

# Thoracic surgery

## Introduction



### Key points

- Thoracic surgery has changed profoundly in the 21st century. Multidisciplinary treatment is evolving and surgeons have major collaborative roles in management of lung cancer, respiratory infections, chest trauma, paediatric respiratory disorders and end-stage respiratory insufficiency.
- Today, lung cancer is the most frequent indication for thoracic surgery.
- Lung transplantation is increasingly an option for patients with end-stage lung disease.
- The organisation of thoracic surgery varies between European countries and precise figures on the number of centres and the number of procedures carried out each year are not available.
- Thoracic surgeons need to be equally competent in pre-operative investigation and planning, the surgery itself and post-operative management.
- Recent developments in thoracic surgery have focused on reducing invasiveness, particularly through the use of video-assistance, and on parenchyma-saving techniques such as sublobar resection.
- To further stimulate progress in general thoracic surgery and to improve outcomes for patients, cooperation with respiratory physicians is of utmost importance.

Thoracic surgery has existed as a specific surgical discipline for more than a century. Initially, its main focus was surgery for tuberculosis and bronchiectasis. However, since 1940, rapid progress has been made in surgery for lung cancer, of the oesophagus and, most spectacularly, of the heart. After 1960, cardiac surgery became a separate subspecialty with an emphasis on coronary bypass surgery, valve surgery and congenital heart surgery. In most European countries, general thoracic (noncardiac) surgery is now well demarcated and exists as a separate specialty. However, the number of centres performing thoracic surgical interventions in Europe is unknown and a substantial number of thoracic surgical procedures are still performed outside dedicated thoracic surgical units. Consequently, no accurate figures on the total number of operations are currently available. As an example, thoracic surgery is not a specifically defined entity in Belgium, where it falls within the discipline of general surgery, together with abdominal, cardiac, vascular, paediatric and trauma surgery. Approximately 2000 pulmonary resections are performed each year in Belgium but only a minority of centres carry out more than 50 major thoracic operations per year. The other operations are spread widely over smaller centres performing less than 10 interventions yearly.

In some other countries (for instance the UK), thoracic surgery is part of the framework of cardiothoracic surgery. In Germany, large

“

## *Lung transplantation is increasingly an option for patients with end-stage lung disease*

”

free-standing units exist in combination with respiratory medicine, together with smaller cardiothoracic units and nonspecialised thoracic surgery units within general surgical clinics. Clearly, therefore, there is still no uniformity regarding general thoracic surgery in Europe. To define a more precise structure for general thoracic surgery, a working group has been established by the European Association for Cardio-thoracic Surgery (EACTS) and the European Society of Thoracic Surgeons (ESTS).

Recently, the Union Européenne des Médecins Spécialistes (UEMS) has created a specific thoracic surgical division, related to its general and cardiothoracic surgical sections. The division's statutes were finalised in June 2012 and representatives from each European country will be nominated. Specific criteria for training and accreditation in thoracic surgery are being developed.

The UEMS division of thoracic surgery is currently surveying the practice of thoracic surgery throughout the European Union (EU). At the time of writing, responses have been received from 22 EU member states: in 11, thoracic surgery is a separate single specialty; in eight, it is considered part of cardiothoracic surgery; and in three, there is no separate specialty of thoracic surgery.

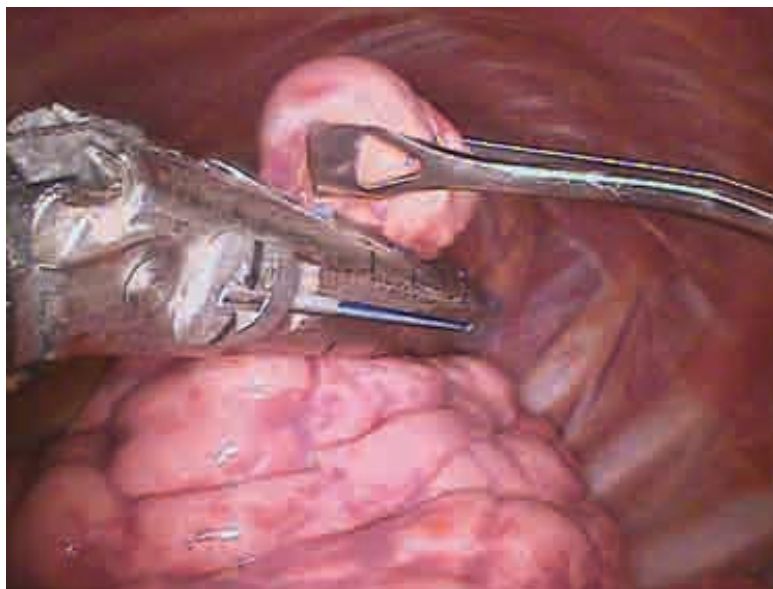
To obtain more precise data on the number of general thoracic surgical procedures carried out in Europe, several large databases have been created. The ESTS has established a voluntary database for general thoracic surgery. In 2011, a total of 24 574 lung resections were reported: lobectomy (removal of a lung lobe) represented 57.5% of cases and pneumonectomy (removal of a lung) 9.5%. A total of 16 710 cases of primary lung cancer were reported, lobectomy and bilobectomy being performed in 76% of cases. Most submitted cases originate from France, where a national database is already established with contributions from 90 thoracic surgical units. The Second National Thoracic Surgery Database Report of the Society for Cardiothoracic Surgery in Great Britain & Ireland, published in 2011, records an impressive total of 109 388 primary lung cancer resections, performed between 1980 and 2010 – with a significant increase in the rate from 2005 onwards.

### *Standards of care*

By definition, general thoracic surgery includes the knowledge, technical skill and judgement required to diagnose and treat diseases of the chest. The entire spectrum

comprises the chest wall, pleura, lungs, trachea and bronchi, mediastinum, diaphragm and oesophagus, in adults and children. General thoracic surgery requires in-depth knowledge of physiology, imaging, organ function testing, investigation, pre-operative evaluation, post-operative and critical care, trauma, oncology and transplantation. It also includes experience in multidisciplinary treatment protocols. The main competence of a thoracic surgeon is the pre-,

**Figure 1** – Wedge excision of lung apex by video-assisted thoracic surgery in a patient with pneumothorax.



#### **Standard**

- Lobectomy
- Bilobectomy
- Pneumonectomy

#### **Conservative or lung parenchyma-sparing operations**

- |          |  |
|----------|--|
| Proximal | Bronchotomy                            |
|          | Rotating bronchoplasty                 |
|          | Bronchial or tracheal wedge excision   |
|          | Bronchial or tracheal sleeve resection |
| Distal   | Segmentectomy                          |
|          | Wedge excision                         |

#### **Extended procedures (lung + other structure)**

- Pericardium (intrapericardial pneumonectomy)
- Diaphragm
- Chest wall (ribs, vertebrae)
- Superior sulcus (Pancoast tumour)

**Table 1** – Types of operative procedures.

intra- and post-operative care of patients with general thoracic surgical diseases. This includes the investigation of patients, decisions on specific treatment, performance of technically correct procedures and provision of expert post-operative care.

## ***Techniques and procedures***

Since 1990, less invasive techniques have been developed, with video-assisted surgical procedures replacing the classical thoracotomy for some indications. The percentage of these minimally invasive procedures has gradually increased over recent years: in the UK, approximately one-third of all lung resections are now performed by video-assisted thoracic surgery (VATS). Similar trends are found in other countries. (An example of a subtotal pleurectomy performed by VATS can be seen at the Multimedia Manual of Cardio-Thoracic Surgery, dx.doi.org/10.1093/mmcts/mms008). A VATS wedge excision is illustrated in figure 1. Recently, robotic surgery has also been introduced in thoracic surgery, providing a superb three-dimensional view and allowing precise operative interventions using highly flexible robotic arms. Thymectomy and resection of smaller anterior mediastinal tumours can be easily accomplished by robotic surgery. Lobectomy and, to a lesser extent, pneumonectomy remain the classic surgical procedures for lung cancer (table 1). However, over the past two decades major efforts have been made to develop more lung parenchyma-saving interventions. Sleeve and double-sleeve lobectomies using broncho-/tracheoplastic and vascular reconstructive techniques have been introduced successfully. These techniques avoid the need for pneumonectomy, resulting in lesser impact on pulmonary function and thus better quality of life, or allowing for appropriate resectional surgery in patients who otherwise wouldn't tolerate pneumonectomy. Increasing attention is also directed towards sublobar resection, *i.e.* anatomical segmentectomy or wide wedge excision in small peripheral cancers: results so far are promising, with similar survival figures in nonrandomised studies to those obtained after classic lobectomy. Indications for surgical treatment of nonsmall cell lung cancer are listed in table 2.

Lung metastasectomy has become a well-accepted procedure in the treatment of lung metastases originating from some solid-organ tumours.

Although still controversial, radical surgery in malignant pleural mesothelioma consisting of either extrapleural pneumonectomy or extended pleurectomy/decortication with or without resection of the diaphragm and pericardium, is performed by a number of thoracic surgeons in an effort to obtain maximal tumour reduction as part of a multimodal therapeutic strategy.

## ***Lung transplantation***

New developments and multidisciplinary cooperation have increasingly made lung transplantation a valid option for selected patients with end-stage lung disease. Worldwide transplantation activity has increased year on year over the past 25 years

Within the seven-country Eurotransplant community, 1182 lungs (528 double lung, 89 single lungs and 37 lungs plus other organ) were transplanted in 2011, an increase of 6.6% compared to 2010. The most common indications are end-stage emphysema, cystic fibrosis, idiopathic pulmonary fibrosis and pulmonary hypertension. Double lung transplantation has become the standard. According to the most recent adult lung transplant report of the International Society for Heart & Lung Transplantation (ISHLT), 3519 lung transplantation procedures were performed globally in 2010, the highest



## Definite

Stage IA	T1a,bN0
Stage IB	T2aN0
Stage IIA	T2bN0, T1a,bN1, T2aN1
Stage IIB	T2bN1, T3N0
Stage IIIA	T3N1

## Investigational

Stage IIIA	T1–3N2, T4N0,1
Stage IIIB	T4N2, T1–4N3

## Exceptional

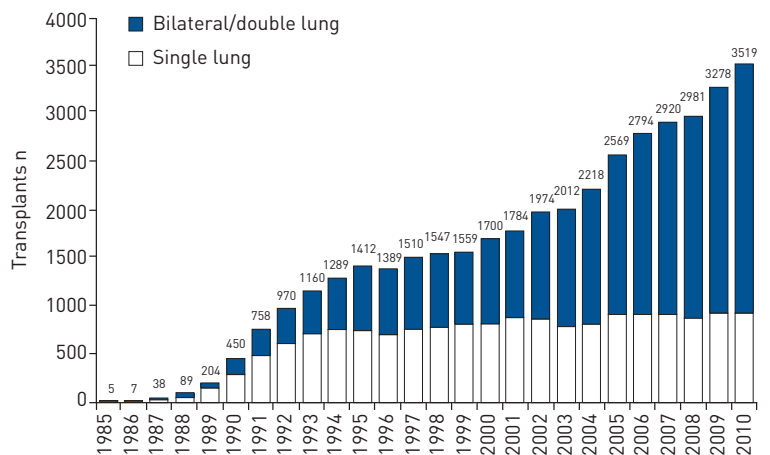
Stage IV – single metastasis
Stage IV – multiple metastases

**Table 2** – Indications for surgical treatment of nonsmall cell lung cancer. See chapter 19 for an explanation of lung cancer staging.

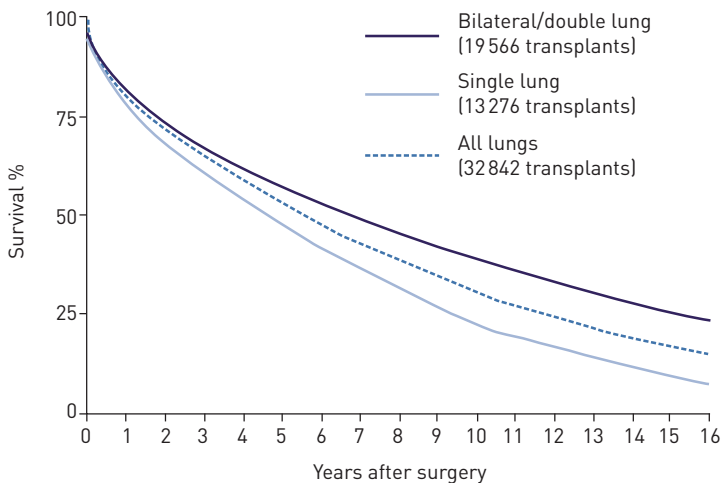
number ever reported. Although lung transplantation remains a high-risk procedure, survival results have improved over the past decade. Five-year survival is now about 50% overall, but more experienced centres now regularly report 5-year survival figures in the region of 70% (figure 3). However, long-term survival remains low compared with transplantation of other solid organs, due to chronic infection and rejection leading to bronchiolitis obliterans syndrome (BOS), which remains the Achilles' heel of lung transplantation.

## Organisation of thoracic surgical centres

To ensure the best possible patient care in thoracic surgery, the EACTS/ESTS working group states that it should be performed within the logistical and economic framework of specialised units. These units should be designed to allow patient care and treatment according to recommended



**Figure 2** – The global number of adult lung transplants reported to the International Society for Heart & Lung Transplantation each year since 1985. Reproduced from CHRISTIE *et al.*, 2012, with permission from the publisher.



**Figure 3** – Survival of adult lung transplant patients (operations performed between 1994–2010) according to type of transplantation. Reproduced from CHRISTIE *et al.*, 2012, with permission from the publisher.

standards, as well as education of surgical trainees, continuous development and research in thoracic surgery.

The working group proposed two types of thoracic surgical centres: highly specialised centres within, or associated with a university, performing at least 250 major thoracic procedures per year, and standard units which are free-standing or combined with cardiac, vascular or general surgery. In a standard unit at least 100 major interventions should be performed annually. Lung transplantation and its alternative procedures should be performed only in centres with special interest and with cardiac surgical facilities.


## Changing roles

Thoracic surgery has changed profoundly in the 21st century. Multidisciplinary treatment is evolving and thoracic surgeons have become major team players in diseases related to thoracic oncology, infection, trauma, paediatric disorders and end-stage respiratory insufficiency.

The changing pattern of thoracic surgical practice is exemplified by a recent new classification of adenocarcinoma, which will have a profound impact on surgical decision making and treatment. For smaller tumours the role of sublobar resection is reconsidered as mentioned above. In the most recent revision of the Tumour, Nodes, Metastases (TNM) classification for lung cancer, important changes were made in the T and M descriptors, with definition of new subcategories. A new lymph node map was introduced together with the concept of nodal zones, reconciling previously published lymph node classifications. A prospective database has already been created to refine the classification ahead of the next revision.

## The future

In order to increase the profile of thoracic surgery within the European Union and elsewhere in Europe, further harmonisation in practice and organisation is necessary. This relates not only to training in thoracic surgery, but also to certification of dedicated thoracic surgical units.



Unified databases, to which the majority of thoracic surgeons contribute, should be made available, detailing not only mortality but also specific outcome measures related to morbidity, survival and quality of life. Postgraduate education remains essential to ensure high-quality surgical interventions, as has recently been demonstrated by a study from the Netherlands evaluating completeness of lymph node dissection in dedicated thoracic surgical centres. Thoracic surgeons should be further involved in randomised clinical trials comparing newly introduced treatment modalities, such as stereotactic radiotherapy or radiofrequency ablation, to classical surgical procedures.

As their field is constantly changing, thoracic surgeons should be prepared to adapt to a new environment bringing not only new challenges but also opportunities to further develop and refine this fascinating specialty.

To further stimulate progress in general thoracic surgery, cooperation with respiratory physicians is of utmost importance to improve the outcome for patients. The structure of the European Respiratory Society provides a solid basis for mutual interactions and exchange of knowledge between the different groups of respiratory medicine and general thoracic surgery. Better patient care will be the ultimate result.

## Further reading



### General

- European Society of Thoracic Surgeons (ESTS) Database Annual Report 2011.
- Klepetko W, Aberg TH, Lerut AE, *et al.* Structure of general thoracic surgery in Europe. *Eur J Cardiothorac Surg* 2001; 20: 663–668.
- Page RD, McShane J, Kinsman R, on behalf of the Society for Cardiothoracic Surgery in Great Britain & Ireland. Second National Thoracic Surgery Activity & Outcomes Report 2011. Henley-on-Thames, Dendrite Clinical Systems, 2011. [www.scts.org/\\_userfiles/resources/634558869917493937\\_Thoracic\\_2011\\_FINAL.pdf](http://www.scts.org/_userfiles/resources/634558869917493937_Thoracic_2011_FINAL.pdf)

### Lung cancer

- Aberle DR, Adams AM, Berg CD, *et al.* Reduced lung-cancer mortality with low-dose computed tomographic screening. *N Engl J Med* 2011; 365: 395–409.
- Bach PB, Mirkin JN, Oliver TK, *et al.* Benefits and harms of CT screening for lung cancer: a systematic review. *JAMA* 2012; 307: 2418–2429.
- Giroux DJ, Rami-Porta R, Chansky K, *et al.* The IASLC Lung Cancer Staging Project: data elements for the prospective project. *J Thorac Oncol* 2009; 4: 679–683.
- Goldstraw P, Crowley J, Chansky K, *et al.* The IASLC Lung Cancer Staging Project: proposals for the revision of the TNM stage groupings in the forthcoming (seventh) edition of the TNM Classification of malignant tumours. *J Thorac Oncol* 2007; 2: 706–714.

- Rusch VW, Asamura H, Watanabe H, *et al.* The IASLC lung cancer staging project: a proposal for a new international lymph node map in the forthcoming seventh edition of the TNM classification for lung cancer. *J Thorac Oncol* 2009; 4: 568–577.
- Travis WD, Brambilla E, Noguchi M, *et al.* International Association for the Study of Lung Cancer/American Thoracic Society/European Respiratory Society international multidisciplinary classification of lung adenocarcinoma. *J Thorac Oncol* 2011; 6: 244–285.
- Travis WD, Brambilla E, Van Schil P, *et al.* Paradigm shifts in lung cancer as defined in the new IASLC/ATS/ERS lung adenocarcinoma classification. *Eur Respir J* 2011; 38: 239–243.
- Van Schil PE, Asamura H, Rusch VW, *et al.* Surgical implications of the new IASLC/ATS/ERS adenocarcinoma classification. *Eur Respir J* 2012; 39: 478–486.
- Van Schil PE. Action point: intraoperative lymph node staging. *Eur J Cardiothorac Surg* 2012; 41: 839–840.
- Verhagen AF, Schoenmakers MC, Barendregt W, *et al.* Completeness of lung cancer surgery: is mediastinal dissection common practice? *Eur J Cardiothorac Surg* 2012; 41: 834–838.

### Video-assisted thoracic surgery

- Swanson SJ, Meyers BF, Gunnarsson CL, *et al.* Video-assisted thoracoscopic lobectomy is less costly and morbid than open lobectomy: a retrospective multiinstitutional database analysis. *Ann Thorac Surg* 2012; 93: 1027–1032.

### Mesothelioma

- Rice D, Rusch V, Pass H, *et al.* Recommendations for uniform definitions of surgical techniques for malignant pleural mesothelioma: a consensus report of the international association for the study of lung cancer international staging committee and the international mesothelioma interest group. *J Thorac Oncol* 2011; 6: 1304–1312.
- Rice D. Surgical therapy of mesothelioma. *Recent Results Cancer Res* 2011; 189: 97–125.

### Lung transplantation

- Christie JD, Edwards LB, Kucheryavaya AY, *et al.* The registry of the International Society for Heart and Lung Transplantation: 29th adult lung and heart–lung transplant report – 2012. *J Heart Lung Transplant* 2012; 31:1074–1086.
- Eurotransplant Statistics Report Library. [statistics.eurotransplant.org](http://statistics.eurotransplant.org)
- Fuller J, Fisher AJ. An update on lung transplantation. *Breathe* 2013; 9: 188–200.