8	13.8	8.3	10.1	5.4	8	<0.05
IDDM	4.7	2.7	4.5	2.9	4.1	3.2	2.3[a]	2.6[a]	<0.05
Renal insufficiency	0.9	2.8	1.9	2.9	1	2.4	0.5	1.9	<0.05
Previous cardiothoracic operation	17.4	2	24.7	2.7	14.8	3.5	18.7	2.6	<0.05
Neoadjuvant therapy									
Chemotherapy	9.5[a]	9.8[a]	9[a]	8.8[a]	8.9[a]	8.5[a]	22.4[a]	22[a]	<0.05
Radiation therapy	6.9	0.1	7.6	0.01	7.3	2.3	15.9	3.8	<0.05
Zubrod score									
0	35.1	48.8	38.7	53.4	39.7	49.9	20.9	43.8	<0.05
1	53.5	40.2	53.4	37.8	54.9	41.4	71.2	44.9	<0.05
2	7	8.8	5.3	7.5	4	7.7	4.8	9.1	<0.05
3	2.8	1.8	1.8	1.1	0.9	0.8	1.9	1.7	<0.05
4	1.5	0.3	0.6	0.2	0.4	0.2	0.7	6.5	<0.05
5	0.2	0	0.1	0	0.1	0	0.6	0	<0.05
ASA classification									
I	1	24.1	0.5	22.4	0.5	20.7	0.5	17.7	<0.05
II	19.8	50.6	15.7	52.9	15.9	53.7	9.9	53.4	<0.05
III	68.1	24.1	73.5	23.9	74	24.8	73.5	26.6	<0.05
IV	11.1	1.1	10.2	0.8	9.5	0.7	15.5	2.1	<0.05
V	0	0.02	0.1	0	0.1	0.1	0.5	0.2	<0.05
PFTs									
FEV_1 (%), median (IQR)	81 (31)	89 (27)	79 (32)	86 (30)	82 (28)	86 (27)	76 (25)	79 (25)	<0.05
DLCO (%), median (IQR)	70 (34)	75 (30)	71 (33)	73 (28)	73 (29)	75 (26)	70 (24)	72 (26)	<0.05

[a] Indicates $p > 0.05$.

Data presented as % unless otherwise specified.

ASA = American Society of Anesthesiologists; BMI = body mass index; CAD = coronary artery disease; CHF = congestive heart failure; DLCO = diffusing capacity of carbon monoxide; ESTS = European Society of Thoracic Surgeons; FEV_1 = forced expiratory volume in 1 second; HTN = hypertension; IDDM = insulin-dependent diabetes mellitus; IQR = interquartile range; PFTs = pulmonary function tests; PVD = peripheral vascular disease; STS = The Society of Thoracic Surgeons.

Table 3. Disease Characteristics of Patients Who Underwent Pulmonary Resections Between 2010 and 2013

Characteristic	Wedge Resection STS (n = 18,858)	Wedge Resection ESTS (n = 7,329)	Segmentectomy STS (n = 1,877)	Segmentectomy ESTS (n = 2,262)	Lobectomy STS (n = 25,466)	Lobectomy ESTS (n = 18,963)	Pneumonectomy STS (n = 1,338)	Pneumonectomy ESTS (n = 2,276)	p Value
Category of disease									
Benign[a]	19.3	24.5	10.7	19.5	6[b]	5.9[b]	3.3[b]	3.3[b]	<0.05
Benign nodule	17.3	10	6.7[b]	6.4[b]	2.6	1.4	0.5[b]	0.3[b]	<0.05
Primary lung cancer	26.8	24.7	65.8	49.9	85.1	86.6	87.0	94.5	<0.05
Metastasis to lung	23.4	40.8	16.1	24.2	5.6	6.1	4.5	1.9	<0.05
Pathologic stage	(n = 5,048)	(n = 1,810)	(n = 1,235)	(n = 1,128)	(n = 21,673)	(n = 16,420)	(n = 1,164)	(n = 2,151)	
Primary tumor									
T0	0.2[b]	0[b]	0.2[b]	0[b]	0.6	0.4	1.2[b]	0.4[b]	<0.05
Tis	0.7	0.1	1.0	0	0.2	0.1	0.2	0	<0.05
T1	60.2	38.5	63.9	50.2	46.3	33.3	11.6	5.9	<0.05
T2	19	15.2	23.5	18.9	36.6	35.4	42.3	37.3	<0.05
T3	5.6[b]	6.1[b]	6.5[b]	4.9[b]	11.2	13.6	30.5[b]	28.3[b]	<0.05
T4	4.1	9.4	1.9	3.9	1.7	2.5	10.6[b]	12.1[b]	<0.05
Tx	0.4	6.8	0.2	5.2	0.3	3.2	0.5	4.2	<0.05
Missing	9.7	23.9	2.8	16.9	3.2	11.5	3.2	11.8	<0.05
Regional nodes									
N0	72.4	38.1	84.8	64	75.3	60.5	36.4	28.3	<0.05
N1	2.3	1.5	4.9[b]	4.7[b]	12.5[b]	12.3[b]	44.1	30.3	<0.05
N2	4.1	9.1	3.5	5.6	8.0	11.4	15.8	25	<0.05
N3	0.3	1.3	0.1[b]	0.2[b]	0.1	0.2	0.5[b]	0.5[b]	<0.05
Nx	10.7	26.1	3.9	8.5	0.8	4.1	0.1	4.2	<0.05
Missing	10.2	23.9	2.8	17	3.3	11.5	3.1	11.6	<0.05
Distant metastasis									
M0	85.1	61.2	94.9	79.2	95.0	85.2	94.5	84.6	<0.05
M1	4.7	14.1	2.0[b]	3.3[b]	1.5	2.4	2.0	3.4	<0.05
Missing	10.2	24.7	3.1	17.5	3.5	12.4	3.5	12	<0.05

[a] Includes abscess bronchiectasis and other benign processes. [b] Indicates $p > 0.05$.

Data presented as %.

ESTS = European Society of Thoracic Surgeons; STS = The Society of Thoracic Surgeons.

between databases; however, fewer patients in the STS database had pathologic N2 disease.

Postoperatively, patients in the STS database were reintubated more often, had more frequent atrial arrhythmias, and experienced more unexpected returns to the operating room (Table 4). Despite this, the median hospital length of stay was shorter for patients in the STS database. These findings were observed uniformly, regardless of operation performed. Thirty-day mortality was higher for patients who underwent wedge resection in the STS database compared with those in the ESTS database (1.9% versus 0.1%; $p < 0.001$). However, mortality was lower for those who underwent lobectomy (1.4% versus 2.6%; $p < 0.001$) or pneumonectomy (4.9% versus 7.3%; $p < 0.001$) in the STS database compared with those in the ESTS database.

Comment

A thoracic surgeon's clinical decision making is multifactorial. It is influenced by patient characteristics and disease processes, as well as cultural, political, financial, and personal biases. This leads to variations in clinical practice, which may translate into variations in patient outcomes. Such variation is reflected in the current comparison of pulmonary resection practices between the STS and ESTS databases.

The 2:1 ratio of male patients to female patients who underwent pulmonary resections in the ESTS database may be partially explained by the higher incidence of lung cancer in men in Europe. In 2012, the incidence of new lung cancers diagnosed in Europe was approximately 68 in 100,000 in men compared with 22 in 100,000 women [13]. Likewise, the nearly equivalent sex distribution of pulmonary resections in the STS-GTSD may reflect the converging rates of lung cancer in American men and women. There has been a steady decline in lung cancer rate in men since the mid-1980s, whereas rates in women have declined only in small cell carcinoma [14]. This trend has paralleled the convergence in tobacco use between men and women in the United States over the past 50 years [15].

Controversy still exists regarding the optimal induction strategy for stage IIIA non-small cell lung cancer (NSCLC), resulting in significant variations in care. In the United States, induction chemoradiation is administered at a rate of 2:1 compared with induction chemotherapy alone [16]. On the contrary, despite the ESTS database being an international registry, there appears to be a strong preference for the use of induction chemotherapy alone in Europe. This intersocietal variation may partially explain the higher rate of N2 disease at the time of pulmonary resection in the ESTS patients. With large database analyses such as this, it is impossible to discern patients with inoperable or marginally operable stage III disease, who may be more likely to receive chemoradiation, from patients with operable N2 disease, who may be more likely to receive chemotherapy alone. In

Table 4. Outcomes of Patients Who Underwent Pulmonary Resection Between 2010 and 2013

	Wedge Resection		Segmentectomy		Lobectomy		Pneumonectomy		
Outcome	STS (n = 18,858)	ESTS (n = 7,329)	STS (n = 1,877)	ESTS (n = 2,262)	STS (n = 25,466)	ESTS (n = 18,963)	STS (n = 1,338)	ESTS (n = 2,276)	*p* Value
Morbidity									
Unexpected return to operating room	1.6	1	2.9	1.3	4.1	1.9	7	4.6	<0.05
Air leak >5 d	4[a]	3.9[a]	7.4[a]	7.4[a]	10.7	9.7	1[a]	0.7[a]	<0.05
Pneumonia	1.5	2.5	3.6	6.2	4.3	7.8	5.3[a]	6.4[a]	<0.05
Initial ventilatory support >48 h	1[a]	0.8[a]	0.8[a]	0.9[a]	0.8	1.8	2.4[a]	3[a]	<0.05
Reintubation	1.6	0.1	3	0.2	3.5	0.3	6.9	0.5	<0.05
Atrial arrhythmia	2.4	1.1	6.8	2.5	11	5.8	21.3	13	<0.05
Myocardial infarction	0.1[a]	0.1[a]	0.2[a]	0.2[a]	0.4[a]	0.3[a]	0.6[a]	0.8[a]	<0.05
Empyema	0.2[a]	0.2[a]	0.3[a]	0.6[a]	0.5	0.7	1.5[a]	2[a]	<0.05
ARF-RIFLE criteria	0.3[a]	0.4[a]	0.7[a]	0.4[a]	0.8[a]	0.7[a]	2.6	0.8	<0.05
Central neurologic event	0.3	2.9	0.7[a]	0.4[a]	0.5	1.1	1.5[a]	1.3[a]	<0.05
LOS (d), median (IQR)	3 (3)	6.4 (10)	4 (3)	8 (20)	5 (4)	9.8 (16)	5 (4)	11.9 (1)	<0.05
Mortality									
In-hospital	1.6	0.1	0.8[a]	1.3[a]	1.1	2.2	4.3	6.7	<0.05
30 d	1.9	0.1	1[a]	1.5[a]	1.4	2.6	4.9	7.3	<0.05

[a] Indicates $p > 0.05$.

Data presented as % unless otherwise specified.

ARF = acute renal failure; ESTS = European Society of Thoracic Surgeons; IQR = interquartile range; LOS = length of stay; RIFLE = risk, injury, failure, loss of kidney function, and end-stage kidney disease; STS = The Society of Thoracic Surgeons.

addition, although most STS and ESTS definitions have been harmonized, any previous thoracic irradiation is captured in the STS-GTSD, whereas only radiotherapy specific to the resected tumor is captured in the ESTS database, potentially accounting for some of the observed intersocietal variation. Regardless, a general trend toward the use of induction chemotherapy alone in Europe is noted. The seemingly high rate of induction chemotherapy observed in the STS wedge resection cohort (9.5%) is likely a reflection of the inclusion of all pulmonary resections in the analysis, not just those for NSCLC. For example, a patient with stage IV sarcoma, who received chemotherapy followed by wedge resection of a pulmonary metastasis, would be captured as a pulmonary resection that received induction chemotherapy.

More VATS pulmonary resections and sublobar resections were performed for patients in the STS database compared with those in the ESTS database. Most likely, this is a reflection of the more recent diffusion of minimally invasive techniques in Europe relative to the United States. Other potential explanations include the lower percentage of node-positive disease and more resections for benign nodules in the STS patients. Despite an overall lower rate of sublobar resections in the ESTS database, a greater proportion of them were in the form of segmentectomy compared with those in the STS. This may be a reflection of a greater proportion of benign disease in the wedge resection cohort in the STS. Although data on histologic type were not available, it is also possible that a higher incidence of centrally located squamous cell carcinoma in European countries contributed to the intersocietal difference in VATS and sublobar resection. Although purely speculative, this is supported by the continued high rate of tobacco abuse in many European countries, a known risk factor for squamous cell carcinoma [17]. The STS-GTSD task force added fields to the collection tool to track histologic data as of January 1, 2015.

Another potential explanation for the lower rate of VATS and sublobar resections in the ESTS database is the preferential use of stereotactic body radiotherapy (SBRT) in Europe to medically treat patients with inoperable early-stage lung cancer, who might have received an operation in the United States. Palma and colleagues [18] queried the Amsterdam Cancer Registry for patients 75 years or older with early-stage lung cancer treated between 1999 and 2007. The authors reported a 16% increase in the use of primary radiotherapy during the study period, with 23% of patients being treated with SBRT between 2005 and 2007. This rate of SBRT use is substantially higher than the 4.2% reported in a Surveillance, Epidemiology, and End Results database analysis of patients 75 years or older with early-stage NSCLC treated between 2003 and 2009 [19]. This would partially explain the generally lower rates of comorbidities observed in those undergoing pulmonary resection in the ESTS-GTSD compared with the STS-GTSD. However, this remains purely speculative, because the current data are not equipped to draw definitive conclusions in this regard.

Hospital length of stay was invariably lower after pulmonary resection in North America compared with Europe. This was observed despite a higher rate of atrial arrhythmias, reintubation, and unexpected return to the operating room in the patients in the STS database. This suggests that nonmedical factors, both economical and cultural, are strong drivers of hospital length of stay. Increasingly, American physicians are encouraged to minimize patients' length of stay with diagnosis-related group-based reimbursement as opposed to the socialized medicine model used in many European countries. In addition, many patients and physicians in the United States view hospital length of stay as an indicator of quality of care, contributing to a tendency toward early postoperative discharge. Another likely contributor was the increased use of VATS and the higher rate of wedge resection (relative to segmentectomy) in the patients in the STS database. Finally, the lack of stepdown facilities and nursing homes in many European countries can delay hospital discharge. Compared with the United States, patients in Europe are more commonly discharged from the hospital directly to their homes, potentially increasing hospital length of stay. The intersocietal variation in unexpected return to the operating room likely reflects the ESTS capturing return to the operating room only for bleeding, whereas the STS captures return to the operating room for any reason. This discrepancy in definitions may account for some of the observed variation in this field.

Thirty-day mortality was lower in the ESTS-GTSD compared with the STS-GTSD after wedge resection, at 0.1% versus 1.9%, respectively. Potential explanations for this variation in mortality include a sicker patient population undergoing wedge resection in the United States. Alternatively, if early-stage lung cancers in marginally operable patients are being treated with wedge resection in the United States but are likely to receive SBRT or supportive care in Europe, this could explain some of the variation observed.

Conversely, the STS-GTSD demonstrated lower 30-day mortality for lobectomy and pneumonectomy. The lower mortality rates observed in the STS may reflect a higher proportion of operations performed by dedicated general thoracic surgeons at tertiary care centers than in Europe. It has been estimated that the STS-GTSD captures only 8% of pulmonary resections for lung cancer nationally and that the results are not broadly generalizable, because the hospital length of stay, morbidity, and mortality rates are significantly lower than those in the Nationwide Inpatient Sample [20]. Alternatively, the increased hospital length of stay, a known risk factor for mortality after lobectomy, observed in the ESTS database may be a contributing component [21]. Unfortunately, any conclusions regarding variation in outcomes between the STS and ESTS databases remain limited and perhaps should not even be submitted because they are not supported by formal comparison and matching of the treated groups.

Limitations of this study include the voluntary nature of the STS and ESTS databases. This leads to selection

bias, because participants are more likely to be dedicated general thoracic surgeons practicing at tertiary care centers, making the results less generalizable. The potential for miscoding and data entry error must also be recognized in any large database analysis. This may be more of an issue in the ESTS database than in the STS database because not all thoracic surgical units in Europe are subject to data auditing. Conversely, a recent external audit of the STS-GTSD demonstrated a 95% concordance rate between submitted and audited data [8]. In addition, differences in patient and disease characteristics not captured in the databases—such as histologic type, cultural biases, ethnic origins, or lifestyle—may account for some of the variation observed between groups. When performing international comparisons of surgical practices and outcomes, it is crucial that as many variables are controlled for as possible. Despite all efforts to homogenize these cohorts, such analyses invariably suffer from bias and confounding, both measured and unmeasured. The ESTS database alone is a multinational registry, which includes data from very different health care systems and patient populations [10]. Finally, the aggregate nature of the STS and ESTS data does not allow for in-depth analysis of various subgroups undergoing pulmonary resection. Ultimately this allows only for speculation regarding explanations for observed variation.

In conclusion, this analysis documents the degree of intersocietal variation in pulmonary resection practices and outcomes between the STS and ESTS databases. Although it is expected that some discrepancy will exist because of regional influences, the observed variation in outcomes suggests the opportunity for quality improvement initiatives. These data provide the basis for further investigation with stage-specific, propensity-matched analyses to better understand the causes of variation in specific patient populations and ultimately work toward uniformly improved outcomes.

Author Interview: The Author Interview can be viewed in the online version of this article [http://dx.doi.org/10.1016/j.athoracsur.2015.12.073] on http://www.annalsthoracicsurgery.org.

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DISCUSSION

DR BETTY C. TONG (Durham, NC): Dr Calhoon, Dr Miller, members of the Association, Dr LaPar. Thank you for the opportunity to discuss this paper, and, Dr Seder, I appreciate your providing me with a copy of the manuscript well in advance.

You have presented an interesting comparison of practice patterns between American and European general thoracic surgeons, and seemingly this will serve as a basis for future initiatives. With that in mind, I have 3 specific questions to pose.

First, the most striking element of the study is that it seems to be qualitative in nature. You have mentioned that there were no statistics done due to the aggregate nature of the data, so then how do we quantify how different these practice patterns really are? As an example, the incidence of postop A-fib after lobectomy was 11% of patients in the STS database and about 6% in the ESTS database. I would assume that these are 2 differences, but are they really, and how do we know which of the described practice patterns are truly different among participants between the 2 organizations?

Second, in the manuscript you suggested that international consensus of best practices may lead to improved patient outcomes. Based on these findings, what specific elements would you include in these best practices and how would you go about ensuring that they are implemented? The one that is most obvious to me would be to increase the prevalence of thoracoscopic surgery, which has many demonstrated outcomes benefits compared to thoracotomy. While you provided some plausible explanations for the lower use of VATS lobectomy among ESTS surgeons in the manuscript, I think that the simple truth is that it still has yet to be widely adopted, with notable exceptions in Denmark and Spain. That being said, if we can't get more than 55% of lobectomies in the STS database done with VATS as a standard, isn't it a little bit hypocritical to expect our European colleagues to follow suit?

And finally, how do you plan to drill down into the data to truly compare apples to apples? This study is a nice starting point, but I think that further comparison of the specific indications for surgery and the related outcomes is very important. This would be hugely informative and lead to even more cross talk and information sharing regarding best practices.

Thank you for your insight and for your contribution to our specialty.

DR SEDER: Thank you for the questions, Dr Tong. With regard to making a more quantitative as opposed to a qualitative assessment of the differences, I am not sure that adding the statistics to it will inform us much further. With over 78,000 patients being analyzed, almost everything will be statistically significant. What we agreed upon at the combined STS and ESTS database task force meeting was to report those variables that seemed clinically significant. Although we could do some simple statistics based on interquartile range and medians, pointing out the clinically significant differences is what we are really trying to get at here. It is going to be up to us, as clinicians, to look at these data and decide whether or not a given difference is clinically significant, which I would argue is more important than statistical significance.

DR TONG: Agree, but where do we draw the line? How do we know it's really different or not? How do we know that the practice patterns are different then? What do you define as "different"?

DR SEDER: I don't know if there is just one answer to that. I suppose that we have to look at it as a society and say that, well, this seems a little bit too high or that seems too low. I am not sure that I have a specific answer for that question.

DR TONG: The quality improvement initiative, any specific suggestions?

DR SEDER: What this study does is lay a foundation. Included in this analysis were patients with benign disease and cancer—any patient who had a pulmonary resection. We would need propensity-matched, stage-specific comparisons to draw definitive conclusions or make definitive recommendations for quality improvement. What will make these comparisons even more powerful is inclusion of the long-term data that the STS is beginning to collect.

DR TONG: I would also suggest that indication-specific comparisons would be very important as well, not just stage specific for the malignant but comparing the benign and the malignant as well, because we all know that the benign patients tend to behave a little bit different than those with malignancies.

DR SEDER: Absolutely. Thank you.