The Society of Thoracic Surgeons and The European Society of Thoracic Surgeons General Thoracic Surgery Databases: Joint Standardization of Variable Definitions and Terminology

Felix G. Fernandez, MD, Pierre E. Falcoz, MD, PhD, Benjamin D. Kozower, MD, MPH, Michele Salati, MD, Cameron D. Wright, MD, and Alessandro Brunelli, MD

Emory University, Atlanta, Georgia; Strasbourg University Hospital, Strasbourg, France; University of Virginia, Charlottesville, Virginia; Ospedali Riuniti Ancona, Italy; Massachusetts General Hospital, Boston, Massachusetts; and St James's University Hospital, Leeds, UK

The European Society of Thoracic Surgery (ESTS) and the Society of Thoracic Surgeons (STS) general thoracic surgery databases collect thoracic surgical data from Europe and North America, respectively. Their objectives are similar: to measure processes and outcomes so as to improve the quality of thoracic surgical care. Future collaboration between the two databases and their integration could generate significant new knowledge. However, important discrepancies exist in terminology and definitions between the two databases. The objective of this collaboration between the ESTS and STS is to identify important differences between databases and harmonize terminology and definitions to facilitate future endeavors.

(Ann Thorac Surg 2015;99:368–76)

The European Society of Thoracic Surgery (ESTS) and the Society of Thoracic Surgeons (STS) general thoracic surgery databases collect data from a large thoracic surgical community in Europe and North America. Their main objectives are similar: to collect data in a standardized fashion to monitor quality of care. However, the respective database committees recognize discrepancies in definitions and terminology, which may hamper future collaboration across databases. The objective of this collaborative work was to harmonize terminology and definitions of risk factors and endpoints between the two datasets.

Material and Methods

A working group was created including members from the two database committees. The group met for the first time in Fort Lauderdale in 2012 during the STS annual meeting to discuss and collaborate on this subject. The panel identified a set of common variables between the two databases. Many of these variables had common definitions already, but others showed discrepancies (Table 1). This set of variables was circulated among all members of the ESTS and STS database committees to propose definitions based on the best clinical evidence and, where evidence was lacking, on expert opinion.

Representatives from each organization proposed definitions independently. For each variable the definition proposed by each organization's representatives was discussed, and a joint definition was agreed during a panel meeting held in Los Angeles in January 2013 during the STS annual meeting.

A final standardized and common set of variable definitions was agreed upon and is shown in Table 2 (including variables present in both databases) and in the Appendix table (including variables not yet in common between the two databases).

The main objective of this set of definitions is to provide standard terminology that may be widely used for clinical and scientific purposes. This set of definitions will be adopted in the future revisions of both European and STS datasets.

Historical Review of the Database

ESTS

The ESTS database was created in 2001 as a joint activity with the sister society, the European Association for Cardio-thoracic Surgery (EACTS). In this first version, data were collected through a computer application (Filemaker Pro). This was password protected, and data

The Appendix can be viewed in the online version of this article at [http://dx.doi.org/10.1016/j.athoracsur.2014.05.104] on http://www.annalsthoracicsurgery.org

Address correspondence to Dr Brunelli, Department of Thoracic Surgery, St James's University Hospital, Beckett St, Level 3, LS9 7TF, Leeds, UK; e-mail: brunellialex@gmail.com.

Table 1. List of All Variables Present in the Two Databases With Commonly Agreed Standardized Definitions

	Variable	Definition
1	Date of birth	Patient's date of birth using 4-digit format for year (dd/mm/yyyy)
2	Age	Patient's age in years, at time of operation; this should be calculated from the date of birth and the date of operation
3	Gender	Patient's gender at birth as either male or female
4	Height, m	Height of the patient in meters at the time of operation
5	Weight, kg	Weight of the patient in kilograms at the time of operation
6	Current treatment for hypertension	Patient has a diagnosis of hypertension, documented by current pharmacologic therapy, diet, and/or exercise to control hypertension
7	Current treatment for cardiac failure	Patient is currently using pharmacologic therapy to treat congestive heart failure; heart failure is defined as physician documentation or report of any of the following clinical symptoms of heart failure described as unusual dyspnea on light exertion, recurrent dyspnea occurring in the supine position, fluid retention; or the description of rales, jugular venous distention, pulmonary edema on physical examination, or pulmonary edema on chest roentgenogram; a low ejection fraction without clinical evidence of heart failure does not qualify as heart failure
8	Coronary artery disease	Patient has a history of coronary artery disease (CAD) as evidenced by one of the following: 1. Currently receiving medical treatment for CAD 2. History of myocardial infarction 3. Prior CV intervention including, but not limited to, CABG, PCI, or both
9	Any previous cardiac surgical procedures	Patient has undergone any prior cardiac surgical procedure that required a general anesthetic and an incision into the mediastinum or chest
10	Neoadjuvant chemotherapy	Patient received preoperative chemotherapy (or chemoradiotherapy) for the current thoracic malignancy; do not report treatment for prior cancers
11	Neoadjuvant radiotherapy	Patient received preoperative radiotherapy (or chemoradiotherapy) for the current thoracic malignancy; do not report treatment for prior cancers
12	Other comorbidities: CVA	Patient has a history of cerebrovascular disease, documented by any one of the following: • Cerebrovascular accident (CVA): Patient has a history of stroke (ie, loss of neurologic function with residual symptoms at least 24 hours after onset) presumed to be from vascular cause • Transient ischemic attack (TIA): Patient has a history of loss of neurological function that was abrupt in onset but with complete return of function within 24 hours, presumed to be from vascular cause
13	Other comorbidities: diabetes	Patient has a history of diabetes diagnosed and/or treated by a physician; do not include gestational diabetes
14	$FEV_{1\%}$	FEV_1 obtained for the patient within 6 months of the operation and expressed as percentage of the predicted for age, sex, and height according to the prediction equations (after bronchodilators if done)
15	DLCO%	Uncorrected DLCO obtained for the patient within 6 months of the operation and expressed as percentage of the predicted for age, sex, and height according to prediction equations
16	ECOG: Zubrod	The Zubrod performance scale should be marked to indicate the level of the patient's performance at the time of operation that most accurately defines the patient's status
17	Diagnosis: lung cancer (NSCLC)	Indicate whether a lung resection was performed for lung cancer (eg, wedge, segment, lobe, pneumonectomy), open or VATS
18	Clinic T	Appropriate descriptor for the primary tumor according to the 7^{th} edition of the AJCC lung cancer staging system; clinical staging is based on the pretreatment estimated (before any induction therapy is done) staging workup, which may include, for instance, CT scan, PET scan, endoscopic ultrasonography
19	cN	Appropriate descriptor for the lung cancer nodal metastases according to the 7th edition of the AJCC lung cancer staging system; all nodes >1 cm on CT or PET/CT are considered positive; all PET-positive nodes are considered positive; results of previous invasive staging (EBUS, mediastinoscopy) should be included here. clinical staging is based on the pretreatment estimated (before any induction therapy is done) staging workup, which may include, for instance, CT scan, PET scan, endoscopic ultrasonography
20	cM	Appropriate descriptor for the lung cancer distant metastases according to the 7th edition of the AJCC lung cancer staging system; clinical staging is based on the pretreatment estimated (before any induction therapy is done) staging workup, which may include, for instance, CT scan, PET scan, endoscopic ultrasonography

(*Continued*)

Table 1. Continued

	Variable	Definition
21	Date of Thoracic surgical procedure	Date of surgical procedure, which equals the date the patient enters the operating room
22	Status	Status that best describes the clinical status of the patient at the time of the primary surgical procedure: 1. Emergent: the surgical procedure must be performed without delay; the patient has no choice other than immediate operation if they do not want to risk permanent disability or death. 2. Urgent: the surgical procedure can wait until the patient is medically stable but should generally be done within 48 hours. 3. Elective: surgical procedure that is scheduled in advance because it does not involve a medical emergency
23	ASA	Patient's American Society of Anesthesiologists Risk Scale for this surgical procedure
24	pT	Appropriate descriptor for the lung cancer primary tumor based on final pathology report according to the 7th edition of the AJCC lung cancer staging system
25	pN	Appropriate descriptor for the lung cancer regional nodes based on final pathology report according to the 7th edition of the AJCC lung cancer staging system
26	pM	Appropriate descriptor for the lung cancer metastases based on final pathology report according to the 7th edition of the AJCC lung cancer staging system
27	pR	Pathology report indicated positive surgical margins
28	Complication: air leak >5 days	Patient experienced a postoperative air leak for >5 days
29	Complication: bronchoscopy for atelectasis	Postoperative atelectasis documented clinically or radiographically that needed bronchoscopy
30	Complication: pneumonia	Defined according to the last CDC criteria: two or more serial chest radiographs with at least **one** of the following: 1. New or progressive **and** persistent infiltrate 2. Consolidation 3. Cavitation **and** at least **one** of the following: 1. Fever (>38°C or >100.4°F) with no other recognized cause 2. Leukopenia (<4000 WBC/mm^3) or leukocytosis (≥12,000 WBC/mm^3) 3. For adults ≥70 years old, altered mental status with no other recognized cause **and** at least **two** of the following: 1. New onset of purulent sputum, or change in character of sputum, or increased respiratory secretions, or increased suctioning requirements 2. New onset or worsening cough, or dyspnea, or tachypnea 3. Rales or bronchial breath sounds Worsening gas exchange (eg, O_2 desaturations [eg, PaO_2/FiO_2 ≤240], increased oxygen requirements, or increased ventilator demand)
31	Complication: ARDS	Adult respiratory distress syndrome defined according to the American-European consensus conference; all of the following criteria should be met: 1. Acute onset 2. Arterial hypoxemia with PaO_2/FIO_2 ratio <200 (regardless of PEEP level) 3. Bilateral infiltrates at chest radiograph or CT scan 4. No clinical evidence of left atrial hypertension or pulmonary artery occlusive pressure <18 mm Hg 5. Compatible risk factors
32	Complication: bronchopleural fistula	Patient experienced a complete or partial dehiscence of the bronchial stump documented in the postoperative period (such as bronchoscopy or other operative intervention)
33	Complication: pulmonary embolism	Patient experienced a pulmonary embolus in the postoperative period as documented by a V/Q scan, angiogram, or spiral CT
34	Complication: initial ventilator support >48 hours	Patient initially was ventilated >48 hours in the postoperative period; ventilator support ends with removal of endotracheal tube or, if the patient has a tracheostomy tube, until no longer ventilator dependent
35	Complication: reintubation	Patient was reintubated during the initial hospital stay after the initial extubation; this may include patients who have been extubated in the operating room and require intubation in the postoperative period

(*Continued*)

Table 1. Continued

	Variable	Definition
36	Complication: tracheostomy	Patient required a tracheostomy in the postoperative period whether performed in the ICU or the OR; prophylactic minitracheostomy on the day of operation should not be considered a complication
37	Complication: atrial arrhythmia	New onset of atrial fibrillation/flutter (AF) requiring medical treatment or cardioversion; does not include recurrence of AF that was present preoperatively
38	Complication: ventricular arrhythmia	Sustained ventricular tachycardia or ventricular fibrillation that has been clinically documented and treated by ablation therapy, implantable cardioverter defibrillator, permanent pacemaker, pharmacologic treatment. or cardioversion
39	Complication: myocardial infarction	Evidenced by one of the following criteria: 1. Transmural infarction diagnosed by the appearance of a new Q wave in two or more contiguous leads on ECG 2. Subendocardial infarction (non Q wave) evidenced by clinical, angiographic, electrocardiographic signs 3. Laboratory isoenzyme evidence of myocardial necrosis
40	Complication: empyema	Patient experienced an empyema requiring treatment in the postoperative period; diagnosis of empyema should be confirmed by thoracentesis; frank pus or merely cloudy fluid may be aspirated from the pleural space; the pleural fluid typically has leukocytosis, low pH (<7.20), low glucose (<60 mg/dL), high lactate dehydrogenase, and elevated protein and may contain infectious organisms
41	Complication: wound infection	Patient experienced a wound infection in the postoperative period as evidenced by meeting two of the following criteria: 1. Wound opened with excision of tissue (I&D) 2. Positive culture 3. Treatment with antibiotics
42	Complication: cerebrovascular complications	Occurrence of one of the following central neurologic postoperative events not present preoperatively: 1. A central neurologic deficit persisting postoperatively for more than 72 hours 2. A transient neurologic deficit (transient ischemic attack or reversible ischemic neurologic deficit) with recovery within 72 hours 3. A new postoperative coma persisting at least 24 hours and caused by anoxic/ischemic and/or metabolic encephalopathy, thromboembolic event, or cerebral bleed
43	Complication: recurrent nerve palsy	Patient experienced in the postoperative period a recurrent laryngeal nerve paresis or paralysis that was not identified during the preoperative evaluation
44	Complication: delirium	Patient experienced a new onset of symptoms like illusions, confusion, cerebral excitement in the postoperative period
45	Complication: renal failure	Defined as the onset of new renal failure in the postoperative period according to one of the following criteria: 1. Increase of serum creatinine to >2.0 mg/dL 2. Two times the preoperative creatinine level 3. A new requirement for dialysis postoperatively
46	Complication: chylothorax	Patient experienced a chylothorax in the postoperative period that required persistent or new drainage and medical intervention (eg, NPO, TPN) or reoperation. Chylothorax is defined by the clinical appearance of the pleural fluid or the presence of pleural fluid triglyceride levels >110 mg/dL with a cholesterol level <200 mg/dL
47	Complication: unexpected admission to ICU	An unplanned transfer of the patient to the ICU owing to deterioration in the condition of the patient requiring active life support treatment
48	Date of discharge	Date the patient was discharged from the hospital (acute care); if the patient expired in the hospital, the discharge date is the date of death
49	Outcome at discharge	Indicate whether patient was alive or dead at discharge from the hospitalization in which the primary surgical procedure occurred
50	Outcome at 30 days	Indicate whether patient was alive or dead 30 days after operation (whether in the hospital or not).

AJCC = American Joint Committee on Cancer; CABG = coronary artery bypass grafting; CDC = Centers for Disease Control and Prevention; CT = computed tomography; CV = cardiovascular; EBUS = endobronchial ultrasonography; ECG = electrocardiogram; ECOG = Eastern Cooperative Oncology Group; FEV_1 = forced expiratory volume in 1 second; I&D = incision and drainage; ICU = intensive care unit; NPO = nothing by mouth; NSCLC = non-small cell lung cancer; OR = operating room; PCI = percutaneous coronary intervention; PEEP = positive end-expiratory pressure; PET = positron emission tomography; TPN = total parenteral nutrition; VATS = video-assisted thoracic surgery; WBC = white blood cells.

Table 2. Common Definitions of Variables Not Present in Both Databases

Variable	Definition
Peripheral vascular disease	Indicate whether the patient has peripheral arterial vascular disease, as indicated by • Claudication with either exertion or rest • Amputation for arterial insufficiency • Aortoiliac occlusive disease reconstruction • Peripheral vascular bypass procedure, angioplasty, or stent • Documented AAA, AAA repair, or stent • Noninvasive/invasive carotid test with >79% occlusion • Previous carotid artery surgical procedure or intervention for carotid artery stenosis
Pulmonary hypertension	• Right heart catheterization: mean pulmonary arterial pressure (PAP) >25 mm Hg at rest or • Echocardiographic diagnosis: tricuspid regurgitation velocity 3.4 m/s, pulmonary artery systolic pressure >50 mm Hg
COPD	GOLD American Thoracic Society definition • No: $FEV_1/FVC \geq 0.7$ • Mild: $FEV_1/FVC < 0.7$ and $FEV_1 \geq 80\%$ • Moderate: $FEV_1/FVC < 0.7$ and $80\% < FEV_1 > 50\%$ • Severe: $FEV_1/FVC < 0.7$ and $FEV_1 < 50\%$
Pulmonary fibrosis	Indicate whether the patient has a diagnosis of interstitial fibrosis based on clinical and radiologic or pathologic evidence
Readmission	Indicate whether patient was readmitted to any hospital within 30 days of discharge because of any cause related to previous operation
FVC (L)	Forced vital capacity: the amount of air (expressed in liters) that can be forcibly exhaled from the lungs after taking the deepest breath possible
FVC%	Forced vital capacity: the amount of air (expressed as percentage of theoretic value) in liters that can be forcibly exhaled from the lungs after taking the deepest breath possible
FEV_1 (L)	Forced expiratory volume in 10 second: the amount of air (expressed in liters) that can be forcibly exhaled from the lungs in the first second of a forced exhalation
FEV_1/FVC (L)	The number that represents the ratio of forced expiratory volume in 1 second (FEV_1) to forced vital capacity (FVC)
$ppoFEV_1\%$	Predicted postoperative FEV_1 is calculated taking into account the number of functioning segments to be resected during operation ($ppoFEV_1$ = preoperative $FEV_1 \times [1 - a/b]$) where a = number of unobstructed segments to be resected and b = total number of unobstructed segments, according to the ERS/ESTS and ACCP guidelines
ppoDLCO%	Predicted postoperative DLCO is calculated taking into account the number of functioning segments to be resected during operation (ppoDLCO = preoperative DLCO × [1 – a/b]) where a = number of unobstructed segments to be resected and b = total number of unobstructed segments, according to the ERS/ESTS and ACCP guidelines
Vo_2max	Vo_2max is the maximal oxygen uptake or the maximum volume of oxygen that can be used in 1 minute during maximal or exhaustive exercise; it is measured as milliliters of oxygen used in 1 minute per kilogram of body weight

AAA = abdominal aortic aneurysm; ACCP = American College of Chest Physicians; COPD = chronic obstructive pulmonary disease; ERS = European Respiratory Society; ESTS = European Society of Thoracic Surgeons; GOLD = generalized obstructive lung disease; STS = The Society of Thoracic Surgeons.

Although the ESTS-STS task force agreed on a common definition of variables that are currently not present in both datasets, their inclusion in future versions or upgrades of the two databases will depend on each individual database committee decision.

REPORT

were exported from within each unit's database using encryption, automatically attached to an email, and sent to the central repository. Approximately 3400 cases of lung resection were collected from 2001 to 2003 from 27 units of 14 European countries.

Database activity was suspended until 2007, when a new version was released. The new version was an online web-based database allowing submission from any computer in the hospital. Database participation remained voluntary and free to all ESTS members. In 2009, the first database annual report, the Silver Book, was published and distributed to all members attending the annual conference. An annual report is now published yearly.

In 2009, a contract was signed with Dendrite Clinical Systems LTD to help the ESTS in professionalizing the database. This collaboration created a platform, which now makes it possible to import data from individual units and from existing national databases. The first country to join the project was France. In 2010, an agreement was signed between the French Society of Thoracic and Cardiovascular Surgery (FSTCVS) and ESTS to import all French data on lung resection to the European platform. Following this example, an increasing

number of countries expressed their interest to join the ESTS database (eg, Hungary, Netherland, Poland).

The ESTS database includes all types of general thoracic procedures. Particular emphasis has been placed on development of the lung excision dataset to create an instrument of audit, which is currently used to assist in the European Institutional Quality Certification Program. This program was launched in 2011 to acknowledge those units demonstrating high quality, according to a composite performance score including both outcome and process endpoints [1] and meeting defined structural and procedural criteria [2, 3] The number of lung resections recorded in the ESTS database increased from 2,000 cases in 2009 to 45,000 cases in 2013. The number of actively participating units (>100 cases submitted) increased from 22 in 2009 to 110 in 2013, representing 15 European countries.

STS

The STS National Database was initiated in 1989 and has become the premier clinical data registry for cardiothoracic surgery [4]. It was designed to capture detailed clinical data and outcomes related to the immediate postoperative period of 30 days. For the past three decades, the Adult Cardiac Surgery component of the STS National Database has been used to support national quality improvement efforts and develop risk models to adjust outcomes based on patient characteristics and disease severity [5].

In 1999, the STS National Database was expanded to include data on general thoracic surgical procedures. In 2002, the STS formally established the General Thoracic Surgery Database (GTSD) component of the STS National Database as a voluntary effort to support continued quality improvement efforts of surgeons and hospitals [6]. By 2003 there were 11,000 thoracic surgical procedures recorded in the GTSD, and by 2006 this increased to 49,000 operations submitted from 225 surgeons [7]. As of 2013 more than 800 participating surgeons from more than 270 participating sites were contributing to the GTSD, with more than 350,000 thoracic operations recorded [8].

Oversight of the GTSD is provided by the General Thoracic Surgery Database Task Force. Participation in the database is voluntary. Data entry is performed by clinical research nurses or surgeons, and the data are uploaded with the use of STS- approved software packages. The Duke Clinical Research Institute (DCRI) in Durham, North Carolina, serves as the data warehouse and analysis center for the STS National Database. Risk-adjusted short-term results are provided to participating institutions by the DCRI on a twice-yearly basis. The GTSD provides participating members with risk-adjusted national thoracic surgical benchmarks for lung and esophageal cancer resections. Database versions are reviewed and updated on a 3-year basis.

In 2010, the first external audit of the GTSD was performed; it has since been repeated annually [9]. Audits have demonstrated high agreement rates with hospital records and validate the accuracy and completeness of the data. In 2012, another milestone was reached when several quality measures derived from the GTSD were endorsed by the National Quality Forum (NQF) [10]. These metrics include both outcome measures (morbidity and mortality after lung and esophageal cancer resections) and process measures (recording of clinical stage and performance status before lung/esophageal cancer resections and recording of pulmonary function before major anatomic pulmonary resection). Therefore, the GTSD is well positioned to drive quality improvement in general thoracic surgery in the future.

Aims of the Database

ESTS

The principle aim of the ESTS database is data collection for monitoring quality of care in Europe. The wide diversity of educational background and clinical practice across Europe demanded an instrument to closely monitor the performance of GTS units with the ultimate objective of standardizing and improving the outcome. To this purpose, a Composite Performance Score (CPS) was developed, including both risk-adjusted outcomes and processes of care indicators to evaluate in a comprehensive and reliable way the performance of individual units contributing to the database. Quality endpoints are represented by elements included in the database and based on evidence-based clinical guidelines. Therefore, the development of risk models from the data submitted to the database must be interpreted as an instrument of clinical audit rather than of patient selection.

STS

The primary goal of the GTSD is to provide feedback on quality assessment data to participating surgeons and hospitals and to serve as a basis for clinical practice improvement efforts [8]. These national data obtained from a spectrum of academic and private institutions allows for the benchmarking of contemporary results of thoracic surgical procedures. The GTSD also serves as a valuable resource for outcomes and health services research. Proposed research projects are initially screened by the STS Access and Publications Task Force. Work from the GTSD has resulted in the development of risk adjustment models for pulmonary and esophageal resections and of analyzed outcomes for various thoracic procedures [7, 11–17].

Participation in the Database

ESTS

Participation to the database project is totally free (for members and invited contributors) and voluntary but strongly recommended. It is possible to access the database from the ESTS website homepage or by using the following address: https://ests.dendrite.it/csp/ests/intellect/login.csp. To join the database a personal login account is needed. It can be requested by downloading

and completing an application form from the ESTS homepage (http://www.ests.org).

STS

Participation in the GTSD is voluntary, although strongly encouraged. Two fees are associated with participation in the database. A participation fee is paid to the STS for costs of collecting data, storage at DCRI, and data analysis and report back to participants. The second fee is associated with the software used for data capture and transmittal to DCRI. Appropriate steps to become a participant in the GTSD are outlined in the STS website [18].

Method of Data Collection

ESTS

Data are anonymously reported, independently accessed, and encrypted. The data of a given unit can be downloaded at the local level and used for internal quality analyses or institutional research purposes. In other words, end users have the possibility to export their data (Microsoft Excel format) in their computers for their own purposes. It runs currently on a Dendrite platform, which ensures appropriate level of software, hardware, extensive data security, and frequent backups. The possibility exists for those units having their own database to import their patients into the ESTS database. A formal request needs to be sent to the ESTS and Dendrite by each December. Additionally, an import agreement is also possible at a national society level. Since 2011, a convergence has been initiated for data import and quality initiatives with the French National Society. All pulmonary resections collected since 2007 in the French national registry have been imported to the ESTS database.

STS

Software for the STS National Database is licensed by independent software vendors that must comply with STS specifications. Dedicated database managers are used by most participant sites. Data managers are an important element of the success of the STS Database, and STS hosts an annual educational meeting to support their efforts known as the Advances in Quality and Outcomes meeting. GTSD participants submit their data twice annually to DCRI during specified data harvests. Data are exported as an American Standard Code for Information Interchange text file from the licensed STS software. This data is then submitted to DCRI through a secure web-based upload [8].

Method and Process of Data Analysis and Feedback

ESTS

The ESTS database is a specialty-specific, procedure-specific, prospectively maintained, periodically audited, and web-based electronic database designed for quality control and performance monitoring. It includes many risk factors, processes of care, and outcomes, which are specially designed for quality control and performance audit. The ESTS database is managed by a database committee, which is responsible for its periodical revisions and updates. An annual report (the Silver Book), is distributed to all ESTS members to benchmark thoracic surgery practice in Europe. In the future, participants will receive a periodic confidential feedback on the quality of their data and their performance against international benchmarks.

STS

The data management process for the STS National Database has been previously described [8]. Once data files are submitted to DCRI with each harvest, they undergo an automated preliminary analysis to ensure that the data are acceptable. Next, files are examined at the individual record and data element level. From this a Data Quality Report (DQR), which contains summary information on data files including missing elements and inconsistencies, is sent to participants. During the 3-week harvest window, participants may amend their data and resubmit.

After each data harvest, feedback reports are generated for database participants by DCRI. These reports contain patient-level demographic information, process of care measures, and outcomes and discharge status. Hierarchical and nonhierarchical modeling approaches are used to risk-adjust mortality and major morbidity outcome measures.

Important Publications from the Database

ESTS

A first analysis from the ESTS was published in 2005, based on approximately 3,500 patients undergoing pulmonary resection [19]. The objective was to develop and validate a risk-adjusted in-hospital mortality model for risk stratification and quality of care investigations. The analysis yielded a parsimonious model composed of two variables: age and predicted postoperative forced expiratory volume in 1 second (ppoFEV1), named the European Society Objective Score (ESOS). This score was subsequently used to evaluate the performance of three European units [20]. The use of ESOS revealed that the performances of all units were in line with the predicted ones during each period under analysis.

In addition, ESTS has developed and published a Composite Performance Score incorporating both outcome and process indicators covering all three temporal domains of the clinical practice (preoperative, intraoperative, and postoperative) [21]. The CPS has been subsequently refined [22] and is currently used for the European Institutional Accreditation Program.

The ESTS Database Committee has put a specific effort into assuring a high quality of data. A total of 49,363 values were recently reviewed to obtain several data quality indicators. The results of the data quality assessment for the analyzed sections of the ESTS Database showed values of completeness of 0.85, correctness of 0.99, and consistency of 0.98. This study may represent a

template to be applied in the medical/surgical field to test the quality of data in clinical registries [23].

STS

The GTSD has generated many important scientific works produced by STS members. Several are highlighted here.

The first publication from the GTSD was a descriptive analysis of the surgical management of primary lung tumors by STS surgeons, reported in 2008 by Boffa and colleagues [7]. This article benchmarked operative mortality (2.5%) and length of stay (median 5 days) for surgical resections of primary lung tumors. A 65% rate of mediastinal lymph node evaluation with pulmonary resection for cancer was reported: a disappointingly low number that has driven quality improvement once disseminated.

As stated, a major aim of the GTSD is to provide risk adjustment models for common general thoracic surgical operations. The first such risk model examining predictors of prolonged length of hospital stay after lobectomy for lung cancer was published in 2008 by Wright and colleagues [13]. Again in 2009, Wright and colleagues [16] developed and published a risk adjustment model examining predictors of major morbidity and mortality after esophagectomy for esophageal cancer. In 2010, yet another risk model was issued by Kozower and colleagues [11] analyzing the predictors of major morbidity and mortality for lung cancer resection. These models have formed the foundation of quality assessment, patient counseling, research, and benchmark comparisons between providers and institutions.

The GTSD has also been used to conduct several important comparative effectiveness analyses, primarily centered on comparisons of minimally invasive (video-assisted thoracic surgery, VATS) pulmonary resection strategies versus traditional thoracotomy approaches. Paul and colleagues [12] demonstrated that a VATS approach to lobectomy for lung cancer was associated with a lower incidence of complications compared with an open approach to lobectomy. However, Boffa and colleagues [17] cautioned that a VATS approach to lobectomy may result in inferior hilar lymph node staging compared with a thoracotomy approach to lobectomy. These analyses have shaped modern thoracic surgical practice, and they are guiding ongoing studies.

How and Why the Two Databases Differ in Data Fields and Approaches

The GTSD and the ESTS-database have a large amount of common and consistent data. Most differences that can be identified are related to the peculiarity of the healthcare systems from which the databases are derived. However, the two registries are very similar in terms of data collection regarding the patients' baseline characteristics and the preoperative comorbidities. In fact, for these sections, it is possible to isolate more than 20 common variables between the two databases.

Regarding the clinical presentation of disease, the TNM descriptors are completely overlapping. The GTSD contains an additional 18 qualifiers, which describe the characteristics and the degree of invasion of the adjacent structures by the primary lung tumor. Differences are also present within the diagnosis section. The STS database collects data about the primary diagnosis following the specification of the ICD-9 list. In the ESTS database, 20 primary diagnoses have been selected qualifying the entered disease. Obviously, these diagnoses could be matched with those of the ICD-9 list.

Similarly, in analyzing surgical procedure qualifiers, the STS database offers a list of more than 200 codes identifying the treatment performed. The ESTS database developed a system of groups and qualifiers arranged in a multiple-choice process for defining the procedure entered. Finally, regarding the descriptors of the postoperative events, the two registries present a high degree of overlap (about 20 similar descriptors) in relation to those items characterizing the postoperative course and the early outcomes of the procedure.

Future Visions for the Two Databases

ESTS

The ESTS Database Committee is devoted to promoting a high-quality culture in the European thoracic community by continuously upgrading the database structure and providing educational opportunities. The ESTS database will continue to provide evidence that measurement of outcomes with benchmark tools is effective in improving surgical safety and patient care. Therefore, a major goal will be to achieve a progressive evolution from morbidity and mortality to total quality management. In other words, within the ESTS database, data will be analyzed over the long term with trending, allowing modulation of short-term variations and providing the ability to assess change over time. Following the fruitful example of France, the ESTS database will continue its expansion by promoting integration of national registries. In addition, satellite databases focusing on very specific topics will soon be launched (ie, thymoma, neuroendocrine tumors, mesothelioma, chest wall operations). This will offer solid ground for further clinical research.

STS

Increased participation from surgeons performing general thoracic surgical procedures is a major goal of the STS GTSD moving forward. An estimated 10% of all surgeons practicing general thoracic surgery (including those practicing general surgery who perform general thoracic surgical procedures) report to the database at present. International expansion would naturally follow. Public reporting of risk-adjusted outcomes for lobectomies will soon be available from the STS GTSD. A necessary next step is also to add longitudinal follow-up to the database. External linkages to claims databases, such as the Centers for Medicare and Medicaid Services MEDPAR files, are planned by the STS and will allow for

the acquisition of longitudinal follow-up information with regard to both survival and cost data: information that would further enhance the value of the GTSD for research.

References

1. Brunelli A, Berrisford RG, Rocco G, Varela G, on behalf of the European Society of Thoracic Surgeons Database Committee. The European Thoracic Database project: composite performance score to measure quality of care after major lung resection. Eur J Cardiothorac Surg 2009;35:769–74.
2. Klepetko W, Aberg THJ, Lerut AEMR, et al. Structure of general thoracic surgery in Europe: by the EACTS/ESTS Working Group on structures in thoracic surgery. Eur J Cardiothorac Surg 2001;20:663–8.
3. Brunelli A, Falcoz PE, D'Amico T, et al. European guidelines on structure and qualification of general thoracic surgery. Eur J Cardiothorac Surg 2014;45:779–86.
4. The Society of Thoracic Surgeons. 2013. (Accessed November 21, 2013. at www.sts.org/sections/nationaldatabase.).
5. Shahian DM, Edwards FH. The Society of Thoracic Surgeons 2008 cardiac surgery risk models: introduction. Ann Thorac Surg 2009;88(1 Suppl):S1.
6. Wright CD, Edwards FH. The Society of Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 2007;83:893–4.
7. Boffa DJ, Allen MS, Grab JD, et al. Data from The Society of Thoracic Surgeons General Thoracic Surgery Database: the surgical management of primary lung tumors. J Thorac Cardiovasc Surg 2008;135:247–54.
8. Shahian DM, Jacobs JP, Edwards FH, et al. The Society of Thoracic Surgeons National Database. Heart 2013;99:1494–501.
9. Magee MJ, Wright CD, McDonald D, et al. External validation of The Society of Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 2013;96:1734–9.
10. The National Quality Forum. 2013 (Accessed November 21, 2013, at http://www.qualityforum.org/Home.aspx).
11. Kozower BD, Sheng S, O'Brien SM, et al. STS database risk models: predictors of mortality and major morbidity for lung cancer resection. Ann Thorac Surg 2010;90:875–83.
12. Paul S, Altorki NK, Sheng S, et al. Thoracoscopic lobectomy is associated with lower morbidity than open lobectomy: a propensity-matched analysis from the STS database. J Thorac Cardiovasc Surg 2010;139:366–78.
13. Wright CD, Gaissert HA, Grab JD, et al. Predictors of prolonged length of stay after lobectomy for lung cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database risk-adjustment model. Ann Thorac Surg 2008;85:1857–65.
14. Shapiro M, Swanson SJ, Wright CD, et al. Predictors of major morbidity and mortality after pneumonectomy utilizing the Society for Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 2010;90:927–35.
15. Onaitis M, D'Amico T, Zhao Y, et al. Risk factors for atrial fibrillation after lung cancer surgery: analysis of the Society of Thoracic Surgeons General Thoracic Surgery Database. Ann Thorac Surg 2010;90:368–74.
16. Wright CD, Kucharczuk JC, O'Brien SM, et al. Predictors of major morbidity and mortality after esophagectomy for esophageal cancer: a Society of Thoracic Surgeons General Thoracic Surgery Database risk adjustment model. J Thorac Cardiovasc Surg 2009;137:587–96.
17. Boffa DJ, Kosinski AS, Paul S, et al. Lymph node evaluation by open or video assisted approaches in 11,500 anatomic lung cancer resections. Ann Thorac Surg 2012;94:347–53.
18. The Society of Thoracic Surgeons. 2013. (Accessed November 21, 2013 at http://www.sts.org/sts-national-database/database-participants/how-become-participant).
19. Berrisford R, Brunelli A, Rocco G, et al, on behalf of the Audit Guidelines committee of the European Association for Cardiothoracic Surgery and the European Society of Thoracic Surgeons. The European Thoracic Surgery Database project: modeling the risk of in-hospital death following lung resection. Eur J Cardiothorac Surg 2005;28:306–11.
20. Brunelli A, Varela G, Van Schil P, et al. Multicentric analysis of performance after major lung resections by using the European Society Objective Score (ESOS). Eur J Cardiothorac Surg 2008;33:284–8.
21. Brunelli A, Berrisford RG, Rocco G, Varela G, European Society of Thoracic Surgeons Database Committee. The European Thoracic Database project: composite performance score to measure quality of care after major lung resection. Eur J Cardiothorac Surg 2009;35:769–74.
22. Brunelli A, Rocco G, Van Raemdonck D, et al. Lessons learned from the European thoracic surgery database: the composite performance score. Eur J Surg Oncol 2010;36:S93–9.
23. Salati M, Brunelli A, Dahan M, et al, on behalf of the European Society of Thoracic Surgeons Database Committee. Task-independent metrics to assess the data quality of medical registries using the European Society of Thoracic Surgeons (ESTS) Database. Eur J Cardiothorac Surg 2011;40:91–8.