



Thoracic surgery in the UK

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The NHS is a government-funded medical and health care service established in 1948 that everyone living in the UK can use and that is free at the point of use (or delivery). This mission has encouraged thoracic surgeons to weigh carefully the clinical and cost effectiveness of surgery, to pursue excellence in training and push the limits of research and innovation.

The combination of high-quality education and world-leading research has been crucial to facilitate advances of Thoracic Surgery in the UK. The Royal Colleges of Surgeons throughout the UK have been responsible for setting standards across the country and worldwide. In 2002, the UK increased the number of thoracic surgeons to enlarge the thoracic workforce to achieve better service provision, higher resection rates for lung cancer (1). Between 2002 and 2016, the number of thoracic surgeons doubled from 40 to 81 (2,3) and according to the 2020 National Lung Cancer Audit (NCLA) report each UK unit activity has risen to a median of 235 cases per year. This was associated with improvement of surgical outcomes: the in-hospital mortality risk following lung resection has fallen from 5% before 1985 to below 2% in 2018 and has been reduced markedly for both pneumonectomy and lobectomy. Overall, 62% of lung cancer patients in stage I and II underwent lung resection as part of treatment in 2018 and of all patients with early-stage disease who did not have surgery 62% received radiotherapy (4).

However, the resection rates are still widely variable between trusts and vary from 13% to 32% of all lung cancers (4).

The UK currently performs most operations for lung

cancer using minimally invasive surgery. Since the 1990's, when the technique was firstly introduced and mainly used for sublobar resection, the proportion of open surgery has been decreasing throughout the years. In 2017, 55% of all cancer resections were performed with VATS technique in the UK with a relatively constant in hospital survival of 99% (4). This year, the VIOLET study established VATS surgery as the standard of care for lobectomy in lung cancer.

The first heart transplant in the UK was performed in 1968 by Donald Ross, a surgeon from the Royal Brompton and Harefield Hospital (5). The British Transplant Society sets the quality standards for such operations and organises organ donation and transplantation services. The availability of donor lungs being scarce, several techniques have been developed such as ex vivo lung perfusion (EVLP) which helps maintaining the lungs outside the body while evaluating the best time for transplant. In 2020 NICE Guidelines published recommendations about the safety and efficacy of this technique (6). Despite this, from 1 April 2019 to 31 March 2020 only 160 lung transplants have been carried out in England and with 2.5 lung transplants per one million population in 2019 (*vs.* 8.4 lung transplants in the US) the UK had the fifth lowest rate of lung transplants in Europe (7).

Although oesophageal cancer resections are no longer performed by thoracic surgeons in the UK, thoracic chest wall deformities (pectus excavatum, pectus carinatum) and chest injuries remain important areas of expertise within the speciality. Surgeons around the country are investing in new ways to correct and repair traumatic or congenital anatomical abnormalities. However, as of 2019 the NHS decommissioned all routine surgery for pectus (8) as the

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evidence was found not to be sufficient to conclude that the physical, psychological, social, and behavioural benefits of surgical treatment of pectus deformities justifies its use (9).

Surgical training has always taken a prominent place in the UK cardiothoracic surgical community. Whilst most of the surgical specialties require the completion of a core training module to proceed with further training, thoracic surgeons are now able to enroll in a competitive directed cardiothoracic focused application after initial period of residency. This educational pathway has a 7-year length and aims to produce independent cardiac, thoracic, or cardiothoracic consultants. The Intercollegiate Surgical Curriculum Programme (ISCP) and regular evaluations of the candidates ensures quality of the training and the adequate personal investment of its trainees (10).

The UK has a long-standing reputation for surgery for mesothelioma and remains the only country in the world to have conducted randomised trials on all three major operations for mesothelioma. MARS investigated extrapleural pneumonectomy (11) and MesoVATS investigated partial pleurectomy (12). Both procedures were not associated with any improvement in survival. In 2023, MARS 2 (13), a UK-wide multicentre randomized controlled trial will answer if pleurectomy decortication and chemotherapy is superior to chemotherapy alone with respect to overall survival for patients with pleural mesothelioma, one of the last remaining radical surgical options for patients with mesothelioma today.

The UK hosts one of the most extraordinary, high-quality auditing systems in the world. Lung cancer resection data is systematically anonymized and collected as the result of a joint effort between respiratory medicine, pathology, thoracic surgery, medical and clinical oncology. Thanks to the commitment of the NHS, in 2019 133 units participated in the process of data gathering and 39,754 cases were included in the database. Yearly, national reports on lung resections present high-quality data with low risk of bias that is later used by researchers to facilitate deeper understanding of surgical practice and lung cancer patient management. In addition, the NCLA publishes spotlight audits on specific topics such as the curative intent treatment rates in patients with stage I and II lung cancer and molecular testing for lung cancer (4) revealing for example that 83% of patients with advanced adenocarcinoma underwent molecular testing and 75% and 58% of patients with *EGFR* mutation and *ALK* mutation respectively received first-line targeted therapies (14).

The UK has a strong reputation for evidence-based cost-effective practice. The establishment of the thoracic

surgery research collaborative allowed the country to lead in the multi-centre randomised thoracic surgical trials as a national cooperative group. The first major grant funded, surgeon led trial was VIOLET demonstrating the superiority of keyhole surgery to open surgery for lung cancer resection and importantly provided UK surgeons with the education and training on how to randomise patients into surgical trials (15). As a country, we are now looking towards surgical multimodality trials, such as RAMON evaluating the role of surgery in advanced lung cancer as part of multi-modality treatment (16). Another high profile UK based translational research programme is TRACERx that is taking place over nine years and aims to define the relationship between intratumour heterogeneity and clinical outcomes after surgery (17).

In 2019, the Secretary of State for Health and Social Care presented an initiative to adopt digital healthcare technologies (genomics, digital medicine, artificial intelligence and robotics) to prepare the healthcare workforce to deliver innovative and up to date medical care (18). Focus now needs to be on strengthening the thoracic surgeons partnership with technology and biomedical engineering. Although robotic surgery has been postulated as the future of thoracic surgery (19), in 2016, NHS England reported insufficient evidence to support the routine commissioning of robotic assisted lung resection for primary lung cancer (20). The Society for Cardiothoracic Surgery in Great Britain and Ireland is currently gathering data to further evaluate the results of this approach.

The unique characteristics of the United Kingdom's Healthcare system in combination with the invaluable contribution of committed thoracic surgeons and prestigious high-profile research have led to a world-leading specialty that continues to push the limits of optimal thoracic surgical management. The future would be focused on improvements to continue to provide the best cost-effective care through further research and adoption of digital healthcare technologies.

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Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

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