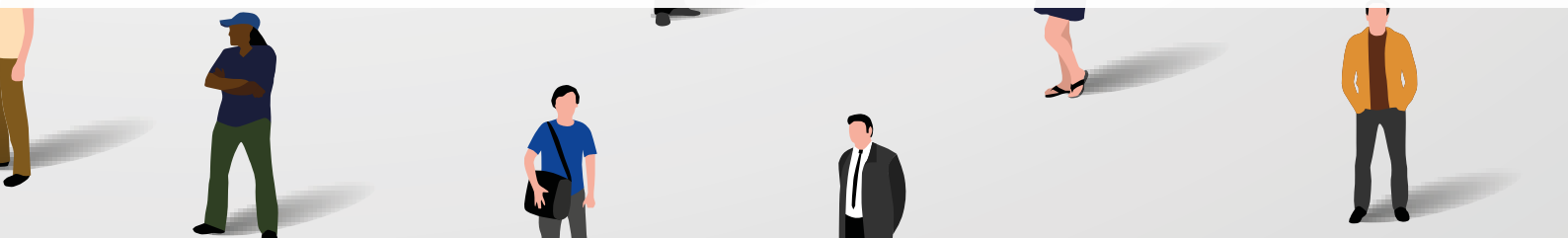




SAC and SCTS

UK CARDIOTHORACIC SURGERY

Workforce report 2019



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A report by the Specialty Advisory Committee
and the Society for Cardiothoracic Surgery in
Great Britain and Ireland.

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Foreword

Cardiothoracic surgery continues to evolve at an increasingly rapid pace, with new technologies being introduced every year, allowing the current patient population to have improved quality of care and new patients to benefit from the services. Although the last cardiothoracic workforce report was produced in 2015, much has changed since then and this has prompted this update.

Along with technical developments, there have been important changes in the organisation of cardiothoracic surgical services, with the emergence of three broad subspecialties comprising adult cardiac, congenital cardiac and general thoracic surgery in addition to the subspecialty of cardiopulmonary transplantation. These changes have immense implications for staffing cardiothoracic hospitals as well as planning the current training of professionals who will look after our patients in the future.

Although staffing of hospitals by consultant surgeons and the training required to produce surgeons of a high calibre for consultant practice in the National Health Service is clearly of major importance, it is also clear that the traditional

model of care, where consultants lead a team of more junior medically qualified surgeons, is no longer sustainable. Instead, other professional roles have emerged over the last decade to provide models of care that would be unrecognisable to previous generations but are now essential for high quality modern cardiothoracic surgical care. These roles are now fully embedded in the cardiothoracic surgical team and have led to many sustained improvements in the care of patients requiring cardiothoracic surgery.

Executive summary

The purpose of this document is to provide insight into the current workforce in cardiothoracic surgery and to assist in planning for the future, particularly in respect to the four principal subspecialties of adult cardiac surgery, general thoracic surgery, congenital cardiac surgery and cardiopulmonary transplantation. The report has been prepared from the joint perspective of the Society for Cardiothoracic Surgery in Great Britain and Ireland (SCTS) and the Specialty Advisory Committee (SAC) for cardiothoracic surgery. It represents a stocktake of both where the specialty is in terms of the current workforce and the future challenges in ensuring that patients undergoing cardiothoracic surgery will have the best care possible and appropriately trained professionals looking after them.

One of the difficulties in workforce planning is knowing how many surgical trainees to appoint every year given that it currently takes a minimum of eight years after professional registration for doctors to acquire the skills necessary for high quality consultant cardiothoracic surgical practice in the National Health Service. As this document shows, much can change within a decade, making predictions for the needs of the future workforce fraught with imperfections.

In England, the responsibility of deciding how many cardiothoracic surgical trainees should be appointed falls to Health Education England, with detailed advice from the SAC, which also works closely with the SCTS in forming its recommendations. The production of this workforce document is a joint venture from the SCTS and SAC working closely together, especially in aspects of education and training.

Adult cardiac surgery

- » For the last decade, the number of overall cardiac surgical operations has been largely static, with no significant changes foreseeable in the future.
- » Within the generality of the specialty, all surgeons are expected to manage patients requiring surgery for ischaemic heart disease and aortic valve replacement. In addition, surgeons have now established subspecialty practices (such as mitral valve repair, complex aortic surgery and minimally invasive cardiac surgery) with the expectations that a volume effect for surgeons and hospitals will lead to improved outcomes for patients.
- » Trusts are increasingly planning to concentrate services for less common operations in the hands of smaller teams of surgeons, often working between hospitals.
- » Trainees are encouraged to plan their training to allow for this subspecialty expertise, which is likely to be increasingly necessary in the future to allow for the safe management of those patients with less common conditions.

Thoracic surgery

- » Overall, thoracic surgical activity has increased significantly over the last decade, with increasing numbers of patients benefiting from surgery, and surgeons being required to work in multidisciplinary teams.
- » The number of patients with primary lung cancers being treated with surgery has doubled between 2005 and 2015. With the introduction of lung cancer screening, this increase is likely to continue.
- » Surgical techniques for thoracic surgery are developing, especially with the rapid expansion of minimally invasive surgery,

which is becoming the standard of care for all patients with stage I primary lung cancer.

- » There has been a rapid expansion in the thoracic surgical consultant workforce meaning that there will be relatively few retirements in the next ten years compared with the workforce as a whole. Nevertheless, there is likely to be a continued expansion in the number of new posts necessary for trusts to staff their services.

Mixed practice cardiothoracic surgery

- » With the separation of adult cardiac and general thoracic surgical services throughout the UK, there have been very few mixed practice consultant surgical appointments in the last decade.
- » Those mixed practice surgeons currently in post are likely to either specialise in one arm of the specialty (cardiac or thoracic) or retire in the next few years, their posts being replaced by cardiac or thoracic surgeons.

Congenital cardiac surgery

- » This is now an established separate subspecialty within the profession and is staffed by surgeons who have completed specific training programmes.
- » Although the incidence of congenital cardiac disease is static, more patients are being treated with surgery throughout their lives and more surgery is required for those patients who survive into adulthood. The overall service is therefore now becoming unified between children and adult hospital sites.
- » There has been a gradual amalgamation of services over the last decade, with ten hospitals providing congenital surgery for children in England; this includes the treatment of patients in Wales. Patients in Scotland requiring surgery for congenital heart disease are treated in Glasgow and those in Northern Ireland travel to Dublin.
- » Recently agreed standards require all

surgeons to carry out at least 125 operations per year and to work in teams of at least 4 surgeons. This means there will be a steady expansion in the number of congenital cardiac surgeons over the next few years.

Cardiopulmonary transplantation

- » Cardiopulmonary transplantation is a demanding area of practice, with the majority of operations being performed out of hours.
- » The number of patients treated in this subspecialty has increased over the last decade, and it is likely to continue to increase with improved donor management, routine use of mechanical assist devices as a bridge to transplantation and changes in the law to allow presumed consent for members of the public to be organ donors.
- » Currently, 36 surgeons provide this service, working in 6 centres. More than half are aged 50 years or over.
- » Most units will require additional appointments of consultants over the next 2–5 years.

Academic cardiothoracic surgery

- » The UK is a world leader in life sciences research and cardiothoracic surgeons have a proven ability to deliver high quality multicentre trials. Nevertheless, the intense operative workload required by the specialty makes it more difficult for academia to thrive.
- » Between 2006 and 2016, 15 trainees have been appointed to academic clinical fellow and clinical lecturer posts. None went on to substantive academic positions at consultant level.
- » There are seven nursing professors with a cardiovascular background (2.5% of all nursing professors).
- » The SCTS has established the Academic and Research Committee to provide a UK forum for cardiothoracic surgical research.

Non-medically qualified health professionals in cardiothoracic surgery

- » These professionals are now an integral part of the cardiothoracic team.
- » Although the boundaries of the roles vary, broadly speaking advanced nurse practitioners (ANPs) work on the intensive care unit, surgical wards and clinics while surgical care practitioners (SCPs) work in theatre.
- » ANPs and SCPs have taken over many of the duties traditionally carried out by cardiothoracic trainees. ANPs provide direct care for patients both before and after their surgery; this includes such tasks as ordering and acting on the results of investigations (e.g. chest x-rays and arterial blood gases). SCPs routinely perform saphenous vein and radial artery harvesting, and act as first assistant in major cases.
- » These professionals are invaluable in providing high quality and sustainable cardiothoracic services, and their numbers will continue to increase. Their skills complement those of other members of the team. They provide extremely useful training for cardiothoracic surgical trainees.

Cardiothoracic anaesthesia and intensive care

- » The total number of consultant cardiothoracic anaesthetists providing services for each unit varies from 7 to 40. The majority also provide anaesthesia for patients other than those undergoing cardiothoracic surgery.
- » The majority of cardiothoracic units do not have separate on-call rotas for cardiothoracic anaesthesia.
- » The formal separation of anaesthesia from intensive care medicine and the need for certification in both specialties makes it harder to attract trainees into cardiothoracic anaesthesia.
- » Half of UK cardiothoracic units have vacancies for consultant anaesthetists.

- » The number of trainees in cardiothoracic anaesthetic training posts is falling.
- » It is increasingly difficult to justify employing middle grade cardiothoracic surgical trainees to look after patients on the cardiothoracic intensive care unit out of hours given their other training needs, which are necessarily displaced by these duties.
- » The number of consultants in intensive care (as opposed to cardiothoracic anaesthesia) and intensive care ANPs contributing to the postoperative care of patients undergoing cardiothoracic surgery is rising rapidly.

Selection, training and assessment of cardiothoracic surgical trainees

- » Selection of trainees in cardiothoracic surgery moved from local to national selection in 2007.
- » Until 2013 trainees were only selected for entry into specialised training in cardiothoracic surgery after completion of core training in the generality of surgery. Core training comprises two years (CT1 and CT2), with specialty training running for a further six years (ST3–ST8). Since August 2013, however, an increasing number of 'run through' trainees have been appointed. Run through training comprises all eight years of targeted specialty training (ST1–ST8).
- » Applications for the posts remain more competitive than many other hospital-based specialties, with a 9:1 ratio for ST1 entry in terms of the number of applicants for the available posts in 2018 and a 4:1 ratio for entry at ST3 level.
- » Training posts are managed by regional Health Education organisations (previously known as the deaneries) where the trainees spend the majority of their training. Trainees follow a defined curriculum, which forms the basis of the targets they are required to achieve at all levels of their training. This includes the FRCS(CTh) exit examination.
- » The SCTS provides a broad and

comprehensive portfolio of educational courses for trainees, targeted specifically to the stage of their training.

- » A Certificate of Completion of Training is awarded by the General Medical Council after receiving an application by the trainee and satisfactory reports from the trainee's Training Programme Director.

Adult cardiac surgery

Hospitals

Current status

There are 35 National Health Service hospitals in the UK and 3 hospitals in the Republic of Ireland providing adult cardiac surgery (Table 1). As well as serving their regions for cardiac surgery, some units are commissioned to provide additional specialist services including transplantation, mechanical circulatory support and pulmonary endarterectomy surgery. Six units provide adult cardiac transplant services and this is described in more detail in the *Cardiopulmonary transplantation* chapter. Three trusts are stand-alone specialist cardiothoracic centres (Royal Papworth Hospital NHS Foundation Trust, Royal Brompton and Harefield NHS Foundation Trust, and Liverpool Heart and Chest Hospital NHS Foundation Trust) but the others all have larger multidisciplinary hospitals. The majority also provide thoracic surgery although three do not have thoracic surgery on the same site.

Table 1

Adult cardiac units across the UK and Republic of Ireland

Region	Number of units
England	29
Scotland	3
Wales	2
Northern Ireland	1
Republic of Ireland	3
Total	38

Future

There are no plans to develop new cardiac surgery units at present. There has been a trend over the last few years to merge smaller units where geographically possible; this has already happened in London and is planned in Manchester. The geography of the UK and Ireland means that there are some isolated areas with lower population density that require local cardiac surgical services, meaning there will still be a need for some smaller units.

Activity

Current status

Adult cardiac surgery activity has remained steady over the last 5 years with approximately 35,000 procedures performed per year in the UK and Ireland. During this time, there has been an increase in less invasive therapy including percutaneous coronary intervention for ischaemic heart disease and in transcatheter aortic valve implantation for aortic stenosis. The average age of patients undergoing cardiac surgery has increased over time in proportion to both the ageing population and the increased expectations from modern medicine.

There is a range in the volume of cardiac surgery performed at each unit dependent on the size of the facility, which is in proportion to the geography and local demands. However, compared with other countries, this range is not excessive and there are no very small units performing only occasional cardiac surgery. In the data submitted to the National Institute for Cardiovascular Outcomes Research for the 2014–2017 three-year period, the smallest centre had performed 1,055 cardiac surgical

procedures and the largest 6,104. Thirteen units are performing >1,000 cardiac operations per year. Approximately 40% of the workload is coronary artery revascularisation for ischaemic heart disease and 40% is valve repair or replacement surgery predominantly for left heart valve disease.

Future

The trends indicate that the overall volume of cardiac surgery may not increase significantly in the near future, but the complexity is increasing with the aging population. There is also no sign that the cardiac surgeon will become redundant, at least for the next 20 years. More patients will need multiple procedures and hybrid operations involving joint working with cardiologists are likely to become more common.

In the field of ischaemic heart disease, the interventional treatments became polarised with cardiologists delivering coronary stenting and surgeons bypass grafts. More recently, as valve interventions have developed, there has been more joint working with cardiologists (e.g. transcatheter aortic valve implantation) and this is set to continue. There is a trend for minimal access surgery and this has been driven by improvements in technology. However, at present, most procedures are an alternative way of doing the same operation and the same surgeons are involved so overall activity has not changed significantly. Capacity for cardiac surgery is mainly limited by the availability of intensive care beds (rather than surgeons) and

in order to reduce waiting times for elective surgery, more dedicated intensive care beds would be required.

Consultant workforce

Current status

There are 257 consultant surgeons performing cardiac surgery, with 211 working in England. The majority of consultant surgeons practising adult cardiac surgery now devote their whole time to this field. Forty-four (17%) also perform thoracic surgery and thirty-two (12%) cardiac transplant surgery. The proportion performing mixed cardiac and thoracic surgery has decreased over time as thoracic services have become more subspecialised, and contemporary trainees elect to specialise in either cardiac or thoracic surgery.

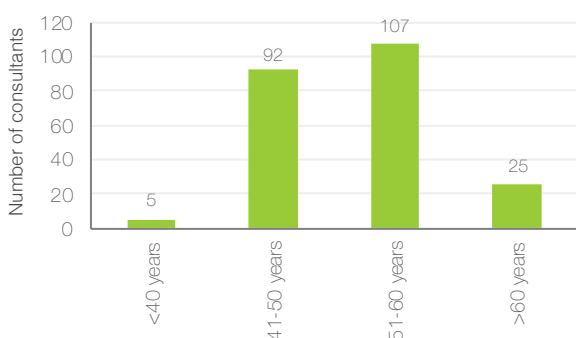
The average age of the current consultants working in cardiac surgery is 50 years (range: 35–68 years) and the majority are male with only 7 female surgeons (3%). Figure 1 shows the number of cardiac consultants by age group. Of the 229 cardiac surgeons with a confirmed age, over half (58%) are over the age of 50 years and 11% are over 60 years old. Only 2% are aged under 40 years. One hundred and five (41%) originally qualified in medicine outside the UK and Ireland, and forty-nine (19%) did their cardiothoracic specialist training abroad.

Future

The demographic characteristics of the current cardiothoracic trainees are different, with a higher percentage of women and doctors qualified from the UK or Ireland. Most will spend fewer total years in training than the generation before and will be appointed as consultants at a younger age. However, they will have benefited from more focused, productive training delivered in fewer working hours. If the future leads to more controlled immigration to the UK and reduced access to European surgeons, the UK will need to train more doctors. This will be especially important in cardiac surgery considering the demographics described above.

In future, it is likely that the majority of cardiac surgeons will have one or two subspecialist

Figure 1
UK cardiac surgeons by age group



interests (e.g. mitral valve repair surgery or aortic surgery), acquired during their training. The trend for this demand is already apparent in advertisements for recent consultant posts. A further influence may come from commissioners stipulating specific experience and/or case volume for particular procedures. Nevertheless, there will continue to be a need for the generic cardiac surgical skills to deliver a safe emergency on-call rota.

Although it is expected that the generation born today will be healthier and live longer (and therefore work longer and retire later), it may not be appropriate for all cardiac surgeons to be operating in their late sixties and the evidence indicates this is rare today. Cardiac surgery is intense, and operations can be long and both mentally and physically demanding. The specialty may need to develop a different model to deal with the trends described above.

It is possible that there will be three stages to a consultant career: the first phase involving more multidisciplinary team (MDT) working with more mentored practice, the middle phase involving more independence and direct clinical practice, and a later phase involving mentoring, teaching and managerial roles without intense on-call commitments or long days operating. Consultant cardiac surgeons operating together for high risk or complex operations is already common in congenital and transplant surgery, and this trend is likely to develop further in adult cardiac surgery.

The wider cardiothoracic team

The modern cardiac surgeon works with a team of medical and non-medical colleagues to provide a patient-focused service. Although the surgical consultant is usually seen as the team leader and remains ultimately responsible for the individual patient, management decisions are shared and all contribute. The cardiologist is responsible for the patient prior to referral, and delivers many of the early investigations and management decisions. Increasingly, referrals will be made following MDT meetings involving a number of experts and evidence-based guidelines rather than on an individual basis. As the treatment options become wider and guidelines and evidence more complex, this trend is likely

to continue.

In the operating room, the surgeon works with specialist anaesthetists and perfusionists (clinical scientists responsible for cardiopulmonary bypass) as well as the nursing scrub team, trainee surgeons and surgical care practitioners, who perform parts of the operation but are not medically qualified. On the ward, there is a trend towards advanced nurse practitioners delivering more of the perioperative care rather than junior doctors and this is likely to continue.

The changing role of the cardiac surgeon is evident in the intensive care unit where patients are looked after immediately following surgery. It is now more common for care to be delivered jointly with specialists in intensive care medicine rather than directed by the consultant surgeon alone, especially when patients need to stay more than 24 hours. Modern intensive care has evolved to allow good recovery for patients even after prolonged multisystem organ support and this advance is only made possible by dedicated intensive care teams.

Job plans

In general, most cardiac surgeons would expect to:

- » perform the equivalent of two days' operating per week
- » spend one half day in an outpatient clinic
- » spend a further half day attending MDT meetings
- » have time devoted to patient administration and ward rounds
- » have flexible time for audit and continuing medical education
- » have additional time for teaching and research

In addition, an on-call commitment is required for treatment of emergencies; this varies between a 1:4 and a 1:8 rota, depending on the size of the unit and number of cardiac surgeons. In smaller units, the frequency of on-call commitments is likely to be greater but the intensity of work and volume of emergencies will be higher in larger units serving a bigger geographical area.

The cover for inpatients at each unit varies and different models have developed. Some

retain the older model of individual consultants taking ongoing responsibility for patients they have operated on but others have devolved responsibility to shared care from the on-call surgeon. With teamwork and a better understanding of work-life balance more embedded in the work schedule of the current trainees, this trend will increase.

Thoracic surgery

Background

General thoracic surgery evolved from general surgery in the late 19th century. Developing primarily out of a need to treat pleural sepsis and tuberculosis, and fuelled by the experiences of managing chest trauma and infections resulting from warfare, it eventually became a specialty in its own right. The introduction of endotracheal intubation and mechanical ventilation enabled intrathoracic procedures to be performed safely, and the innovation and experiences of dealing with trauma from both world wars allowed this new specialty to flourish. Lung cancer surgery took its first fledgling steps in the 1930s at a time when no other effective cancer treatment options (radiotherapy or chemotherapy) existed.

The introduction of cardiopulmonary bypass and allied technologies in the second half of the 20th century saw cardiac surgery expand, and the specialty became cardiothoracic surgery. Over the next 40 years, cardiac surgery evolved as the dominant partner in terms of activity and surgeon numbers in the UK.

In the UK, the specialty of thoracic surgery encompasses surgery on the lungs, mediastinum, pleura and chest wall. Approximately 70% of procedures are for cancer. The majority of these are for primary lung cancer but cases also involve metastases from other organs and other intrathoracic tumours. Oesophageal cancer is now managed primarily in upper gastrointestinal units but a small number of thoracic surgeons are still involved in this type of surgery. Chest wall sarcomas, paediatric thoracic surgery, severe emphysema surgery, pectus correction and endobronchial treatments tend to be undertaken in a smaller number of specialist units. A significant proportion of non-elective surgery is performed for non-cancer conditions such as pleural sepsis and pneumothorax. The wide range of conditions treated and procedures performed makes this

an exciting specialty but it also has significant implications for workload and training.

In 2002 a working party set up by the British Thoracic Society and the SCTS to consider the critical underprovision of thoracic surgery in the UK published its report. This report highlighted the fact that the lung cancer resection rate in the UK was only 10%, less than half of that in many European countries and the US, and UK five-year lung cancer survival was also significantly lower.

At that time, there were fewer than 40 specialist thoracic surgeons in the UK and much of the thoracic surgery workload was being performed by mixed practice surgeons but in small numbers, with more than half undertaking an average of <1 lung cancer resection a month. With a goal to double the number of specialist thoracic surgeons and lung cancer resections, there was an increase in cardiothoracic training numbers, a proportion of which were specifically allocated for thoracic surgery. This expansion and more focus on thoracic surgery training in cardiothoracic programmes has finally borne fruit.

Trends in surgical activity over time

The SCTS has tracked adult thoracic surgery activity in public hospitals since 1980, with units submitting total surgical activity and unit mortality rates for all thoracic surgery procedures on an annual basis. Since 2014 the *Lung Cancer Clinical Outcomes Publication* under the auspices of NHS England has also retrospectively reported lung cancer surgery activity and outcomes in English units.

The SCTS returns confirm that overall surgical activity and lung cancer resections showed an inflexion point in the mid to late 2000s (Figures 2 and 3). This in part reflected the first wave of

Figure 2
Whole SCTS registry activity (excluding endoscopy)

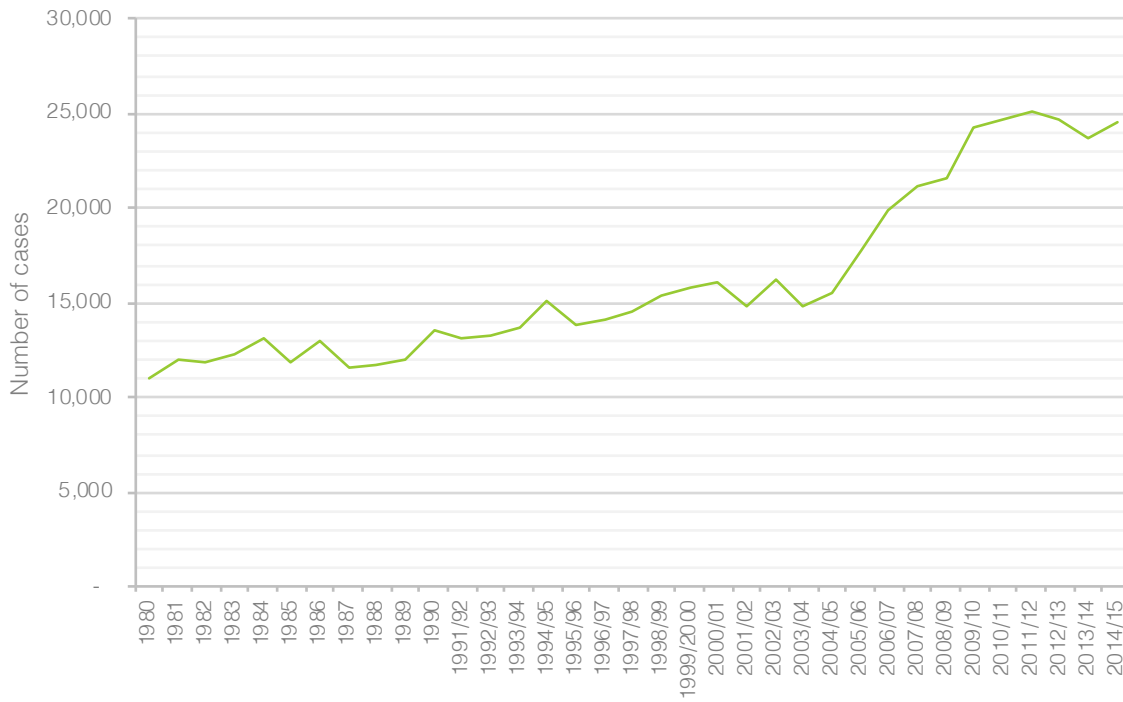


Figure 3
All resections for primary lung cancer

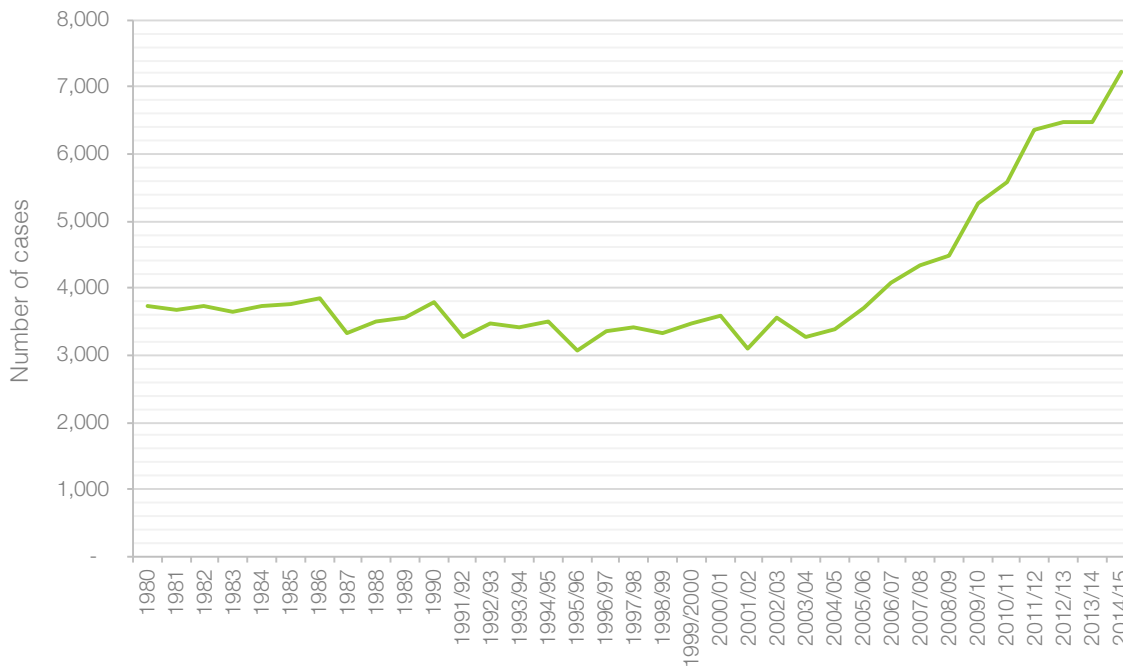
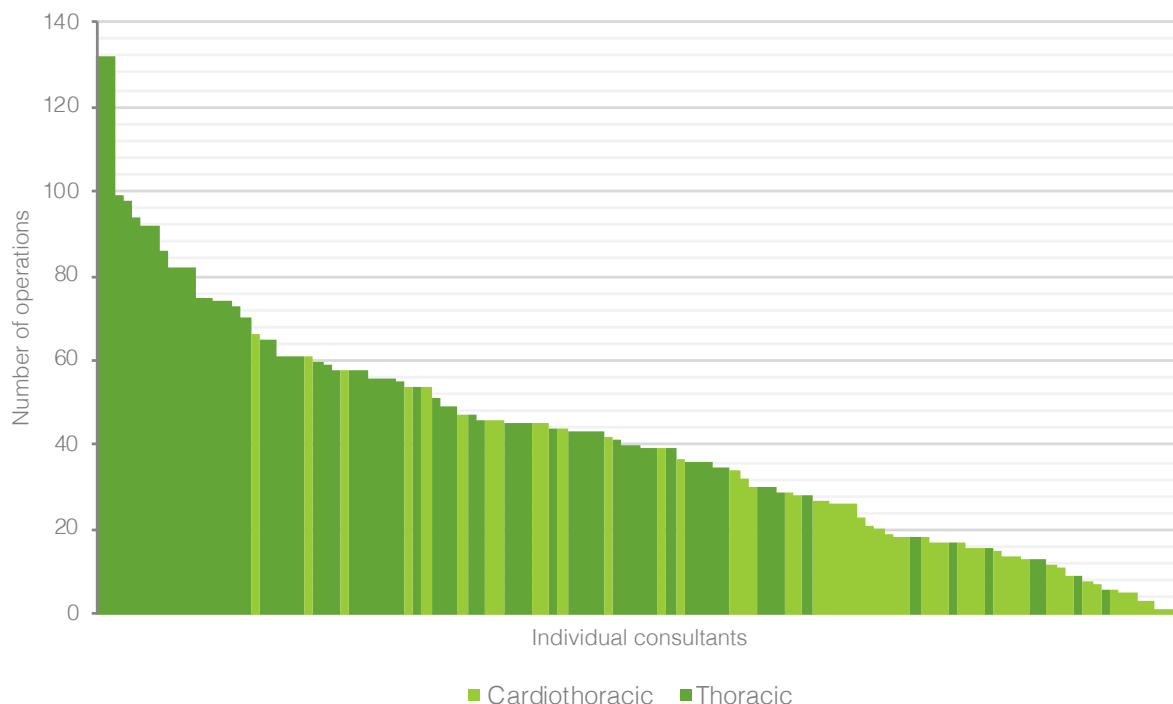


Figure 4

Number of operations for primary lung cancer performed by individual surgeons in 2012



designated thoracic surgery trainees completing their training and a recognition in cardiothoracic trainees generally that this was an expanding specialty, at a time where the future of cardiac surgery was looking less certain. Before this, activity had been broadly static since 1980. Between 2003 and 2011, an extra 10,000 cases were performed, representing an increase of around 68%. Lung cancer resection numbers rose even faster, with nearly a doubling of activity over the same time period. Despite this increase in activity, there has been a gradual reduction in the number of patients undergoing exploratory surgery, and the overall survival rates at 30 days and 90 days have also increased over time.

The aim to reduce the number of surgeons performing occasional lung cancer surgery has also been achieved. The number of surgeons undertaking any lung cancer surgery has been static at around 120 but the activity of individual surgeons has markedly increased. In 2012 the median number of cases per surgeon was 30 per year. By 2015 this number had risen to 49

per year (a 63% increase). It is likely that the shift away from mixed cardiothoracic practice, which was a common working pattern among lower volume surgeons in 2012 (Figure 4), has contributed to this change. The 2017 NHS England commissioning guidance for thoracic surgery is expected to further accelerate this trend, with a planned aim to end cardiothoracic mixed practice, and most cardiothoracic units are moving to an arrangement where cardiac surgery and thoracic surgery services, even if co-located, are clinically and managerially separate.

Changes in types of surgical procedures

The focus on improving the amount and quality of thoracic surgery in the UK has also influenced the type of surgery that is being performed. The benefits of minimal access techniques in most branches of surgery are now widely accepted

Figure 5
Open surgery and VATS total activity (based on SCTS returns from 1980–2015)

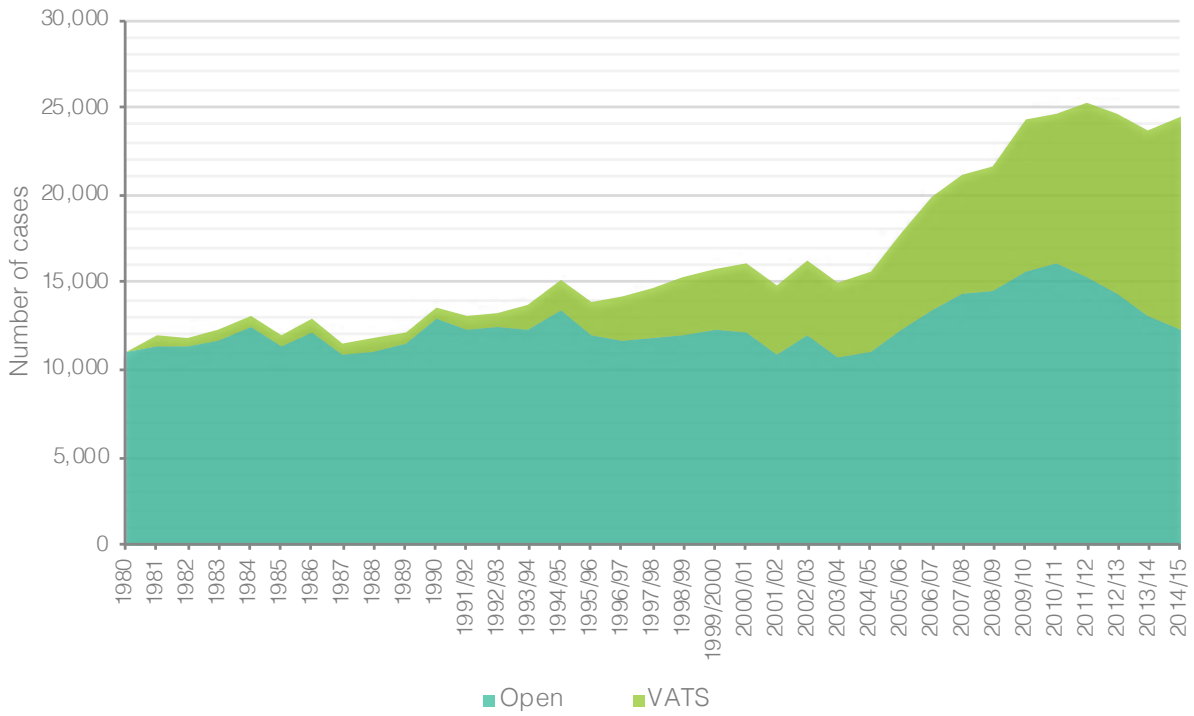
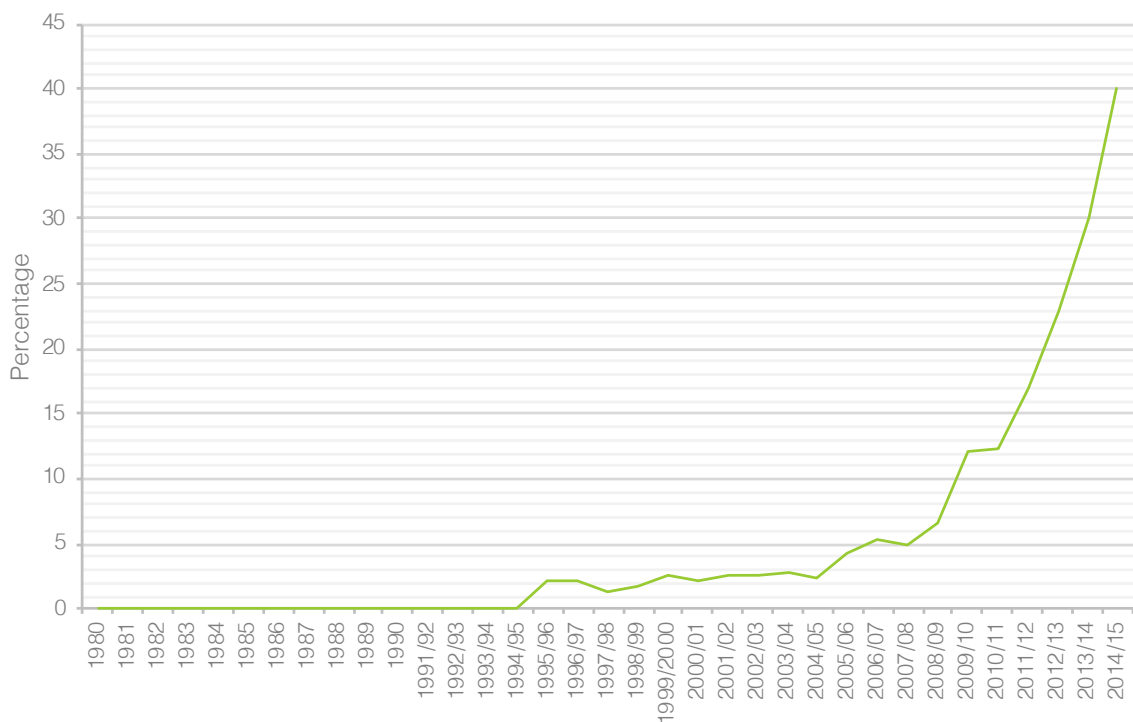


Figure 6
VATS procedures as a percentage of isolated lobectomies and bilobectomies for primary lung cancer (based on SCTS returns from 1980–2015)



and thoracic surgery is no exception.

The annual SCTS returns and the *Lung Cancer Clinical Outcomes Publication* have documented a significant shift to minimal access thoracic surgery over time. From being a very small proportion of overall activity in the 1980 returns, it now forms around half of all activity (Figure 5).

The use of minimal access approaches (video assisted thoracoscopic surgery [VATS]) for lung cancer resections in particular has increased considerably over the last ten years. It accounted for 40% of all lung cancer resections in the 2014/15 SCTS returns data (Figure 6) and was the most common approach for stage I lung cancer

Table 2

Changes to units between 1995 and 2015

C = cardiac only; T = thoracic only; CT = unified cardiothoracic service;

C+T = separate cardiac and thoracic services in same hospital

City	Hospital	1995	2015
England			
Basildon	Basildon University Hospital		CT
Birmingham	Heartlands Hospital	T	T
Birmingham	Queen Elizabeth Hospital	C	C
Blackpool	Victoria Hospital	CT	CT
Bradford	Bradford Royal Infirmary	T	
Brighton	Royal Sussex County Hospital		C
Bristol	Bristol Royal Infirmary	CT	C+T
Bristol	Frenchay Hospital	T	
Cambridge	Royal Papworth Hospital	CT	CT
Coventry	University Hospital Coventry	CT	CT
Exeter	Royal Devon and Exeter Hospital		T
Hull	Castle Hill Hospital	CT	CT
Leeds	Killingbeck Hospital	CT	
Leeds	Leeds General Infirmary	CT	C
Leeds	St James's University Hospital		T
Leicester	Glenfield Hospital	CT	C+T
Liverpool	Liverpool Heart and Chest Hospital	CT	CT
London	Guy's Hospital	T	T
London	Hammersmith Hospital	CT	CT
London	Harefield Hospital	CT	CT
London	King's College Hospital	CT	C
London	London Chest Hospital	CT	
London	Middlesex Hospital	CT	
London	Royal Brompton Hospital	CT	CT
London	Royal London Hospital	CT	
London	St Bartholomew's Hospital	CT	CT
London	St George's Hospital	CT	CT
London	St Mary's Hospital	CT	
London	St Thomas' Hospital	T	C
London	University College Hospital		CT
Manchester	Manchester Royal Infirmary	CT	C
Manchester	Wythenshawe Hospital	CT	CT
Middlesbrough	James Cook University Hospital	CT	CT

City	Hospital	1995	2015
Newcastle	Freeman Hospital	CT	CT
Norwich	Norfolk and Norwich University Hospital	T	T
Nottingham	Nottingham City Hospital	T	C+T
Oxford	John Radcliffe Hospital	CT	CT
Plymouth	Derriford Hospital	CT	CT
Sheffield	Northern General Hospital	CT	CT
Southampton	Southampton General Hospital	CT	CT
Stoke-on-Trent	Royal Stoke University Hospital	CT	CT
Truro	Royal Cornwall Hospital	T	
Wolverhampton	New Cross Hospital		CT
Scotland			
Aberdeen	Aberdeen Royal Infirmary	CT	CT
Edinburgh	Edinburgh Royal Infirmary	CT	CT
Glasgow	Glasgow Western Infirmary	CT	
Glasgow	Hairmyers Hospital	T	
Glasgow	Glasgow Royal Infirmary	CT	
Glasgow	Golden Jubilee National Hospital		CT
Wales			
Cardiff	University Hospital of Wales	CT	CT
Swansea	Morrison Hospital		CT
Northern Ireland			
Belfast	Royal Victoria Hospital	CT	CT

resections in the 2017 *Lung Cancer Clinical Outcomes Publication* (2015 data). A very small number of lung cancer resections are now being performed robotically in a handful of surgical units.

Consultant workforce

Over the last ten years, both cardiac and thoracic surgery have become more specialised. Separate teams covering different aspects of adult cardiac surgery are being set up within individual units, and the separation of cardiac and thoracic surgery is gaining momentum. Specialised thoracic surgery commissioning has recommended that thoracic surgery is delivered by teams of at least three surgeons, with minimum requirements regarding number of theatre sessions, clinics, multidisciplinary team (MDT) meetings and support from specialist nurses. It has also recommended separate consultant on-call rotas for thoracic surgery and only surgeons

with a thoracic surgery practice can provide emergency care. It will therefore be more difficult for mixed practice cardiothoracic surgeons to fulfil these requirements in a job plan with 10 programmed activities.

As a result, there have been significant changes in workforce distribution, with closure of some smaller units, and amalgamation and expansion of others (Table 2). When compared with a SCTS survey from 1995, seven cardiothoracic units and four thoracic units have closed while five new cardiothoracic units and two new thoracic units have been established. The current distribution of thoracic services is shown in Table 3.

A survey by SCTS in 2016 identified 81 general thoracic surgeons and 44 mixed practice cardiothoracic surgeons. Two units had associate specialists providing a consultant level service (Plymouth and Exeter). There were 17 units (47%) where all staffing was by general thoracic surgeons only and 6 units (17%) had

Table 3

Distribution of thoracic services in 2018

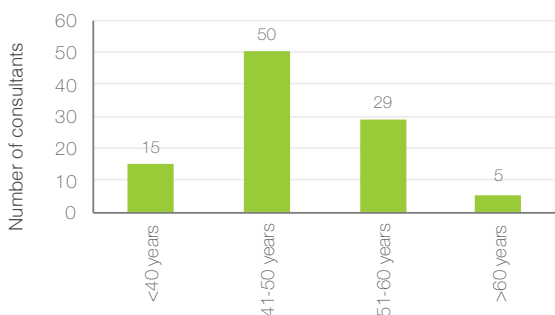
City	Hospital	Status
England		
Basildon	Basildon University Hospital	Cardiothoracic
Birmingham	Heartlands Hospital	Thoracic
Blackpool	Victoria Hospital	Cardiothoracic
Bristol	Bristol Royal Infirmary	Thoracic
Cambridge	Royal Papworth Hospital	Cardiothoracic
Coventry	University Hospital Coventry	Cardiothoracic
Hull	Castle Hill Hospital	Cardiothoracic
Leeds	St James's University Hospital	Thoracic
Leicester	Glenfield Hospital	Thoracic
Liverpool	Liverpool Heart and Chest Hospital	Cardiothoracic
London	Guy's Hospital	Thoracic
London	Hammersmith Hospital	Cardiothoracic
London	Harefield Hospital	Cardiothoracic
London	King's College Hospital	Cardiothoracic
London	Royal Brompton Hospital	Cardiothoracic
London	St Bartholomew's Hospital	Cardiothoracic
London	St George's Hospital	Cardiothoracic
London	University College Hospital	Cardiothoracic
Manchester	Wythenshawe Hospital	Cardiothoracic
Middlesbrough	James Cook University Hospital	Cardiothoracic
Newcastle	Freeman Hospital	Cardiothoracic
Norwich	Norfolk and Norwich University Hospital	Thoracic
Nottingham	Nottingham City Hospital	Thoracic
Oxford	John Radcliffe Hospital	Cardiothoracic
Plymouth	Derriford Hospital	Cardiothoracic
Sheffield	Northern General Hospital	Cardiothoracic
Southampton	Southampton General Hospital	Cardiothoracic
Stoke-on-Trent	Royal Stoke University Hospital	Cardiothoracic
Wolverhampton	New Cross Hospital	Cardiothoracic
Scotland		
Aberdeen	Aberdeen Royal Infirmary	Cardiothoracic
Edinburgh	Edinburgh Royal Infirmary	Cardiothoracic
Glasgow	Golden Jubilee National Hospital	Cardiothoracic
Wales		
Cardiff	University Hospital of Wales	Cardiothoracic
Swansea	Morrison Hospital	Cardiothoracic
Northern Ireland		
Belfast	Royal Victoria Hospital	Cardiothoracic

all their services provided by cardiothoracic surgeons. In 13 units (36%), both cardiac and thoracic surgeons contributed to the service (including emergency care). Six units (17%) had appointed locum thoracic surgeons either to cover sickness or with the intention of appointing substantive surgeons to a new post.

A repeat survey in 2017 revealed further changes to the UK workforce, with 112 specialist thoracic surgeons and 33 cardiothoracic surgeons providing thoracic surgery services. Eleven of these were in locum posts at the time of the survey.

In the next five years, it is very likely that there will be complete separation between cardiac and thoracic surgery, at least in England. It is anticipated that surgeons currently in mixed cardiothoracic practice will have to decide in which specialty they wish to continue practising. This will further impact on the total number of specialist thoracic surgeons. Until this process is complete, it is difficult to predict future workforce requirements in thoracic surgery. However, at the moment, the majority of thoracic surgeons are in the first 10–15 years of their consultant practice (Figure 7) and so fewer posts may be freed owing to retirement. The number of training posts in both cardiac and thoracic surgery will have to be carefully calculated with this in mind.

Figure 7
UK thoracic surgeons by age group



The next ten years: the influence of evidence-based research

Over the last decade, the UK thoracic surgery community has been at the forefront of the development and recruitment of patients to important randomised controlled trials (RCTs). These are already beginning to shape national and international practice, and current studies are likely to have an important effect on both the volume and types of procedures performed in the UK in the coming decade. The need to be able to provide surgeons fully trained in the full range of minimal access surgical techniques (including robotic surgery) will be critical. Nevertheless, there is still a significant proportion of operations that can only be performed through open surgery, and it is vital that these surgical skills are not lost in the enthusiasm for VATS and robotics. Thoracic surgeons will also need to be adept in bronchoscopic procedures as well as chest wall resection and reconstruction techniques. All studies reported below are UK-based unless stated otherwise.

Minimally invasive surgery

The VIOLET study is currently randomising lung cancer patients with tumours up to 7cm in size that are staged as cN0/1 and comparing lobectomy via an open thoracotomy approach with lobectomy via a VATS approach. This is a pragmatic study and so specific VATS or open techniques are not prescribed but are at the discretion of the individual surgeon. The primary outcome measure is quality of life. If the results show equivalence in outcomes for the VATS approach, all future patients with early stage lung cancer should have access to VATS given the intuitive advantages of minimally invasive operations compared with open thoracotomies.

Sublobar lung resection and SABR

Although several guidelines now recommend sublobar resection for specific situations (e.g. pure ground glass opacities, impaired respiratory reserve), there is interest in promoting VATS segmentectomy as the primary treatment modality for T1aN0 and T1bN0 tumours (i.e. <2cm) in peripheral invasive lung cancer. Two international

trials will report soon: the Japanese JCOG 0802/WJOG 4607L study and the North American CALGB 140503 study. Both are large and are randomising patients with tumours up to 2cm in size to either lobectomy or sublobar resection. (Wedge resections are permitted in the CALGB trial.) Non-inferiority of segmentectomy would lead to a paradigm shift in the surgical management of small primary lung cancers and would require specific training in VATS segmentectomy.

Stereotactic ablative radiotherapy (SABR) is a potential threat to the dominance of surgery in the management of early stage lung cancer. The SABRTOOTH study aimed to determine the feasibility and acceptability of conducting a phase III RCT comparing SABR with surgery in patients with peripheral stage I non-small cell lung cancer considered to be at higher risk of complications from surgical resection. Unfortunately, this important study closed because of poor recruitment, possibly secondary to poor randomisation strategies and a failure to engage with centres with a proven record in recruiting to surgical trials.

Lung cancer screening

The UK government has yet to commit to lung cancer screening, with the exception of the programme in Manchester. The Yorkshire Lung Screening Trial is a Leeds-based study using mobile computed tomography scanners. The results of the Dutch NELSON trial are also awaited. If positive results drive the adoption of a national screening programme, a significant increase can be expected in the number of patients with pulmonary nodules requiring diagnostic and therapeutic intervention of some sort. Although dependent on the results of the VIOLET and segmentectomy studies mentioned above, it is likely that a large proportion of these procedures will be VATS segmentectomies.

Mesothelioma

The UK is currently in the midst of a mesothelioma epidemic. Incidence has been increasing year on year, and although it is predicted to peak and then fall off in the next few years, the management of mesothelioma patients will remain a significant part of the workload for the current generation of thoracic surgeons. The role

of more radical surgery in the context of trimodality treatment in these patients is still uncertain.

The MesoVATS study was a multicentre RCT that examined the role of VATS partial pleurectomy (VAT-PP) versus talc pleurodesis in patients with malignant pleural mesothelioma. Overall, there was no difference in survival between the two groups. VAT-PP resulted in more complications, longer hospital stay and was more expensive. Nevertheless, VAT-PP may have a role in the management of trapped lung. The MesoTRAP study is now recruiting and randomising patients to either VAT-PP or indwelling pleural catheter in this specific situation.

The MARS trial compared radical treatment for mesothelioma (trimodality treatment consisting of chemotherapy, extrapleural pneumonectomy and adjuvant radiotherapy) versus chemotherapy alone. Although this was just a feasibility study, there was a significant survival disadvantage in those patients randomised to surgery. This resulted in the almost complete abandonment of extrapleural pneumonectomy in the UK. However, continued interest in extended pleurectomy/decortication led to the development of the MARS 2 study. It is testing the hypothesis that (extended) pleurectomy/decortication and chemotherapy is superior (30% relative improvement) to chemotherapy alone with respect to overall survival. MARS 2 is currently recruiting. If a survival difference is demonstrated, it is likely that radical mesothelioma surgery will only be commissioned in a few specialist centres.

Pulmonary metastasectomy

Resection of pulmonary metastases in the setting of colorectal cancer has an unproven impact on long-term survival. The PulMiCC trial aimed to randomise patients to surgery (pulmonary metastasectomy) or no surgery to address this uncertainty. Over 500 patients were registered but only 93 were randomised and the study was closed to recruitment in 2017 because of poor accrual. Nevertheless, PulMiCC represents both the largest prospective registry and the largest RCT in this field in the world. It will report shortly. At this stage, it is difficult to know how the results will affect future practice.

Interventions for emphysema

Despite the results of the North America-based NETT trial, uptake of lung volume reduction surgery has been poor and in the UK, it is largely concentrated in just a few centres. Interest in endobronchial therapies (and particularly National Institute for Health and Care Excellence [NICE] approved endobronchial valves [EBVs]) has been driven by a number of recent studies comparing EBV versus best medical therapy. Some of these have involved UK units (BeLieV-eR-HiFi, LIBERATE). The CELEB trial is currently randomising patients with heterogeneous emphysema to unilateral VATS lung volume reduction surgery or EBV therapy.

Endobronchial coil insertion has a less robust evidence base. However, there is a National Institute for Health Research-based prospective registry in the UK. NICE guidance only permits coil insertion as part of a study or registry.

Emphysema MDTs are a mandatory requirement for any centre wishing to pursue EBV therapy and it is likely that this will become a requirement for all lung volume reduction strategies. This has already resulted in an increase in all interventions (including lung volume reduction surgery) and the positive results of LIBERATE will almost certainly accelerate this. This is an area where treatment is delivered variably by either thoracic surgeons or respiratory physicians.

Enhanced recovery after surgery

Although no UK-based prospective RCTs exist to study the effects of enhanced recovery after surgery (ERAS) programmes compared with usual perioperative care, the international ERAS Society guidelines for perioperative care in thoracic surgery have just been submitted for publication. The principal authors are UK surgeons and anaesthetists. A real-time prospective database is being developed by the ERAS Society and may be funded by industry for adoption in the UK. This would allow units to benchmark themselves, improve patient care and identify gaps in the evidence base for further research.

The next ten years: training and resources

We have already reached a stage where the majority of lung cancer resections and many other thoracic surgery procedures are performed using minimal access techniques. These techniques will refine and develop, and will inevitably be influenced by the results of some of the trials mentioned above.

What is more difficult to predict is what the net overall impact of lung cancer screening, increased adoption of SABR and alternative therapies such as radiofrequency ablation, and novel techniques such as navigational bronchoscopy and radionuclide location of impalpable nodules will be on the numbers of patients having surgery for diagnostic or therapeutic reasons. Whether it will be the thoracic surgeons or the respiratory physicians performing some of these procedures is also uncertain and as new techniques are adopted, they may well start to influence other aspects of thoracic surgical practice. If surgeons are not the primary clinicians involved in solitary pulmonary nodule management, we may lose a significant proportion of our current cancer surgery workload.

It is likely that in the near future the UK VATS lung cancer resection rate will rise to the same rate as specialist European centres such as Copenhagen (around 70–80%) and then stabilise when all thoracic surgeons have attained the necessary VATS skills. If in the future there is compelling evidence of superiority of SABR or other treatments over surgery for the earliest stage cancers, however, the number of cases coming to surgeons may drop. The greatest increase in lung cancer incidence in the UK currently is in elderly women, who may be less suitable for surgery even with the benefits of minimal access approaches and ERAS.

Robot assisted thoracic surgery (RATS) is likely to be the biggest change in the next 5–10 years. There has been an expansion in the number of surgical robots in the UK, primarily for urological and pelvic surgery. Better robot access is allowing thoracic surgeons to start training in these techniques and several UK units are now starting robotic programmes.

Nevertheless, at the moment, the future of RATS commissioning in the UK is uncertain and the cost of disposables significant. RATS potentially has significant advantages for the resection of mediastinal tumours and more locally advanced lung cancers that are less suitable for conventional VATS approaches, and it extends the benefits of minimal access surgery to patients who would normally require open procedures. It is hoped that the availability of more cost effective robotic systems and cheaper disposables will make this a reality in the UK.

The adoption of RATS could have a considerable impact on training. Basic robotic training can be undertaken online and on simulators. It will be a while before we have enough trained robotic surgeons in the UK to provide all the necessary training although there is inevitably some overlap with standard VATS and open techniques, which will hopefully mean the learning curve is speedy and steep.

Summary

Thoracic surgery is an exciting and varied specialty that is currently enjoying a resurgence in interest and resources. The recent workforce expansion, specialist commissioning requirements and future separation from cardiac surgery will further promote the delivery of high quality surgery to an increasing number of patients. There are still uncertainties, however, as to the likely overall workload and surgical skills required for the next generation of thoracic surgeons.

Mixed practice cardiothoracic surgery

Background

The current role of the mixed practice surgeon is the subject of considerable debate. Training has historically been in both disciplines but with the advent of job planning, restrictions in programmed activities and subspecialty techniques, it is now difficult to see how a new trainee could be deemed trained to the required competency in both disciplines. However, there remain a number of mixed practice units and mixed practice surgeons. This is a commentary about the current practice in the UK and Ireland with an opinion about the future trends.

Table 4 lists the units in the UK and Ireland where mixed practice cardiothoracic surgery is performed by all of the surgeons whereas Table 5 lists those where it is performed by some of the surgeons. The remaining centres are either single specialty or have cardiac and thoracic surgeons.

Current practice

There are currently 33 mixed practice consultant surgeons in the UK. This differs significantly from the number quoted in the 2015 workforce report of 75. This large drop is a consequence of the gradual separation of the two subspecialties; surgeons are increasingly concentrating in either cardiac surgery or thoracic surgery by giving up the other component in their job plans. Retiring mixed practice surgeons also contribute as no new mixed practice colleagues are being appointed.

Cardiothoracic surgeons need to ensure that the two specialties within their overall practice are managed effectively and that one group of patients is not disadvantaged by the requirements of the other. Surgeons practising cardiothoracic surgery usually cover at least one lung cancer multidisciplinary team (MDT) meeting and one peripheral clinic per week in addition to duties at their base hospital.

Increasingly, cardiothoracic surgeons are having to prioritise theatre utilisation between cardiac and thoracic surgery (i.e. longer time required for cardiac operations vs intervention for lung cancer in the shortest timeframe possible in order to meet national targets for waiting times). Many mixed practice surgeons feel that maintaining a cardiac workload complements their non-cardiac practice while providing comparable clinical outcomes.

Job plans

As can be seen from the chapters on cardiac and thoracic surgery, the work is intense. This is no different for cardiothoracic surgeons, who have to strike a balance between the two very different disciplines. Most job plans would include two full days of operating, one thoracic MDT meeting, one cardiac MDT meeting and a mixed outpatient clinic. In reality, most mixed practice surgeons work in an environment with both thoracic and cardiac surgeons, and can focus on some specialist aspect of their work. There are very few units in England, Wales and Northern Ireland where cardiothoracic surgeons

Table 4

Units where mixed practice cardiothoracic surgery is performed by all of the surgeons

City	Hospital
England	
Basildon	Basildon University Hospital
Wolverhampton	New Cross Hospital
Republic of Ireland	
Cork	Cork University Hospital
Galway	University Hospital Galway

Table 5

Units where mixed practice cardiothoracic surgery is performed by some of the surgeons

City	Hospital
England	
Blackpool	Victoria Hospital
Coventry	University Hospital Coventry
Hull	Castle Hill Hospital
Liverpool	Liverpool Heart and Chest Hospital
London	Hammersmith Hospital
London	St Bartholomew's Hospital
London	St George's Hospital
London	University College Hospital
Plymouth	Derriford Hospital
Stoke-on-Trent	Royal Stoke University Hospital
Scotland	
Aberdeen	Aberdeen Royal Infirmary
Edinburgh	Edinburgh Royal Infirmary
Glasgow	Golden Jubilee National Hospital
Northern Ireland	
Belfast	Royal Victoria Hospital
Republic of Ireland	
Dublin	Mater Misericordiae University Hospital

are expected to do everything. In Scotland and the Republic of Ireland, some units still have cardiothoracic surgeons providing most services, with some specialised services (tracheal resection, transplantation etc) performed by the designated national provider. It remains to be seen how these services will be reconfigured over the next decade.

Training in cardiothoracic surgery

There is no difference in commitment to training between cardiac surgery and thoracic surgery. However, licensing for training (an upcoming General Medical Council requirement) may have an effect on the delivery of training if the specialty continues to divide into separate components. There is no reason why a trainee cannot be exposed to different aspects of the specialty if training is delivered effectively.

There is a strong voice in the cardiothoracic community calling for agreement on the minimum exposure to thoracic surgery required in a 'cardiac themed' training post and vice versa. Using data collected from various surveys, the Specialty Advisory Committee and SCTS (in consultation with cardiothoracic trainees) advise that experience of 1–2 years in each discipline is recommended to develop the necessary basic competencies.

It is difficult to see how a trainee could develop advanced competencies in both cardiac and thoracic surgery during a training programme without a period of training after award of the Certificate of Completion of Training (as is mandatory for consultant posts in congenital cardiac surgery). Trainees who apply for jobs in mixed practice units will have to provide evidence of their competence but as things stand, the training, Certificate of Completion of Training and intercollegiate examination are in cardiothoracic surgery, and this is likely to remain so for the foreseeable future.

Future practice

Advances in operative techniques have helped to drive specialist practice in both limbs of the specialty. Minimally invasive procedures continue to evolve and expand with developments in technology and increasing surgeon experience. Now that a significant amount of data has emerged on the safety and efficacy of such surgery, there is evidence to support the widespread adaptation of these techniques. In the future, it is likely that there will be a greater request for such approaches by patients as re-

duced surgical trauma allows for a faster return to normal activities and improved quality of life.

NHS England commissioners have been persuaded that thoracic surgery should only be delivered by thoracic surgeons. Training in cardiothoracic surgery is moving towards 'thoracic themed' or 'cardiac themed' posts so there are unlikely to be mixed practice surgeons in England following this. No such agreement has been reached in Scotland, Wales or Northern Ireland or in the Republic of Ireland so it remains to be seen how mixed practice cardiothoracic surgery will fare in the medium term.

In future, we could see units developing a basic service with a cardiothoracic surgeon in both disciplines whereas the more complex work may go to a senior, specialist surgeon. This would be beneficial in catering to the demand and service provided.

Congenital cardiac surgery

Background

Surgery for congenital heart disease accounts for 10–15% of the total cardiac surgical workload in the UK and Ireland, comprising 5,500–6,000 cases per year. Approximately 80% of the congenital workload is in babies and children (<16 years). Absolute numbers have increased gradually over time. This is related to both population growth and innovation within the specialty, which has expanded the range of lesions that can be operated on and the number of patients who can be offered treatment. More recently, the surgical workload has plateaued, predominantly because of innovative catheter procedures that can provide either initial palliation or definitive treatment.

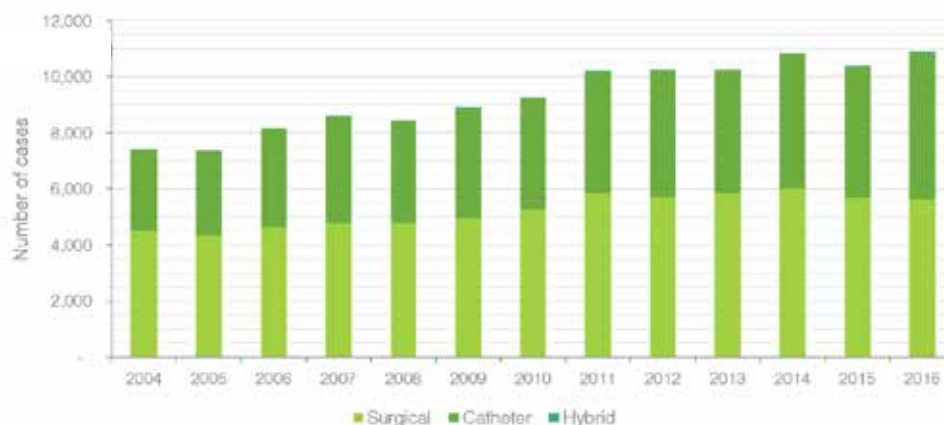
The latest addition to the surgical armamentarium is the hybrid surgical procedure, in which a catheter intervention and surgical procedure are combined in the same treatment

session. The number of these procedures is growing and in some centres, up to 5% of surgical procedures are now carried out in a hybrid setting (Figure 8).

Improved antenatal detection of heart defects (from 36% of patients operated on for congenital heart disease in 2010/11 having been diagnosed before birth to just over 50% in 2015/16) does not appear to have had a major impact on the overall number of newborns undergoing surgery for congenital heart disease. It has, on the other hand, allowed more advanced planning of the surgical pathway, with fewer patients presenting with cardiovascular collapse.

Many patients now undergo successful surgery in childhood and progress into adulthood. This has created a new population of patients with operated congenital heart disease and it is estimated that approximately 10% of these will require further surgical intervention. Traditionally, paediatric congenital cardiac surgeons continued

Figure 8
Number of congenital cardiac cases submitted to the National Congenital Heart Disease Audit



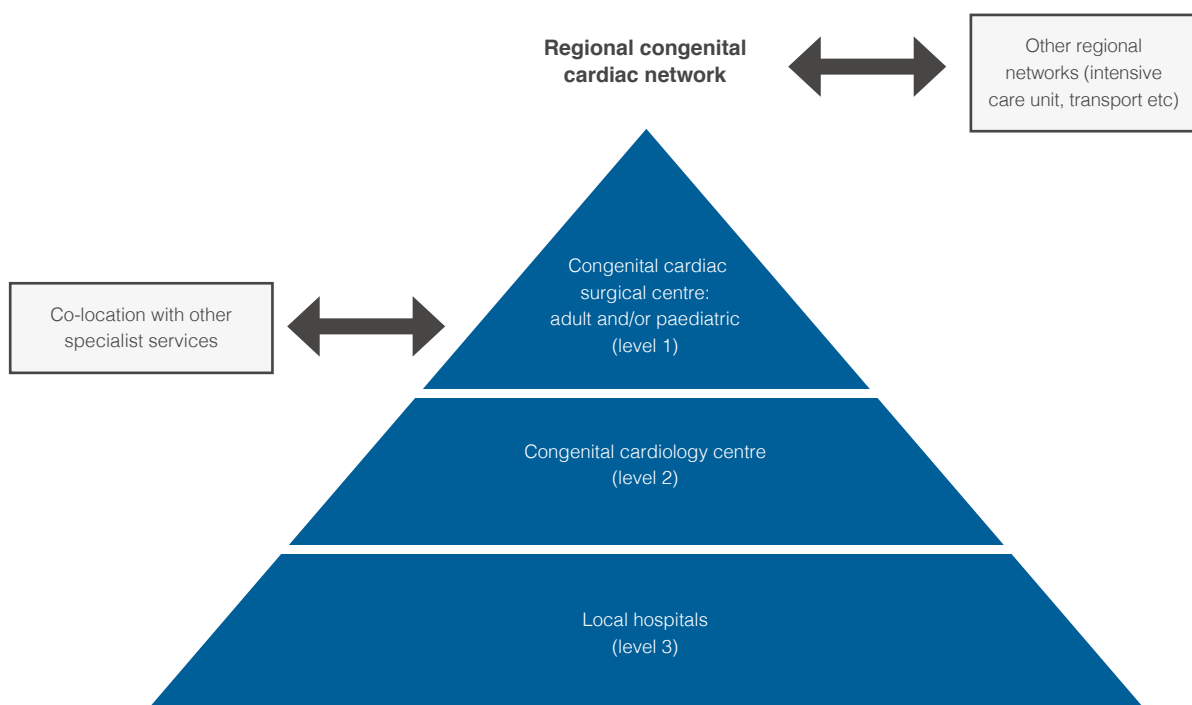
to care for these patients as they become adults. While the initial expectation was that the number of operations performed would grow rapidly, the overall number of procedures reported to the National Congenital Heart Disease Audit (NCHDA) has remained remarkably stable at around 20% of total congenital surgical activity. This is thought to be related to an increase in interventional procedures (particularly for the right ventricular outflow tract) as well as some of the aortic work being taken on by specialist aortic surgery teams.

Historically, paediatric cardiac surgery was performed alongside adult cardiac surgery in the same units and by the same surgeons. However, with increasing advances in techniques, and expansion in both the range and the complexity of the procedures, particularly in neonates, there has been a gradual transition into a subspecialty of congenital cardiac surgery over the last 30 years. This subspecialisation has no doubt contributed to the current excellent results and the NCHDA shows that outcomes are among the best in the world with no statistical outliers in UK centres.

Paediatric cardiac surgery has been under intense public scrutiny since the Bristol Royal Infirmary Inquiry of the late 1990s. Consequently, there have been a number of attempts to define national service delivery. Initial efforts focused on children’s heart surgery only but the New Congenital Heart Review (2013–2017) covered the entire management of congenital heart disease over the lifetime of the patient, and resulted in a separate set of service standards for paediatric and adult patients. These standards evolve around a pyramidal regional network structure with congenital cardiac surgery and intervention provided in level 1 centres, congenital cardiology in level 2 centres and local support in level 3 centres. Co-location of surgical centres with a number of other specialist services is mandatory (Figure 9).

The service standards were accepted by NHS England in 2016 and following assessment of current units against the standards, it was announced in November 2017 that all existing paediatric cardiac surgery units in England would stay open (albeit some with special conditions). Most adult congenital cardiac

Figure 9
Regional network approach to management of congenital heart disease



programmes remained but a small number of stand-alone adult congenital cardiac units were decommissioned. Around the same time, a review of congenital cardiac services in the Irish Republic and Northern Ireland resulted in the introduction of an all-Ireland service. All paediatric cardiac surgery and intervention is now delivered in Dublin, with closure of the Belfast paediatric unit (although Belfast continues to provide adult congenital cardiac surgery). In Scotland, cardiac services had been centralised in Glasgow a decade earlier. A full list of the centres commissioned to provide surgery for patients with congenital heart disease is given in Table 6.

Current practice

Congenital cardiac surgery remains one of the most demanding and technically complex areas in cardiothoracic surgery. It is also one of the most rewarding as successful surgery is not just life-saving but also offers many young patients the chance of a long and good quality life. Surgeons deal with many different pathologies and there is a large range of procedures, often with high technical complexity, in which proficiency is required. (There are currently 39 different primary procedures alone that are recorded in the NCHDA.) The small size and delicacy of the neonatal tissues can be very challenging, as can adult congenital cardiac procedures involving multiple redo sternotomies.

Table 6

Centres commissioned to provide cardiac surgery for patients with congenital heart disease

City	Trust	Paediatric	Adult
England			
Birmingham	Birmingham Women and Children's NHS Foundation Trust	√	
	University Hospitals Birmingham NHS Foundation Trust		√
Bristol	University Hospitals Bristol NHS Foundation Trust	√	√
Leeds	Leeds Teaching Hospitals NHS Trust	√	√
Leicester	University Hospitals of Leicester NHS Trust*	√	√
Liverpool	Alder Hey Children's NHS Foundation Trust	√	
	Liverpool Heart and Chest Hospital NHS Foundation Trust*		√
London	Great Ormond Street Hospital for Children NHS Foundation Trust	√	
	Barts Health NHS Trust		√
London	Guy's and St Thomas' NHS Foundation Trust	√	√
London	Royal Brompton and Harefield NHS Foundation Trust*	√	√
Newcastle	Newcastle upon Tyne Hospitals NHS Foundation Trust*	√	√
Southampton	University Hospital Southampton NHS Foundation Trust	√	√
Scotland			
Glasgow	Royal Hospital for Children	√	
	Golden Jubilee National Hospital		√
Ireland			
Belfast	Royal Victoria Hospital		√
Dublin	Our Lady's Children's Hospital	√	
	Mater Misericordiae University Hospital		√

*Commissioned subject to conditions

Dual operating has been invaluable in maximising expertise and professional support for colleagues, and it has long been an integral part of the close teamwork that defines congenital cardiac surgical teams. Furthermore, the complexity and high risk nature of much of the neonatal and infant surgery means that most newly appointed surgeons will continue to require considerable support at the beginning of their job. Following a long procedure in the operating theatre, it is not unusual to spend time on the intensive care unit for close interdisciplinary postoperative management, especially for small infants.

Combined surgical and interventional procedures are on the increase, and continue to evolve. Access to a hybrid operating theatre has now become a standard of care in most congenital units. This is particularly useful in limiting the number of sternotomies in patients who require multiple interventions over a lifetime and in those at very high risk of open heart surgery.

Over recent years, it has become apparent that postoperative extracorporeal membrane oxygenation (ECMO) support improves outcomes in selected patients and ECMO is now delivered in all congenital cardiac units. Increasingly, cardiac surgeons are also involved in ECMO cannulation for respiratory support and for short-term mechanical cardiac assistance for reasons unrelated to cardiac surgery. Cardiac transplantation and long-term mechanical cardiac assistance continue to only be delivered in nationally designated cardiac transplant centres.

Congenital cardiac surgical practice involves operating across a large age range. Most paediatric cardiac operations are nowadays performed in a children's hospital and adult congenital heart disease services are increasingly located in large teaching hospitals. However, there is no requirement for paediatric and adult services to be on the same site. Consequently, depending on local arrangements, congenital cardiac surgeons may operate on children and adults in the same hospital or there may be a need for split site working, in separate children's and adult hospitals. Currently, about half of the congenital

cardiac units in the UK and Ireland have a split site arrangement.

After an earlier 'divorce' of congenital cardiac surgery from its adult parent specialty, there is now a renewed interest in collaboration. As a result, minimal access surgical techniques developed for adult acquired practice are becoming available for congenital cardiac patients (such as mini-mitral surgery), as are new techniques developed for reconstructive aortic surgery and percutaneous valve implantation. On the other hand, expertise of congenital cardiac surgeons in dealing with a small aortic root may benefit adult acquired cardiac surgical patients, as is their experience in multiple sternotomies or right heart operations. For this reason, combined adult and congenital operating is increasing. The exact division of labour will be different in various units depending on the training and interests of surgeons.

Although surgical skill remains a very important determinant of outcome, the impact of multidisciplinary teamwork must also be emphasised. This has been recognised by the NCHDA, which reports results as unit outcomes rather than individual surgeons' results. One of the new standards introduced following the New Congenital Heart Review specifies a minimum caseload of 125 operations per surgeon per year (averaged over a three-year period). There is ongoing debate regarding exactly which procedures should be counted and also on how dual operating should be valued.

Consultant workforce

At present, congenital cardiac surgery is delivered by 45 consultants across the 12 congenital cardiac programmes in the UK and Ireland. Forty of these consultants hold substantive posts and five are in a locum position. The locum consultants include a number of non-EU surgeons awaiting recognition of their specialist training. Traditionally, many of the congenital cardiac surgeons came from abroad and 60% of the current workforce has a primary medical qualification from outside the UK or Ireland. The age distribution of the current congenital cardiac consultant workforce is shown in Figure 10.

In addition to the 45 consultants providing the delivery of congenital cardiac surgical services across the UK and Ireland, a further 2 congenital cardiac surgeons are in recently established academic positions.

Since the 2015 workforce review, when there were 42 consultant surgeons, the overall number of consultant congenital cardiac surgeons has not significantly changed. There have been two retirements, three surgeons moved abroad and three changed position within the UK. As a result, there have been eight new consultant appointments in the UK and Ireland. All of these candidates achieved their primary medical qualification abroad.

The recently adopted standards for congenital cardiac services in England state that by 2021 all ten units should have at least four surgeons. Currently, up to four English units meet this requirement (not all can achieve a true 1:4 on-call rota), and assuming the workload remains the same and there are no other changes, at least six substantive appointments will need to be made over the next three years to meet this criterion. Predicting retirement is notoriously difficult but currently, 6 consultants are over 60

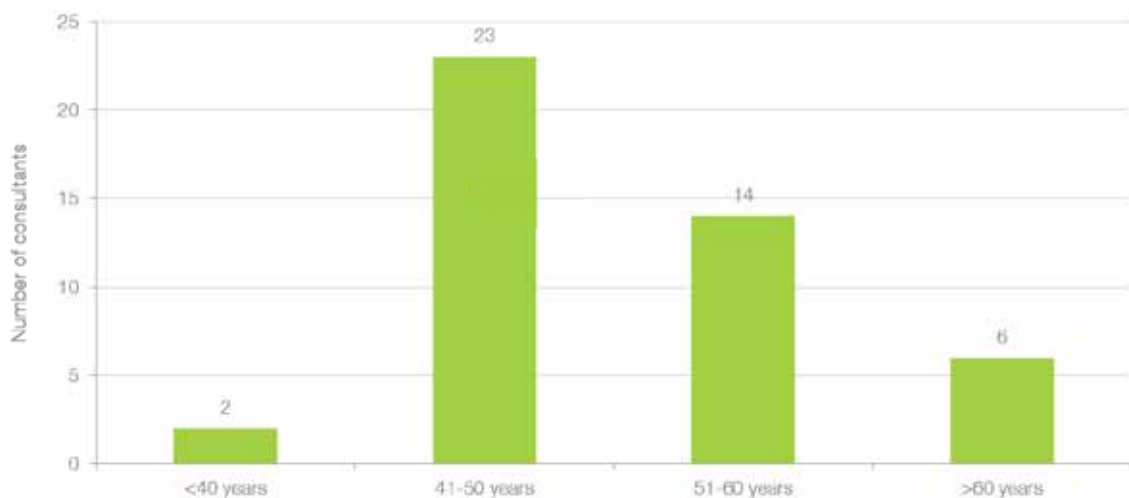
years old, and 14 consultants are aged between 50 and 60 years. Furthermore, over the last decade, up to one established consultant per year has moved abroad. It is therefore estimated that over the next decade, 15–20 new congenital cardiac surgeons will be needed.

Job plans

Nowadays, surgeons who operate on patients with congenital heart disease will almost always be dedicated congenital cardiac surgeons and a mixed congenital/adult acquired practice is rare. The recently introduced standards that specify a minimum of 125 congenital cardiac operations per year also discourage significant non-congenital operating.

Most congenital cardiac surgeons will be expected to carry out the full spectrum of congenital cardiac surgery across the ages although there will inevitably be a degree of ‘superspecialisation’ within any unit, with individual surgeons having their own area of special interest. The expectation is that job plans include at least 1.5 operating days per week and

Figure 10
UK congenital cardiac surgeons by age group



more commonly 2.0 operating days. As many operations are complex, most surgeons will have extended operating days of 3 programmed activities (PAs). The recognition of dual operating in job plans is strongly supported.

There is increasing emphasis on a multidisciplinary team (MDT) approach to decision making for all (paediatric and adult) congenital cardiac patients. In addition, further MDT meetings may have to be attended for specialty interests (e.g. joint working in an aortic service). Joint ward rounds and attendance at MDT meetings have become an essential component of all job plans.

The outpatient commitment in congenital cardiac surgery is relatively limited and consists predominantly of preoperative counselling. Most of the follow-up outpatient work is undertaken by paediatric and adult congenital cardiologists.

The commitment to audit of providing accurate and timely submission data for the NCHDA needs to be acknowledged. In services where the paediatric and adult units are on different sites, the travel between sites for operating and attending MDTs has to be taken into account when job planning. Owing to the need for adequate operative exposure, the high intensity of the workload, and the increasing MDT meetings and collaborative working, most job plans will comprise 10+2 PAs.

The on-call commitments can be onerous. Although operating in the middle of the night is unusual these days, the high proportion of neonatal surgery means that operations may need to be carried out at short notice (including at weekends). Postoperative management frequently involves a joint effort between surgeons and intensive care units, especially for newborn patients. ECMO for respiratory and cardiac support in neonates and infants is often a consultant-delivered service (typically out of hours as an emergency). Most units currently have three surgeons on a 1:3 on-call rota, with newly appointed surgeons backed up by a senior colleague in the beginning of their career. The new standard of four surgeons per unit by 2021 will make on-call commitments more sustainable.

Work–life balance

The heavy clinical workload and the nature of the work make for a potentially stressful job with unsocial hours. This is exacerbated if split site work is required. However, the variety of the work and the satisfaction of significantly improving the lives of many congenital patients continues to provide an ongoing stimulus. The general acceptance for colleagues to readily cross-cover and share postoperative care helps to distribute the clinical load, as does the teamworking with cardiologists and intensivists. The factor that will possibly have the most significant impact on work–life balance is the push towards larger teams to increase the amount of peer support and provide more sustainable on-call rotas.

Training in congenital cardiac surgery

Congenital cardiac surgery was recognised as a new subspecialty within cardiothoracic surgery in 2013. Trainees first complete the national curriculum, which will lead to award of the cardiothoracic surgery Certificate of Completion of Training, after which they can apply for two years of congenital cardiac subspecialty training. Although congenital cardiac surgery is currently not a mandatory part of the national curriculum, most trainees with an interest in this field will already have spent 6–12 months as a ‘taster’ in congenital cardiac surgery during their training. Entry in the congenital subspecialty training programme is competitive. National trainees who were awarded the Certificate of Completion of Training after 2014 are now required to have subspecialty recognition before being eligible to apply for a congenital cardiac consultant post in the UK. This does not apply to non-UK applicants, who will have to provide evidence to the appointments committee of alternative satisfactory congenital training.

The first national congenital subspecialty training programme in England was established in 1997, and rotates between Birmingham Children’s Hospital and Great Ormond Street Hospital in London. Further programmes have since been established between Alder Hey

Children's Hospital (Liverpool) and Freeman Hospital (Newcastle), and the Evelina London Children's Hospital and Royal Brompton Hospital in London. With the drive towards larger congenital cardiac centres, it is expected that training criteria will be met in the majority of UK centres in the future.

Over recent years, there has been a limited interest of national trainees for congenital subspecialisation. It is hoped that now the reorganisation of congenital cardiac services has been concluded and larger units are being created, this will help to attract a new generation of UK congenital cardiac surgeons. At the same time, access to the national congenital cardiac training schemes needs to be broadened to accommodate suitable overseas candidates. This is important as there is a need to expand the consultant pool.

The greatest challenge remains the provision of adequate operative experience for trainees. The technical complexity and intense scrutiny can make it difficult to give out cases. Despite this, it is expected that trainees going through the programme will have performed a minimum of 75 procedures. There is a general understanding that newly appointed consultants will need up to a further two years of training and mentoring on the job. The recent application of 3D printing of heart models has been useful in the planning and discussion of operations with trainees. Most of the training currently focuses on neonatal surgery. Changes in training may be necessary to reflect the emerging adult congenital practice.

Future practice

Surgical activity is closely related to the incidence of congenital heart disease in newborns, which has remained remarkably constant at about 8 cases per 1,000 live births. Nevertheless, there is some geographical variation in activity. This can be due to varying incidence of congenital heart disease between areas composed of different ethnic groups or differences in birth rate (for example, as a result of immigration of young families).

Although a number of congenital cardiac

procedures can now be provided by catheter intervention, there will be a continued need for congenital cardiac surgical operations in the foreseeable future, particularly complex neonatal surgery. In addition, advances in surgical techniques and perioperative care have improved survival, especially for children with single ventricle circulation. This has increased candidacy for further staged procedures.

Patients with operated congenital heart disease surviving into adulthood are now the fastest growing congenital cardiac population and it had been calculated that this would result in an increase of 0.7–4.0% in adult congenital cardiac surgical procedures. However, this has not been borne out by the adult congenital cardiac surgery activity, which has remained stable at around 20% of overall activity. It has been recognised that selected patients will benefit from advances in adult acquired practice (particularly for valve-based procedures) and some may receive their treatment by specialists in these fields rather than by congenital cardiac surgeons (or as a joint venture). The congenital cardiac MDT will play a pivotal role in the direction of treatment for these patients, and the particular patient pathway will depend on local expertise in the congenital and adult acquired teams. This will have an impact on congenital cardiac surgical activity.

Congenital heart disease involves a lifelong connection with the congenital team. Traditionally, patients remained associated with their named surgeons and physicians. In the fast moving world of new treatment modalities and working practices, this system is changing. With the introduction of more streamlined patient pathways and supporting health technology (such as electronic prescribing), there is an increasing role for advanced nurse practitioners in the pre- and postoperative care of patients as well as for follow-up. The same is true for the surgical procedure, where surgical care practitioners can assist or take over part of the operation and help with training junior staff. The role and responsibilities of these healthcare workers within the congenital cardiac team continue to evolve, both with regard to planned treatment and also for emergency and out-of-hours work.

The recently introduced standards of care for the management of congenital cardiac patients aim to achieve excellent and reproducible care throughout the country as well as providing sustainable services, for patients and health professionals alike. For this to be successful, adequate investment in staffing and health service technology will be required. This should include access to a multitude of skilled health professionals working in well organised MDTs, advanced imaging, long-range communication, electronic patient records and evidence-based patient pathways.

Cardiopulmonary transplantation

Current practice

Advanced heart and lung failure therapies (including transplantation and bridging to transplantation with mechanical circulatory support devices [MCSDs]) are provided at seven designated UK centres (Table 7). These advanced heart and lung failure teams consist of surgeons, physicians, transplant coordinators and allied staff (social workers, physiotherapists, psychologists and palliative care staff).

Consultant cardiothoracic surgeons at these tertiary centres are involved throughout the patient pathway, including:

- » assessment of patients with advanced heart and lung failure
- » transplant or MCSD implant operation
- » early postoperative care
- » dealing with early and late surgical complications of transplantation and MCSD therapy

They will undertake elective and emergency cardiothoracic surgery alongside their commitment to the transplant programme. Some consultant surgeons are also involved in donor assessment and retrieval of cardiothoracic donor organs as part of the UK National Organ Retrieval Service (NORS).

Over the last decade, there has been a significant increase in the number of cadaveric donors in the UK. This is reflected in a corresponding rise in annual heart and lung transplant activity (Figure 11).

Heart and lung transplant procedures are demanding since they are often performed as emergencies out of hours. Over the last decade, these have become even more challenging because:

- » allocation of donor organs is increasingly prioritised for the clinically more urgent and therefore sicker patients
- » a growing number of heart recipients have undergone previous cardiac operations or

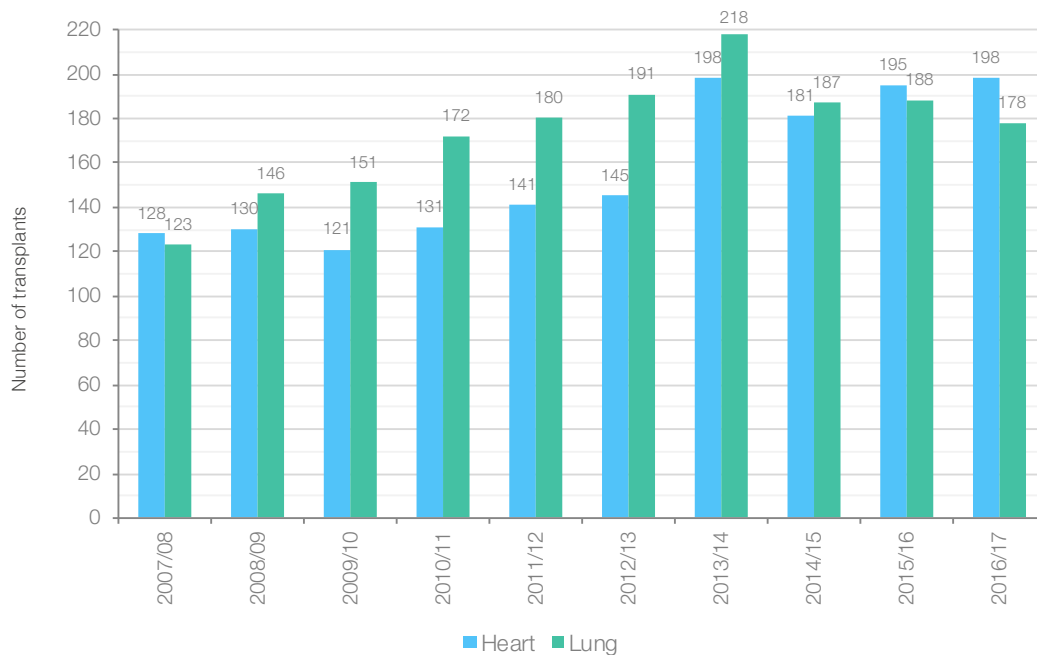
Table 7

UK centres providing advanced heart and lung failure therapies

City	Hospital	Adult		Paediatric	
		Heart	Lung	Heart	Lung
Birmingham	Queen Elizabeth Hospital	√	√		
Cambridge	Royal Papworth Hospital	√	√		
Glasgow	Golden Jubilee National Hospital	√			
London	Great Ormond Street Hospital for Children			√	√
London	Harefield Hospital	√	√		
Manchester	Wythenshawe Hospital	√	√		
Newcastle	Freeman Hospital	√	√	√	√

Figure 11

Number of cardiothoracic organ transplants in the UK



have been implanted with ventricular assist devices as a bridge to transplant, making their surgery prolonged and technically difficult

- » bilateral sequential lung transplant (instead of single lung transplant) has become the standard of care for most end-stage lung conditions as it is associated with superior short- and long-term outcomes despite the initial surgery being of greater magnitude

As a result, heart and lung transplant procedures have become more protracted, requiring sustained concentration and stamina from the surgical team even though the operations take place most often through the night. Furthermore, the close monitoring of early post-transplant survivals in the UK puts added pressure on transplant teams.

Transplant fellowships

In the UK, most heart and lung transplant operations are performed by cardiothoracic surgeons although a small number of general thoracic

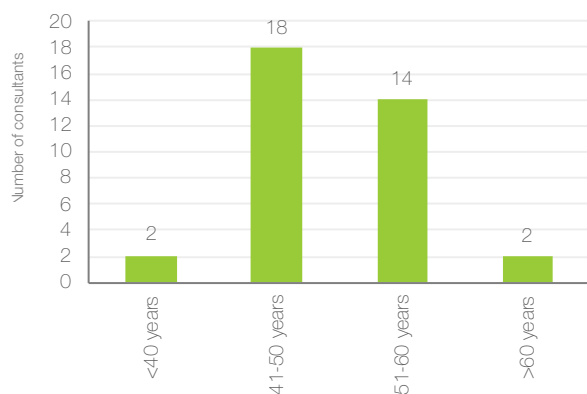
surgeons also perform lung-only transplants. Currently, there are three 18-month surgical transplant fellowships in the UK that offer comprehensive training in advanced heart and lung failure therapies to provide future transplant consultants. These specialist fellowships are available at Freeman Hospital in Newcastle, Royal Papworth Hospital in Cambridge and Wythenshawe Hospital in Manchester.

Technology innovations

There have been major advances in MCS/D therapy in the last decade. As survival rates improve, clinically unstable patients are increasingly bridged to heart or lung transplants using MCS/D. In many countries, implantable left ventricular assist devices are also used as a permanent treatment for patients with advanced heart failure who are ineligible for transplant. Even though this indication is currently not funded in the UK, it is likely that it will eventually become the standard of care.

In terms of donor organ retrieval, there has been intense interest in the development of

Figure 12
UK transplant surgeons by age group



machines for *ex vivo* donor organ perfusion after hearts or lungs have been retrieved. Machine perfusion of donor organs can maintain organ viability for longer periods than cold ischaemic storage. It also has the potential to improve donor organ quality and may even permit reconditioning of suboptimal organs that have initially been turned down for transplantation so they can subsequently be transplanted successfully, thereby increasing donor organ utilisation. It may also allow for other therapies to condition the organ prior to implantation to reduce rejection tendencies. It is likely that the use of these novel technologies will call for more consultant surgeon involvement in donor organ management.

Visions for the future

NORS scout project

Between April 2013 and March 2014, the Cardiothoracic Transplant Advisory Group piloted a 'scout' programme. This involved sending a trained member of the cardiothoracic retrieval team (the NORS scout) to the donor hospital to assist with early donor assessment and donor optimisation once consent for organ donation had been obtained. The donor heart utilisation rate in scouted donors increased from 27% to 44%.

An external review of the scout pilot concluded that it significantly increased the donor heart utilisation rate and heart transplant numbers, and recommended that this should become

a formally commissioned service. A business case is being put together for NHS Blood and Transplant to consider.

The scouts are likely to be made up of a new group of allied health professionals who will be trained in advanced donor care including invasive haemodynamic monitoring, transoesophageal echocardiography, fiberoptic bronchoscopy, and management of fluids and vasoactive agents. A national curriculum for NORS scouts will have to be agreed and a training faculty will be appointed.

Each of the cardiothoracic transplant units will probably have to recruit sufficient scouts to provide a service 24 hours a day. This will represent an exciting new opportunity for allied health professionals with an interest in advanced cardiovascular care.

Taking Organ Transplantation to 2020

NHS Blood and Transplant published a strategic document entitled *Taking Organ Transplantation to 2020* with recommendations aiming to enable the UK to match world-class performance in organ donation and transplantation. The goals include:

- » increasing consent for organ donation from 57% to >80%
- » increasing the rate of deceased donors per million population (pmp) from 19.1 pmp to 26 pmp
- » increasing the organ utilisation rate by 5% (i.e. increasing the donor heart and lung utilisation rate from 30% to 35%)
- » increasing the deceased donor transplant rate from 49 pmp to 74 pmp

Presumed consent for organ donation

In the current system, people who wish to donate their organs after death have to sign up as a donor on the National Health Service organ donor register and tell their family (i.e. they need to opt in). In December 2015 Wales introduced a system of presumed consent to organ donation; those who do not wish to be an organ donor can opt out by registering their decision. Scotland is planning to introduce similar opt-out legislation for organ donation by 2021. In October 2017 the Prime Minister announced a consultation on changing to an opt-out system of organ donation

Figure 13

Number of new posts anticipated over the next five years

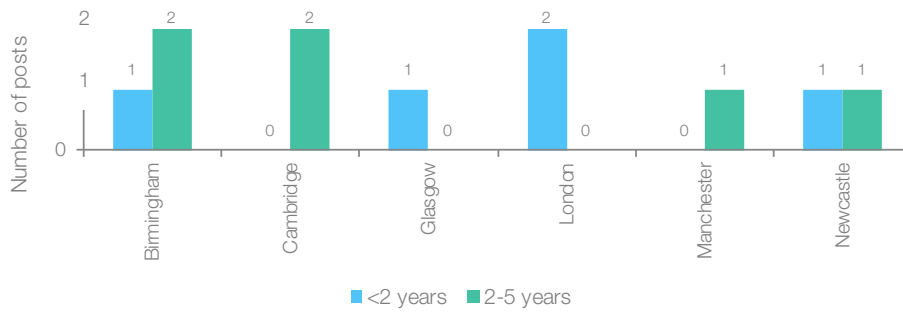


Figure 14

Number of transplant surgeons retiring each year, assuming a retirement age of 60 years



in England. The introduction of appropriate initiatives and changes to the law could potentially result in a 50% increase in heart and lung transplant activities over the next 5–7 years.

Requirement for future cardiothoracic transplant surgeons

With the initiatives to increase donor organ numbers and the greater use of MCS/D therapy for patients with end-stage heart and lung diseases, an expansion of a suitably trained surgical workforce will be required to deliver these highly specialised clinical activities. A workforce survey was conducted by questioning each director of the transplant centres in December 2017. There are currently 36 cardiopulmonary transplant surgeons. Four of these are thoracic surgeons performing only lung transplantation.

Figure 12 shows the number of transplant consultants by age group. Almost half (44%) of the current consultant workforce is over the age of 50 years and 14% are over 55 years old. Only 6% are aged 40 years or younger. Most consultants currently practising transplantation are job planned to spend 8–10 hours per week on this discipline alongside their routine and emergency commitments in general cardiothoracic surgery.

The units report a likely recruitment need of five new posts in the next two years, and six new posts between two and five years from now (Figure 13). This, however, would simply maintain the status quo and does not account for the anticipated major increases in activity that are likely through new legislation on donation and the applications of new technologies to

increase organ utilisation.

Aside from the posts expected to be advertised by individual centres over the next five years, longer-term recruitment plans will have to be made based on the likelihood of transplant surgeons retiring or leaving the transplant rota as they advance in their career. Figure 14 illustrates the number of consultants expected to retire each year over the next 25 years. Given that such a considerable proportion of current surgeons are aged 50 years and over, there will be a projected need for substantial recruitment to the discipline from 2023 onwards and recruitment to training posts should anticipate this demand in the near future. These numbers do not take into account additional staffing requirements being mandated by an increase in activity. Recruitment to the fellowship programme will require an 18-month lead time.

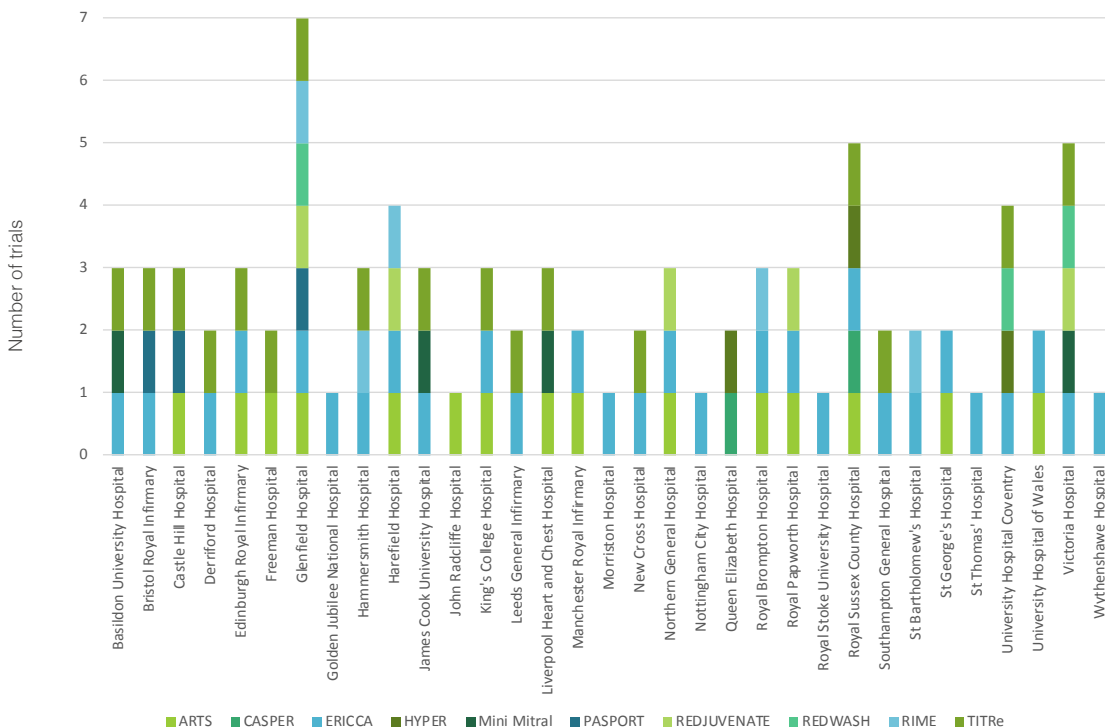
Academic cardiothoracic surgery

What is our vision?

The UK is the world leader in life sciences research. This is a highly productive sector of the economy and as a result, it will receive increasing investment from the government in the medium to long term. The 2017 *Life Sciences Industrial Strategy* report predicts that there will be at least a 50% increase in clinical trials

activity over the next five years. Cardiothoracic surgery has a proven ability to deliver high quality multicentre trials that change practice, with thousands of patients recruited to trials of interventions during or after surgery over the last decade (Figure 15). Changes in demography along with the development of new and possibly superior minimally invasive treatments for cardiothoracic diseases

Figure 15 Recruitment to multicentre trials in UK cardiac surgical centres between 2007 and 2017. (Data from published trial reports.)



present challenges that the specialty must meet to prosper. The combination of a health service organised to deliver high quality research across sites, significant research funding (£1 billion per year from the National Institute for Health Research [NIHR], £350–£400 million per year from Cancer Research UK and £100 million per year from the British Heart Foundation [BHF]) and the availability of high quality researchers means that the UK is in an enviable and almost unique position to tackle these challenges.

The vision of the SCTS is that all cardiothoracic surgeons, nurses and allied health professionals (AHPs) see research as essential for the progress of the specialty, supporting research where possible. Together, we in the UK have the capacity to deliver a portfolio of pragmatic clinical trials that address key areas of uncertainty. This is linked to the development of a cohort of young researchers who can lead research in the specialty in the future.

Where are we now?

Senior academics in cardiothoracic surgery

The 2015 cardiothoracic surgery workforce report demonstrated that the great majority of UK academics were in honorary positions, with relatively few substantive university appointments. UK surgeons in honorary academic posts have led many of the key clinical trials in cardiothoracic surgery over the last decade (including ERICCA, VIOLET, PuMiCC, MARS 1, MARS 2, PEGASUS and ARTS) despite having

little or no time within job plans specifically dedicated for research. Of those in substantive academic positions, none were in transplantation or congenital heart disease.

Academic trainees

The number of academic trainees appointed in cardiothoracic surgery over the first ten years since the NIHR was established is shown in Table 8. The numbers of NIHR academic clinical fellows (ACFs) and clinical lecturers (CLs) appointed in general surgery and cardiology are listed for comparison. Although these are much larger specialties, the relative magnitude of the difference (at least tenfold) identifies a shortfall in the development pipeline of new academic surgeons in our specialty.

Of the five cardiothoracic ACFs appointed between 2006 and 2016, the relative proportion who went on to undertake a postgraduate degree was comparable with that for general surgery ACFs (Figure 16). In contrast, whereas two-thirds of general surgery CLs went on to substantive academic positions, no CLs in cardiothoracic surgery went on to a university appointment (Figure 17). Overall, the NIHR integrated academic pathway has failed to deliver a substantive senior university academic in cardiothoracic surgery over the first decade of the programme.

Congenital and transplant surgery

These two subspecialties are particularly underrepresented in the cardiothoracic academic workforce. Clinical research in congenital

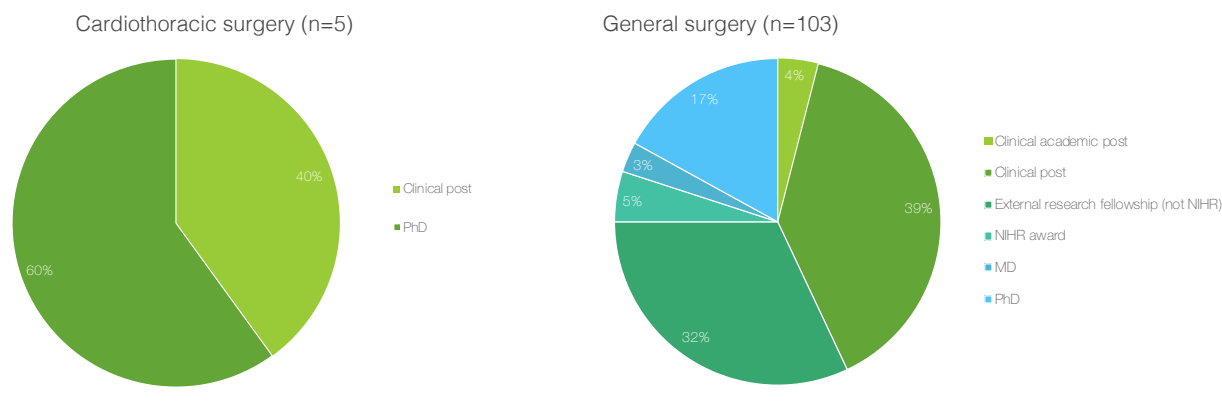
Table 8

NIHR academic trainees appointed between 2006 and 2016. (Data provided by NIHR Trainees Coordinating Centre.)

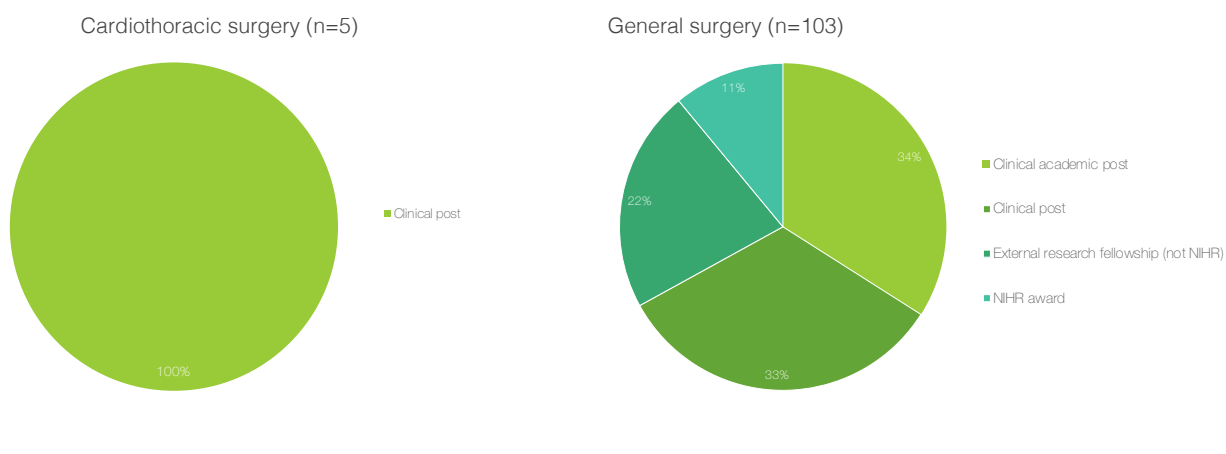
Specialty	ACFs		CLs		Total
	Current	Ended	Current	Ended	
Cardiothoracic surgery	4	5	2	4	15
General surgery	32	103	20	36	191
Cardiology	25	62	26	33	146

Figure 16

First destinations for NIHR ACFs at February 2017. (Data provided by NIHR Trainees Coordinating Centre.)

**Figure 17**

First destinations for NIHR CLs at February 2017. (Data provided by NIHR Trainees Coordinating Centre.)



cardiac surgery has mainly been driven by efforts of individual cardiac units. There have been no large randomised controlled clinical trials in congenital heart surgery in the UK, and worldwide only one high quality multicentre trial has been reported: the single ventricle reconstruction trial published by the Pediatric Heart Network in North America in 2010.

The paucity of randomised controlled trials is perhaps not surprising as congenital heart disease comprises a heterogeneous group of anatomical diagnoses and pathophysiology, and spans a broad age range. The ongoing reorganisation of congenital cardiac services in the UK over the last 15 years has further complicated efforts for multicentre research collaboration, as have the new standards for congenital heart disease, which require that

surgeons perform at least 125 operations per year. However, with the plans for commissioning of congenital cardiac surgical services announced by NHS England in November 2017, the way has now been paved for research collaboration. In addition, the national service standards will ensure that a high quality service is guaranteed across participating research centres.

Surgical research related to cardiopulmonary transplantation has focused in recent years on the benefits of machine perfusion of organs. This can take the form of systems to reduce ischaemic time, which is critical in heart transplantation and *ex vivo* techniques to recondition rejected organs in order to make them transplantable. The technology has allowed heart retrieval from donors after cardiac death

with great clinical success. Research is still being carried out on mechanical support and the evolution of device therapy utilising new technologies for pumps and driver software to minimise medium- and long-term complications. Minimally invasive surgical techniques also continue to be studied academically in their application to transplant surgery.

No formal academic partnership or framework between surgeons currently exists that concentrates on cardiothoracic transplantation despite the wealth of innovative and exciting opportunities that the discipline presents. Meetings bringing together cardiopulmonary transplant surgeons to discuss projects hosted by The Royal College of Surgeons of England (RCS) have taken place but these need to become regular, focused opportunities to consider future projects.

Nursing and allied health professionals

Nationally, it is recognised that there is a shortage of nursing and AHP (NAHP) research, and that the NAHP evidence base needs to increase. This is also true specifically for NAHP cardiothoracic research. In the UK, there are only 7 nursing professors with a cardiovascular background (2.5% of all nursing professors) and none specialise in cardiothoracic research whereas there are 24 cardiothoracic surgeon professors. Consequently, the vision of the SCTS CT Forum is to encourage, promote and assist in the development of NAHP clinical academic career and research opportunities in cardiothoracic surgery in the UK. This is particularly important in areas that impact clinical practice, patient and staff wellbeing, and that have the potential to influence policy.

Early in 2017 a questionnaire was developed with the aim of identifying nurses and AHPs engaged in cardiothoracic research, and what support (if any) members would like the SCTS to provide. The main findings from the 53 respondents were:

- » *Education level:* The majority were educated at BSc level while one individual (1.9%) had a MRes degree and two (3.8%) a PhD degree, with one in an academic post.
- » *Research experience:* Twelve respondents (22.6%) were an active member of a

research team and fifteen (28.3%) were involved in conducting their own research.

- » *Research funding:* Seven respondents (13.2%) had been awarded research funding in the last five years (2 NIHR awards, 2 BHF awards, 1 Royal College of Nursing award and 4 local trust charity awards). Of those who had undertaken a MSc or PhD degree, the majority were self or departmentally funded.
- » *Publications:* Eleven respondents (20.8%) had published in the specialty.
- » *Research support:* The majority (52.2%) indicated they would like research network opportunities and teaching on research-related subjects. Over 40% also indicated they would like email alerts/bulletins of research funding opportunities, signposting to relevant research resources (both 21, 45.7%) and a CT Forum research newsletter (20, 43.5%). A further 18 (39.1%) indicated that support for MSc/PhD supervision would be valued.

Overall, this highlighted a need to increase NAHP research capability and capacity in cardiothoracic surgery in the UK.

What are the main challenges?

Leadership

The shortfall in senior university academics and honorary appointments with paid academic time reduces the capacity of the specialty to provide leadership in academic organisations. Although there are a number of highly successful individuals in cardiothoracic research, many major centres and training rotations do not have a research-active professor. In the 2015 workforce review, 8 of the 14 university academic appointments were located in 3 centres. This is a major disincentive to trainees who are interested in undertaking research and creates significant barriers to those who may wish to enter the academic training pathway. The absence of research leaders also limits the ability of cardiothoracic surgeons to represent the spe-

cialty in funding or strategic bodies that identify resource and research priorities. Ideally, all of these issues could be addressed in the medium term by increased investment in trainees who will ultimately take up a career in research.

Training in cardiothoracic surgery

The trainees with a national training number are highly capable and often have strong academic credentials. For example, up to 17 of the 40 points available in the national training number application matrix can be acquired from academic outputs (papers, presentations and degrees). However, the academic criteria for being awarded a Certificate of Completion of Training (CCT) in cardiothoracic surgery are modest (evidence of study of research methodology or a higher degree, publication of 4 peer-reviewed papers, 6 research presentations, and completion of a good clinical practice course and a research methodologies course) and lower than in other specialties.

For comparison, trainees in trauma and orthopaedics are required to have completed a good clinical practice course, evidence of research methods training or completion of a research methodologies course, evidence of journal club activity and any two of the following: a higher degree, two published research papers, two presentations and evidence of recruiting at least five patients into a research ethics committee approved study or at least ten patients into a multicentre observational study. The limited requirement for research activity during training in cardiothoracic surgery has led to poor engagement of cardiothoracic trainees with the RCS surgical trials initiative relative to other surgical specialties.

Academic training

The shortfall in academic training in cardiothoracic surgery has been described above. The solution to this problem has multiple components. First, there must be better engagement with medical students to increase awareness of cardiothoracic surgery and to identify potential academic foundation programmes thereafter. Second, although some training programmes have ACFs, these are few in number. In order to

address this, the specialty needs to develop a dialogue with the Specialty Advisory Committee (SAC) to increase the availability of these positions. Third, there needs to be alignment of research training with national research strategies (such as the newly announced NIHR themes) and provision of more flexible training programmes for women wishing to pursue academic careers. The development of trainee research networks and the new Associate Surgical Specialty Lead role (for trainees) will also help align activity with the RCS surgical trials initiative.

Funding

The single most important factor that determines whether a surgeon in training will pursue an academic career is receiving funding to support research time as well as research costs. Undertaking research without these is often frustrating and typically results in poor quality outputs. Alternatively, working as part of a well resourced multidisciplinary team to address a clear research question is easier, rewarding and more likely to result in high impact outputs.

Competition for funding is intense and researchers in non-craft specialties are often able to commit a larger proportion of the working week to research without detriment to their clinical performance. Research grant applications from surgeons must, however, meet the same standards as their non-surgical colleagues. Ultimately, success relies on the ability of the individual to network with colleagues as well as researchers in other disciplines to apply the correct methods to answer important research questions. Other specialties have led the way in this respect with collaboratives in general and orthopaedic surgery currently conducting large portfolios of randomised trials in the UK.

Infrastructure

The evaluation of novel devices and interventions has a greater impact when conducted by networks of academics. In North America, the funding of a programme of trials identified by an appropriate priority setting exercise has resulted in important advances in knowledge, high impact outputs and changes in practice. These trials are delivered by a group of surgeons with

a proven track record in surgical research. In comparison, trial networks in the UK must be established anew with every additional trial that is funded.

Ongoing initiatives

In 2015 the SCTS developed a strategy to address shortfalls in research capacity in cardiothoracic surgery. First, it established a new Academic and Research Committee with representation from academics in all the major subspecialties as well as trainees, nurses and AHPs. At the same time, the SCTS funded the appointment of a surgical specialty lead for cardiothoracic surgery as part of the RCS surgical trials initiative.

Last year, the SCTS launched a new national research meeting to be held every autumn. Its aim is to showcase high quality research outputs from trainee surgeons and other researchers across the specialty. There is also an educational component with guest lectures on research methodology. It is hoped that this research-centred forum will foster the development of networks and collaborations that are essential for modern research. Moreover, it will provide a meeting around which other initiatives can organise such as the new Nursing and Allied Health Professionals Research Group (NARG) and the Cardiothoracic Trainees Research Collaborative.

Engagement with the SAC has led to an increase in the number of academic trainee opportunities. The SAC has also invited the Academic and Research Committee to develop proposals for organised training in research methodology and for an increase in the level of academic outputs required for award of the CCT. Other initiatives such as engagement with medical students and school age children are likely to attract high quality applicants to cardiac surgery with additional benefits for the development of academia. Initiatives specific to individual subspecialties are described below.

Adult cardiac surgery

In 2017 the BHF sponsored a workshop to develop a national strategy for cardiovascular

surgery research. The workshop identified unmet needs in the areas of academic training, innovation and links with industry, and the infrastructure required to deliver large multicentre trials.

Subsequently, the BHF has appointed a chair in congenital cardiac surgery as well as a senior professorial research fellow in vascular surgery, bringing the number of senior surgical academics funded by the BHF to four. It has also commissioned a cross-specialty working group that includes cardiologists and surgeons to prepare an application for a national trials network.

Furthermore, the BHF has given a clear steer towards the need for a national Priority Setting Partnership to identify the top 10 research questions to be addressed by clinical trials over the next 5–10 years. This is a well defined process (led by the NIHR-funded James Lind Alliance) that involves a series of national surveys sent to healthcare professionals, patients and carers. This identifies the research priorities of all stakeholders. This process has been funded by Heart Research UK. It is hoped that these initiatives will ultimately lead to a national research network with a well defined governance structure and representation from all UK units. This may then be utilised to deliver a portfolio of multicentre trials that answer the most important research questions identified by the Priority Setting Partnership.

Thoracic surgery

The UK Thoracic Surgery Research Collaborative was established in 2010 to bring together research-active thoracic surgeons with a view to delivering a portfolio of multicentre trials. The national collaborative was successful in the acquisition of a NIHR grant in 2014 for VIOLET (a multicentre trial of keyhole surgery for lung cancer) and a NIHR grant in 2017 for MARS 2 (a trial of surgery for mesothelioma). The collaborative has extended the scope to include industry-funded, surgeon-led translational research on blood-based biomarkers for cancer recurrence after surgery. In addition, resources have been allocated to support the wider thoracic research infrastructure through education of thoracic surgeons on trial recruitment (funded by the QuinteT Recruitment Intervention) embedded within each trial, and a national thoracic surgery

patient and public involvement group has been established to support patient and carer input as well as contribution to thoracic surgery research and new grant applications.

Congenital cardiac surgery

The shortfall in academic surgeons in this subspecialty has been addressed recently by the appointment of a BHF chair in congenital cardiac surgery in 2017, in addition to an existing BHF clinical research fellow in Birmingham Children's Hospital. These initiatives have in turn led to the development of a nascent national clinical trials network. It is envisaged that this will enable surgeons to work within a high quality clinical research framework without having to establish new resources at local level. Equally, the multi-disciplinary nature of congenital cardiac teams and their location in university teaching hospitals provides the environment to support and deliver research.

The National Congenital Heart Disease Audit provides a source of high quality data for outcome analysis. It has collected the outcomes of all UK and Irish congenital cardiac surgical centres for the last 15 years, is linked for mortality detection by the Office for National Statistics and is the only validated congenital database in the world. Statistical modelling of the audit has created partial risk-adjusted predictions of outcome that are now mandatory in English congenital units for near real-time monitoring of results.

Cardiopulmonary transplantation

Specific national research programmes in transplantation include INOAR (Increasing the Number of Organs Available for Research; a subgroup of the NHS Blood and Transplant [NHSBT] Research, Innovation and Novel Technologies Advisory Group), which makes recommendations on how to address the gap between the availability of and demand for organs for research purposes, and the Quality in Organ Donation project (a UK-wide programme funded by NHSBT), which facilitates research by collecting blood, urine and tissue samples of appropriately consented/authorised organ donors for biomarker discovery and precision medicine.

The NIHR Blood and Transplant Research Unit (BTRU) in Organ Donation and Transplantation is a strategic partnership between the University of Cambridge and Newcastle University (and their associated transplant units), and NHSBT. Launched in October 2015 and receiving £3.8 million of funding over five years, the overarching aim of the BTRU is to develop and evaluate novel approaches and technologies that will increase the availability of suitable donor organs for transplantation while improving graft survival. In order to help achieve this aim, existing links are being strengthened and new collaborations are being built between leading scientists and clinicians to create a BTRU that attracts the best young doctors and scientists, and helps them develop into the future researchers in transplantation.

Nursing and allied health professionals

Strategies employed to build and maintain NAHP research capacity in the specialty include:

- » developing research priorities based on those highlighted by the respondents to the NAHP questionnaire in 2017
- » highlighting existing funding sources for MSc degrees and exploring options for future cardiothoracic/SCTS funding sources
- » highlighting existing funding sources for PhD studentships and exploring options for increasing access to existing funding opportunities that are not currently open to nurses and AHPs
- » establishing a SCTS research network (using the expertise of those individuals who have indicated they would be willing to support others)
- » providing research support to members (e.g. research networking opportunities, signposting to relevant research resources, teaching on research-related subjects, research newsletter, email alerts/bulletins of research funding opportunities and MSc/PhD supervision support)

The SCTS NARG was established in late 2017 in order to implement these strategic objectives. It now has a dedicated page on the SCTS website (<https://scts.org/narg/>). The NARG is open to SCTS nurse and AHP members who are inter-

ested in cardiothoracic research, at any level. The aim is to provide the opportunity to network, seek and offer research support, and to facilitate research collaborations. In addition, NARG members will have access to:

- » a CT Forum research support directory that includes NARG members who are willing to provide research support/mentorship/supervision to other CT Forum members
- » an expanding online research resource library (including relevant funding calls as well as MSc and PhD opportunities)
- » details of research events hosted by the SCTS or other affiliated associations

These initiatives will work in parallel with other SCTS and RCS strategies within the specialty.

Summary

Cardiothoracic surgery attracts a highly capable motivated workforce. When mobilised, the UK delivers high quality research that changes practice. As the specialty evolves to meet the challenges of older and sicker patients, careful evaluation of new technologies as well as indications for surgical treatment will be increasingly important. The research infrastructure and capacity in the UK provides an unparalleled opportunity for SCTS members to define the future scope of cardiothoracic surgery.

Advanced nurse practitioners and surgical care practitioners

Background

The 2015 cardiothoracic surgery workforce report acknowledged the contribution from ‘advanced nurse practitioners / nurse practitioners / surgical care practitioners / specialist nurses and allied health practitioners’, and the invaluable support they offer patients throughout their inpatient journey (page 9). In further recognition of this, the 2019 workforce review will include the extended surgical team incorporating non-medical roles.

Over the last ten years, the National Health Service (NHS) has seen a plethora of job titles develop for nurses and allied health professionals (AHPs) to broadly describe their role; examples include donor care physiologist, critical care practitioner and non-medical consultant in physiotherapy or pharmacy (in addition to those mentioned in the 2015 workforce report). Increasing demands on the NHS as a result of demographic changes and national initiatives to improve services as well as the reduction in junior doctors’ working hours have been major drivers for the flexibility in the way nurses and AHPs work. There is little doubt that changes in legislation giving prescribing authority to nurses and AHPs have had a positive impact, enabling nurses and AHPs to practise more independently and make better use of their skills.

With a financially challenged NHS that is faced with rising cost pressures alongside the development of a seven-day service, non-medically trained staff are a significantly cheaper workforce. Given the right experience, knowledge and skills, nurses and AHPs are able to manage a wide range of complex health needs in an ageing population. Combined with the benefit of a career pathway that allows progression at a clinical level, this is an attractive option for both nurses and AHPs as well as healthcare organisations. Added to this is the growing body of evidence that supports the positive impact that advanced practitioner roles have on patient experience, patient outcomes and patient safety.

To consider all these roles in this report would be unwieldy and impractical. The current review therefore focuses on advanced nurse practitioner (ANP) and surgical care practitioner (SCP) roles, and how they have evolved in the cardiothoracic arena, as well as suggesting what the roles might look like in the future and how they will contribute further to the extended surgical team.

Table 9

The number of ANPs and SCPs at the 14 cardiothoracic units responding to the survey

City	Hospital	ANPs	SCPs	Total
Basildon	Basildon University Hospital	0	6	6
Birmingham	Queen Elizabeth Hospital	10	6	16
Brighton	Royal Sussex County Hospital	8	3	11
Cambridge	Royal Papworth Hospital	23	15	38
Liverpool	Liverpool Heart and Chest Hospital	20	0	20
London	Harefield Hospital	10	3	13
London	Royal Brompton Hospital	7	5	12
Manchester	Wythenshawe Hospital	2	4	6
Manchester	Manchester Royal Infirmary	1	3	4
Middlesbrough	James Cook University Hospital	5	6	11
Oxford	John Radcliffe Hospital	2	7	9
Plymouth	Derriford Hospital	9	8	17
Sheffield	Northern General Hospital	2	7	9
Southampton	Southampton General Hospital	14	5	19
Total		113	78	191

Current practice

Overview

Gathering a baseline of how many ANPs work in cardiothoracic surgery is an almost impossible task. Unlike non-medical prescribers (who are registered with the Nursing and Midwifery Council on successful completion of the relevant course and examinations), there is no regulation of ANPs. Similarly, SCPs currently have no professional body with which they register but a survey by the Association of Cardiothoracic Surgical Assistants indicates that there are approximately 320 qualified cardiothoracic SCPs in the UK, which corresponds to roughly a third of the total number of SCPs in all specialties.

In the UK, although SCPs have a structured training and examination process, there is wide variation in the scope of practice, education and training of ANPs, and no protection of role titles. This is in part due to the lack of clarity around what actually constitutes advanced clinical practice. In November 2017 Health Education England published its multiprofessional framework for advanced clinical practice, which included a definition and summarised the expectation that anyone working at that level

‘will exercise autonomy and decision making in a context of complexity, uncertainty and varying levels of risk, holding accountability for decisions made’.

In order to carry out a national workforce review of ANPs and SCPs working in cardiothoracic surgery, a letter from the President of the SCTS and its Nursing and AHP Representative was sent to all directors of nursing in cardiothoracic centres in the UK and Ireland. The letter requested an indication of how many ANPs and SCPs worked in their respective trust, and asked whether they would be willing to complete a short survey. The response was woefully inadequate: there were only two replies.

Approaching colleagues directly in cardiothoracic centres around the country yielded better results but does not give the national picture. The SCTS is nevertheless grateful to colleagues who submitted complete data for the survey. Common themes became apparent and these are likely to be representative across the specialty.

There were 191 respondents to the survey; 113 (59%) of these were ANPs (or trainees) and 78 (41%) were SCPs (or trainees). The respondents were based at 14 units (Table 9). Over two-

Box 1

Common competencies and tasks undertaken by ANPs as reported in a 2018 SCTS survey (113 respondents)

Competencies and tasks undertaken by ANPs

- » Clerking incorporating comprehensive history taking
- » Physical examination
- » Requesting certain investigations based on differential diagnosis (e.g. 12-lead electrocardiography, chest radiography, arterial blood gas, routinely requested blood tests). Other investigations for which ANPs have authority to request will be based on specialist area.
- » Differential diagnosis and diagnosis
- » Interpretation of results, optimising treatment and management plan
- » Independent non-medical prescriptions – transcribing regular medications on admission to hospital, prescribing new treatment while in hospital, prescribing discharge medications
- » Venepuncture and cannulation
- » Arterial blood gas sampling
- » Initial assessment of the acutely unwell/deteriorating patient (ABCDE assessment)
- » Initiation of non-invasive ventilation
- » Performing a fluid challenge
- » Advanced life support

Generic competencies include education/teaching, application of research and quality improvement methodology, and leadership using critical and reflective thinking.

ANPs work in collaboration with all healthcare professional groups, and recognise when timely and appropriate referral is necessary to facilitate optimal care for patients.

thirds (69%) stated they were involved in audit while 45% were involved in service evaluation and 41% in research. Eighty per cent reported having teaching responsibilities.

Roles and responsibilities

There is an assumption that the service needs of the organisation will dictate how advanced clinical roles develop. For example, where there is a relatively high number of ANPs on the wards and outpatient clinics, the SCPs undertake most of their work in theatre. The opposite is true in organisations where there are fewer or no ANP roles. It is evident that there is growing dependency on these roles. ANPs report that they are included in the junior doctor rota for ward cover, and SCPs are regularly first and second assistants in theatre.

ANPs and SCPs work alongside the medical team as a complementary workstream. They take responsibility for the routine daily management

of patients on the ward, from the time of their admission (clerking, clinical assessment and examination, and prescribing) to the time when they are discharged (medications for discharge and general practitioner correspondence).

As ANPs are integral to the team outside theatre, SCPs are very much part of the surgical team in theatre and their role has developed considerably since 1989 when the main job of the surgical assistant (as they were known then) was to harvest the long saphenous vein. This skill was taught on the job and without any competency-based examinations. Trainees were taught skills such as suturing, haemostasis, tissue closure and opening techniques, and conduit harvesting. The training now involves a curriculum-based master's programme, developed with support from The Royal College of Surgeons of England (RCS) and higher education institutions, with a quality assured examination set up by the RCS and SCTS

in 2014. The Department of Health public consultation on professional registration of SCPs (possibly with the General Medical Council or another professional body) ran from October to December 2017. The findings are awaited.

Boxes 1 and 2 illustrate the common competencies and tasks undertaken by ANPs and SCPs. There are generic features that emerge from both ANP and SCP roles that are unsurprising given the extent of their autonomy, allowing them to practise at a level set within the limits of their competency rather than a pre-defined, role-specific limit. These are:

- » clinical judgement and decision making
- » critical thinking and analytical skills
- » professional leadership and clinical inquiry
- » coaching and mentoring
- » teaching
- » research skills
- » the desire to improve practice

The ANP and SCP workforce of the future

There can be little doubt that sustaining safe and effective cardiothoracic surgical care in the NHS of the future is dependent on non-medical roles and a change in what was previously considered the traditional workforce model. Role boundaries have all but disappeared; wards are staffed with unregistered teams who work alongside registered nurses who in turn are responsible for supervising and directing patient care. Technical interventions such as phlebotomy and cannulation are performed by staff who are trained to undertake these tasks but not necessarily registered with a professional body, such as healthcare support workers.

Roles are increasingly defined and determined by the needs of the service. Nurses and AHPs have risen to the challenge of the reduction of junior doctors' working hours, and evidence suggests that not only is there parity in the

Box 2

Common competencies and tasks undertaken by SCPs as reported in a 2018 SCTS survey (78 respondents)

Competencies and tasks undertaken by SCPs

- » Harvesting conduit for coronary artery bypass grafting (vein or radial artery)
- » Vein mapping
- » Acting as first and second assistant in all cardiothoracic procedures
- » Postoperative wound assessment including application of vacuum pumps
- » Suturing
- » Arterial blood gas sampling
- » Insertion of central lines
- » Clerking
- » Clinical examination
- » Prescribing
- » Venepuncture and cannulation
- » Catheterisation
- » 'SHO [senior house officer] duties on the ward'
- » Ordering investigations and reviewing results
- » Discharge summaries
- » Palliative management
- » Complex discharge planning

service previously provided by doctors but there are in fact many benefits. Timely decision making, an improved patient experience, a more cost effective workforce and greater job satisfaction have been reported.

This has to be countered with a word of caution. Vacancies in nursing are at an unprecedented level, and recruitment into ANP and SCP roles often comes from already overstretched healthcare professions such as nursing. There is much debate on this topic beyond the scope of this review but the SCTS acknowledges that removing skilled, experienced staff from an already depleted workforce has the potential to simply move the problem from one area to another.

In respect of what ANP and SCP roles will look like in the future, the 2018 survey results demonstrated a wide variation in the distribution of ANP and SCP posts among the 11 participating cardiothoracic centres as well as variation in the scope of practice, minimum academic requirement and training. Regulation of these roles remains entirely the responsibility of the employer and depends on local procedures. Following the reports by Keogh and Francis (both published in 2013), it is regrettable that there is still no regulatory body to set the framework of practice and monitor standards, and with whom ANPs and SCPs can register.

In the absence of regulation, the Royal College of Nursing has recently introduced credentialling, a system in which nurses working at an advanced level are invited to be credentialled by the college, having their qualifications, skills and experience recorded. This is entirely voluntary and only applies to nurses. The uptake has yet to be evaluated.

Anecdotal evidence and findings from the 2018 ANP/SCP survey suggest that some organisations have embraced non-medical roles more widely than others. This will be for a variety of reasons but a poorly defined remit of the roles and lack of governance have been major restraints. Moving forwards, professional regulation must be a priority to reduce the random use of titles that may infer a level of clinical expertise that is unverified. Such governance will require engagement and support at a national level. There is much to be

learned from the experience of colleagues in the US and indeed closer to home in Scotland, where progress in such matters is considerably further.

Patient acceptability is crucial to the continuing development of non-medical roles. The technology is available to fly pilotless planes but will passengers ever have the confidence to travel in them? The same might be said for a patient coming into hospital; will patients have the confidence to proceed with their treatment if they know a significant proportion of their care will be managed and delivered by a non-medically trained workforce throughout their inpatient stay? Future research should focus on ways to quantify the impact of non-medical roles through prospective data collection relating to organisational priorities, patient safety and patient expectation, such as length of stay, same day admission and patient satisfaction.

Consistency in the distribution of roles among all cardiothoracic centres is an ambitious goal in light of the current recruitment and retention challenges but organisations need to address this now if there is to be a workforce fit for purpose in ten years' time. Instead of *if*, the default needs to be *when*. Trust boards have to consider flexible, family friendly working to retain staff as well as ways to keep staff motivated and enthusiastic in the workplace. The offer of rotational posts and access to educational opportunities are key factors in staff retention.

SCPs and ANPs will continue to play an important role in the education of junior doctors in theatre and on the wards as well as providing training and support to nurses and other AHPs. In the past, junior doctors have expressed concern about competing for the same training opportunities as SCPs. Now SCPs are regarded as the experts in their role and are frequently responsible for training junior doctors in theatre.

It is incumbent on ANPs and SCPs not only to demonstrate advanced practice but also to consider the concept of *advancing practice* for the benefit of patients, recognising that innovation, education, research and clinical leadership are inherent components to their role as advanced practitioners. The vision for cardiothoracic care in the future is a seamless patient pathway managed by an expert

multiprofessional team delivering evidence-based, patient-centred care.

Summary

Over the next ten years:

- » The ANP and SCP workforce will need to grow considerably to be present in all cardiothoracic centres around the UK, providing cover 24 hours a day.
- » Advanced practitioners will be registered and regulated by a professional body.
- » The definition of advanced practice will be well established and the minimum academic requirement will be at master's level.
- » ANPs and SCPs will lead multicentre research studies.
- » SCPs will develop skills in more complex procedures as well as robotic/minimally invasive cardiothoracic surgery.
- » More SCPs will be awarded honorary fellowship status by the surgical royal colleges. (Currently, two SCPs in the UK have been awarded this: one in general surgery and one in cardiothoracic surgery.)
- » Advanced practitioners will support consultants in the process of consent and shared decision making as part of the multidisciplinary team.
- » Nurse-led discharge and outpatient follow-up clinics will be the rule rather than the exception.
- » Advanced practice and associated outcomes data will be shared and benchmarked against other UK cardiothoracic centres.
- » Advanced practitioners will refer as appropriate, recognising the boundaries of their practice.

Cardiothoracic anaesthesia and intensive care

In 2016 the Association for Cardiothoracic Anaesthesia and Critical Care (ACTACC) produced a far-reaching nationwide survey and subsequent analysis of workforce issues in all adult cardiothoracic centres.¹ The results demonstrated a severe and potentially worsening shortfall in consultant and trainee numbers across the UK. The ACTACC has already fully engaged with the Royal College of Anaesthetists, the Faculty of Intensive Care Medicine, Health Education England and the Department of Health to disseminate its findings, and to discuss potential solutions.

The total number of consultant cardiothoracic anaesthetists in each department varies from 7 to 40 and about 75% of these also undertake sessions in non-cardiothoracic anaesthesia. At present, more than 70% of centres do not have separate on-call rotas for cardiothoracic anaesthesia (CTA) or cardiothoracic intensive care. If these centres were required to provide separate consultant rotas for CTA and cardiothoracic intensive care (as per section 1.1.5 of the current *Guidelines for the Provision of Intensive Care Services*),² then the total number of additional/new consultants needed across the UK would be 78. Consequently, there is little prospect of this situation changing rapidly given the existing shortfall in consultant numbers.

The frequency of on-call commitments varies across centres, from a minimum of 1:5 to a maximum of 1:12. Across the UK, the average frequency for a consultant in general anaesthesia is usually less onerous than 1:8 (which in practical terms equates to one on-call shift every week). This is undoubtedly a

significant factor among trainees when they are considering the future work–life balance as a consultant.

Consultants in approximately a third of centres have totally flexible job plans within the cardiothoracic department (i.e. theatre and intensive care unit sessions flex according to monthly departmental requirements). There is some evidence that job plans with very high levels of flexibility were less conducive to an acceptable work–life balance and less accommodating in terms of consultants delivering non-cardiothoracic lists.

At present, no adult CTA departments have ‘round-the-clock’ resident consultant staffing. Nevertheless, it is worth noting that in general intensive care, there are now an increasing number of trusts around the UK where resident consultant cover is well established.

The total number of anticipated/predictable consultant retirements across the UK within the next 5 years is 71. Newly appointed consultants from the 1990s are now nearing retirement, resulting in a comparative glut of retirements within the next five years. This figure may clearly be subject to an increase if the new consultant contract is perceived as unfavourable.

Worryingly, 50% of UK centres currently have consultant vacancies and of these centres, at least half have two or more vacancies. The majority of centres have advertised consultant posts within the last two years and approximately a third of these posts have not been filled. Only a third of UK centres rated their prospects of recruiting to vacant consultant posts as ‘good’.

Two-thirds of centres offer a senior training fellowship in CTA and most had identified potential

future recruits among these fellows. However, fill rates for specialty training posts in several deaneries have fallen significantly over the last year.

Feedback from members of the ACTACC indicated growing concerns about recruitment and job sustainability in CTA. The formal separation of anaesthesia and intensive care medicine (via the formation of the Faculty of Intensive Care Medicine and separate Certificates of Completion of Training) continues to present real challenges for CTA/cardiothoracic intensive care. Trainee feedback from across the UK has resoundingly demonstrated that there is little appetite or intention among trainees to undertake dual certification in anaesthesia and critical care, in addition to further subspecialty training in CTA/cardiothoracic intensive care. Appointment as a consultant in CTA alone now requires 18 months of dedicated time in the field and formal advanced transoesophageal echocardiography accreditation.

The extent to which the recommendations in the Shape of Training report will be instituted in the National Health Service is still far from clear. It is nevertheless essential that CTA and cardiothoracic intensive care remain an inherent part of the specialty training programmes in both these areas in order to encourage and channel trainees into the specialty.

In addition to the ongoing issues of consultant recruitment, there are also concerns regarding middle grade recruitment in CTA/cardiothoracic intensive care. Many UK cardiothoracic centres employ non-UK-trained graduates on their middle grade rotas and in recent years, a high percentage of these doctors have been recruited from EU countries. The precise implications of Brexit are far from clear but any political process that alters employment eligibility for EU doctors in the UK has the potential to impact negatively on CTA medical staffing.

On a positive note, there has been a rapid growth in the number of cardiothoracic centres employing advanced critical care practitioners in cardiothoracic intensive care units (CITUs) (largely in place of vacant junior medical staff posts). The advanced critical care practitioners project is expanding exponentially across the UK, and these individuals are recognised as being a sustainable and high quality solution for

many mid-tier critical care staffing issues.

Many smaller volume centres currently utilise middle grade cardiothoracic surgeons to staff the CITU out of hours as appropriately trained alternative staff are not available. This has clear implications for surgical training time and the round-the-clock delivery of quality care within an increasingly subspecialised cardiothoracic high dependency/intensive care environment. It also has implications for commissioning/funding given that this arrangement lies largely outside current UK critical care standards.

The ongoing development of regional 'cardiac arrest centres' has led to an increase in the numbers of ventilated out-of-hospital cardiac arrest patients admitted to CITUs. This has inevitably placed further strain on critical care bed availability and it is likely that these numbers will continue to rise. Current efforts, involving cardiology and critical care doctors, are focused on developing an algorithm to determine which patients should (or should not) be accepted into this pathway.

The availability of CITU beds is coming under ever increasing pressure. Although there are calls for the ringfencing of cardiothoracic surgical beds, it is worth noting that there are numerous other conflicting demands. These include local trust and regional critical care network escalation and transfer policies, winter bed pressures and recent legal rulings³ that may have direct implications for admitting out-of-hospital cardiac arrest patients.

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National selection

Background

The decision to adopt a centralisation of recruitment in cardiothoracic surgery was taken in 2007. Traditionally (or at least until the Calman reforms in 1996), this specialty had used the standard system of moving up through the ranks, ultimately achieving a senior registrar post as a springboard towards applying for consultant jobs. With the introduction of national training numbers (NTNs) in the specialty, more structure was added to the recruitment process as a NTN 'guaranteed' a six-year structured training programme with a consultant job at the end of it.

Originally, NTN posts were appointed by specific regions and deaneries. However, a crisis was reached when changes in cardiac surgery (following the failure of the Medical Training Application Service [MTAS] recruitment system in 2007, coupled with a block on recruitment, which had started in 2004) meant there were too many trainees ready for consultant jobs and not enough posts. At one stage, there was an excess of more than 90 trainees 'ready' for consultant jobs, which led to many seeking alternative careers. After the collapse of MTAS, a more centralised system of recruitment was pursued.

Following a significant amount of discussion and consultation within both the SCTS and the Specialty Advisory Committee (SAC), plans were drawn up to hold the first national selection process in 2008. This took place in Birmingham and although it was successful, many lessons were learnt and the system has been in a continual state of improvement since then. Broadly speaking, the system settled with the current generic model in 2011 but changes have been made every year in an attempt to make it the fairest and best method possible for differentiating between candidates. This iterative process is based on what worked well from the deanery perspective but also using feedback

from candidates, assessors and the lay team.

Initially, selection was entirely for entry at ST3 level, offering a six-year training programme and a Certificate of Completion of Training (CCT) date for all appointees. In 2012 a decision was made to broaden this to incorporate a limited number of entries at ST1. This was piloted in cardiothoracic surgery for August 2013 and has been included as a formal process for all consecutive years. The success of ST1 entry has been so great that applications and recruitment numbers at this level continue to rise year on year. This is in contrast to the ST3 numbers, which have declined steadily.

It has been recognised that as one of only two surgical disciplines that offer ST1 entry (neurosurgery is the other), cardiothoracic surgery is effectively getting the pick of the talent at a very early level, which is encouraging for the future of the specialty. In order to appoint a trainee at ST1, deaneries need to demonstrate a formal and varied programme for the first two years, considering that the successful appointee may have been exposed to very little cardiothoracic surgery and often still needs to sit the MRCS examination.

The process

The centralised selection process is under the auspices of the Wessex office of Health Education England (HEE), which runs the entire recruitment programme for cardiothoracic surgery. The whole process has changed in many ways since its inception, in a constant attempt to reach an ideal standard. There are very strict timeframes for each stage of the process, ultimately leading to the formal assessment of shortlisted candidates in the first week of February.

Bid submission

The deaneries are asked in mid-June via their Training Programme Directors (TPDs) to submit their bids for the number of trainees they think they can accommodate in their programme the following year. They must specify a number of ST1 and a number of ST3 trainees (separately), and complete a detailed application form with several domains. It requires a great deal of information, and evidence of training and training capacity as well as evidence of success in the FRCS(CTh) examination and in consultant appointments. The form is usually completed by the TPD and must be signed off by other senior members of the deanery (including the core lead if ST1 trainees are being requested and importantly, the Postgraduate Dean).

All the bid forms that are received on time are scored by the national selection leads representing the SAC according to a strict numerical matrix. The scores are collated and the applications ranked. It is certainly possible for a very poor (substandard) application to be dismissed if it is thought not suitable for award of a trainee so it is important that the forms are completed meticulously.

Workforce planning

In consultation with the SCTS, the SAC Chair performs a workforce planning exercise to try to establish how many NTN should be appointed at each level, based on the projected CCT dates and the numbers of likely consultant jobs available in those future years. Clearly, this is an inexact science but an estimate must be made and it is important to avoid excesses (which would lead to qualified trainees not getting jobs, as happened prior to the introduction of national selection). These 'bulges' are monitored very carefully and advice is given to the national selection leads regarding the number of trainees to be offered.

Normally, at ST1 level, all deanery bids/applications of a satisfactory standard will be granted the numbers of trainees applied for. Conversely, at ST3 level, owing to the mass effect of previously appointed ST1 trainees moving through into their ST3 year, caution must be applied when deciding on numbers to award. If the number of NTNs requested on the

application forms is in excess of the numbers that the SAC and HEE Wessex have deemed appropriate, then offers will be made to the highest ranking deaneries until the prescribed number is reached. This will mean that some deaneries will not get the NTNs they applied for, demonstrating the importance of submitting a high quality bid form.

This 'rationing' is a new phenomenon (occurring for the first time in 2017) since the first ST1 trainees have only been in play for five years and are starting to make their presence felt in terms of workforce planning numbers. In essence, the more ST1 trainees are appointed, the fewer places there will be for ST3 entry two years later. This is a factor that needs to be appreciated by the TPDs when preparing their bid forms. The direction of travel shows a clear swing towards ST1 entry and the quality of the applicants is very high. However, more SACs from other surgical specialties are likely to adopt ST1 entry in the near future, which could create a more diluted pool and greater competition for the best candidates.

It is important to note that in order to be eligible for ST1 entry, candidates are only allowed to have spent a maximum period of 18 months in cardiothoracic surgical posts. There is no such maximum time or restriction for ST3 entry although from the start of the process in 2008, a 'time versus experience' operative matrix has been used to try to 'screen in' trainees making the best progress.

There is no limit on the number of times that candidates can apply for ST3 entry. This creates a worrying situation of 'frequent flyers', where some poorer candidates who have 'learnt' how to be shortlisted on the basis of their form keep having multiple attempts at national selection. This may exclude some potentially stronger candidates from being shortlisted for the assessment process. The concept of limiting the number of attempts is a contentious issue, and has been addressed by the Department of Health and the General Medical Council but is still under discussion.

Advertising the posts

The advertisements go out in the autumn, once the offers have been made and it has been

established how many posts are available nationally (and in which deaneries). At present, there are two different processes for application at ST1 and ST3. ST1 candidates must fill in a structured online application form and submit it to HEE Wessex. Each form is marked by a panel of three assessors (consisting of TPDs and SAC members) and an aggregate score is recorded. The candidates are then ranked accordingly.

For ST3 entry, candidates submit a self-assessment form based on their portfolio. The scoring is derived from a matrix that is provided to the candidates. Some of the scores are weighted according to time spent in the specialty. A total score is calculated, which is submitted to HEE Wessex along with the candidate's form. Once again, candidates are ranked but the ranking is entirely dependent on the honesty of the candidates when completing the forms. Although a 'checking' process to weed out discrepancies and errors is carried out by the deanery, this cannot be foolproof.

The final layer of scrutiny for ST3 candidates takes place at the portfolio review station and during the quality assurance process carried out by the assessors on the assessment day itself but of course by this stage, it is too late to offer a place on the shortlist to any unsuccessful candidates. If a probity issue or score discrepancy is discovered here, the candidate is simply asked to withdraw from the process. This is an area that needs to be tightened up and it is likely that a method similar to that for ST1 ranking will be adopted. Interestingly, this was the system for ST3 in the early years of national selection.

Shortlisting

Once the candidates have been ranked, the list of candidates is assessed and a decision made as to how many to invite for the national selection assessment process. This is based directly on the number of posts on offer in that particular year. (See section on workforce planning above.) In general, a ratio is selected of between 2 and 2.5 candidates per post available. Consequently, if there are 10 ST1 posts available, between 20 and 25 candidates will be invited to national selection assessment. The decision of exactly how many to invite and where to make the cut-off

is based on finding a clear gap between scores (usually at least 2 or 3 points). This avoids somebody missing out by being only 1 point behind another candidate.

There is discussion around whether to have a fixed cut-off score that is identical every year. At present, this would not be robust because of the variables involved in the scoring programme although it is hoped to move towards this in the future.

Assessment

The national selection assessment runs over two days at the beginning of February. For the past six years, it has been held at Botley Park Hotel near Southampton, which provides an ideal environment in terms of rooms and infrastructure. ST1 and ST3 stations had always been mixed across the two days until 2018, when the two applicant groups were each assessed on different days: ST3 on day 1 and ST1 on day 2. This minimises confusion and logistical issues, and will be adopted as the standard model for the future. It also avoids any difficulties for the assessors in gauging the level of knowledge or ability expected from a particular candidate.

Prior to the assessment process commencing, the national selection leads or relevant deanery are notified of any conflicts of interest in order to avoid situations where assessors and candidates know each other. A table of assessor pairs and candidates is drawn up, trying to ensure that each candidate meets different pairs of assessors across the process.

The actual assessment consists of a number of stations (Box 3), each overseen by a pair of assessors. Scoring is always out of 100, 25 points being available for each of the assessment stations. (For ST1 candidates, the shortlisting score is used as a surrogate for the ST3 portfolio review station.) Each station lasts for 30 minutes (including 5 minutes for scoring) but the objective structured assessment of technical skills (OSATS) is divided into two stations of 30 minutes each, the first being video assisted thoracoscopic surgery/knot-tying and the second being excision of skin lesion (for ST1) or anastomosis (for ST3).

For ST3, formal quality assurance takes place behind the scenes to check the portfolios in

Box 3

Stations at the assessment days for ST1 and ST3 applicants

ST1

- » Structured questions (5 scenarios/questions)
- » Communication skills
- » OSATS (video assisted thoracoscopic surgery/knot tying/excision of skin lesion)

ST3

- » Portfolio review
- » Structured questions (5 scenarios/questions)
- » Communication skills
- » OSATS (video assisted thoracoscopic surgery/knot tying/anastomosis)

detail. While specific questions are asked of the candidates at the portfolio station relating to domains such as research, audit and operative experience, the portfolio quality assurance process is different. Each portfolio is checked meticulously by a pair of assessors for discrepancies and probity issues. The findings are cross-referenced with the score/comments for the portfolio station, and presented formally to a panel comprising the national selection leads, the Wessex Dean and a lay chair for signing off (or otherwise).

Scoring has traditionally been performed 'longhand' with multiple scoresheets being collated by an administration team. However, in 2018 an electronic version was piloted. This involved each assessor being given a uniquely registered e-tablet on which they entered their scores and comments. This information was transmitted wirelessly in real time to the central coordination computer run by the deanery lead for national selection. Any discrepancies or problems could be flagged up immediately.

Notification of results

Once the scores have been collated and checked, the results are analysed by the national selection leads and a cut-off point is decided, hopefully appropriate to the number of posts available. If two or more scores are very close around the cut-off point, it is up to the discretion of the Wessex Dean (following discussions with the Postgraduate Dean of that particular region

and the SAC Chair) whether to award any extra posts. Usually, a clear cut-off point is achieved that matches the number of posts available.

All candidates will have previously ranked the deaneries in their order of preference. This enables HEE Wessex to perform an electronic 'matching' process. The top ranked candidate will get their first choice but the next successful candidate on the list will only get their first choice if it has not already been taken by a candidate ranked above them. In this case, they will be offered their second choice and so on.

Once candidates have been informed of the rotation they are being offered, they have a limited period of time to accept, hold (until a nationally set deadline) or decline the offer. In the event of a post being declined, the offer is made to the next ranked person on the 'reserve list', assuming the overall score has been deemed satisfactory for appointment. The deaneries and TPDs are then notified of the numbers of the NTN trainees that they will be receiving so they can prepare the rotations accordingly.

Data and results**Applications and appointments for ST3**

Figure 18 shows the steady decline in both applications and appointments at ST3 following the initial wave of enthusiasm in 2009/10 after the process was introduced in 2008. There was a lot

Figure 18
Applications and appointments for ST3

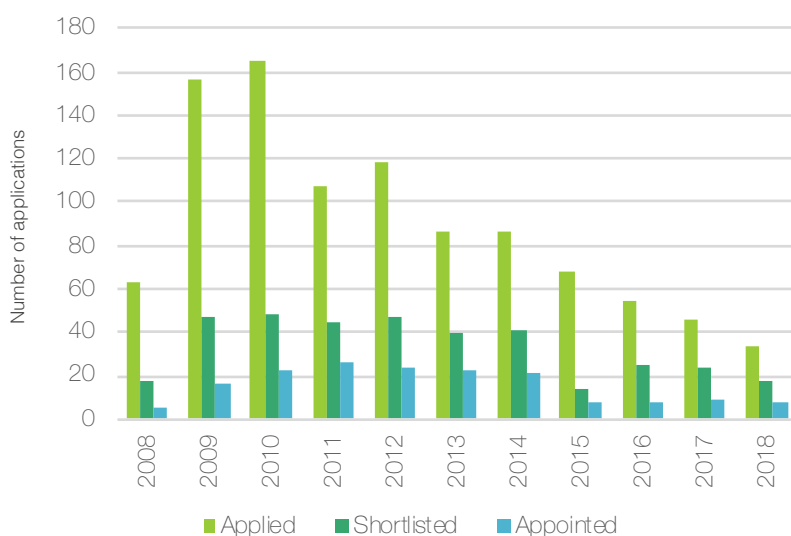
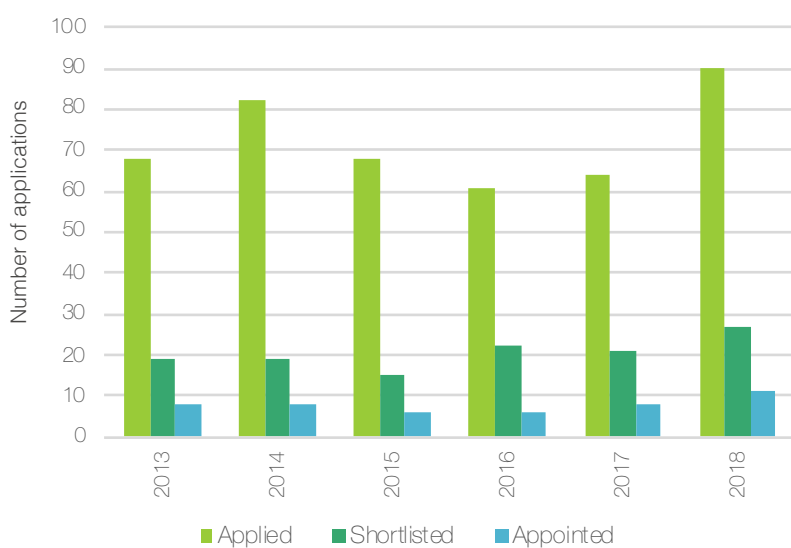


Figure 19
Applications and appointments for ST1



of fine tuning of the national selection process over the first few years but since the current generic model was adopted in 2011, a clear pattern of decline in ST3 applications has been seen, reflecting the 'supply and demand' nature of the workforce planning information.

The shortlisting and appointment numbers for ST3 have remained very stable over the past four years. Nevertheless, 2018 is the first year where trainees who were originally appointed at ST1 have reached and passed beyond ST3 within

their deaneries. This means they are already occupying training slots, thereby reducing the numbers available to the ST3 bidders. As a result, ST3 numbers had to be rationed and some deaneries were not awarded the numbers they bid for, despite having submitted a satisfactory bid form.

Applications and appointments for ST1

Since its introduction in 2013, entry at ST1 has been remarkably consistent, with similar

numbers of applicants and appointments until a significant (and as yet unexplained) rise in 2018 (Figure 19). It has been observed at national selection assessment that the overall quality of shortlisted candidates is outstanding and that there are never any concerns about appointed candidates being fit for selection.

The general pattern is of a reduction in ST3 numbers and an increase in ST1 numbers. The reasons for this are multifactorial but it is clear that some ST3 candidates are on their third or fourth attempt at national selection and this raises concerns among the assessors about the ability to 'game' the system, having been in middle grade 'registrar' posts for many years (sometimes even in excess of ten years).

At ST1 entry, candidates are rarely allowed more than one attempt owing to ineligibility if they have spent more than 18 months in the specialty. At ST3 level, there is currently no such regulation, leading to multiple attempts (some of which are successful) by candidates who are perhaps not of the highest standard. There is work in progress to rectify this, potentially through introducing regulation or a system where candidates score less on the application form the more time they have spent in the specialty.

for ST3 and replacing it with an online application form to be scored by three assessors (as per ST1). This would reduce the need for such rigorous portfolio quality assurance at the national selection assessment day as this could instead be performed during the shortlisting phase, thereby preventing any candidates getting through to the assessment stage under false pretences.

- » putting a maximum number of attempts in place for ST3 entry.

There will undoubtedly be continual adjustment as this is a dynamic process. The direction of travel appears to be towards ST1 entry although it is unlikely that ST3 entry will cease in the near future owing to the strict conditions of eligibility for ST1 applicants. Possibly the most serious issue to tackle is the prediction of numbers required in the future and therefore the numbers of posts to offer. This is the domain of the workforce planning project and it needs to be as accurate as possible to avoid unwanted 'bulges' in future years, where there are not enough jobs available for trainees.

Summary

National selection has been an outstanding success in cardiothoracic surgery since its introduction and the adoption of ST1 entry has enhanced this further. The current model seems to work well but there are ongoing evaluations and assessments to avoid complacency, and to ensure good levels of differentiation and fairness. Constant re-evaluation of the stations (particularly OSATS) guarantees that the discriminatory power between candidates is high. If a station is deemed to have low discrimination, it needs to be adapted or substituted with a new station.

Changes that are probably also required include:

- » restructuring the deanery bid forms and coordinating the scoring system accordingly in line with the domains
- » removing the self-assessment scoring

The cardiothoracic curriculum

Background

The curriculum in cardiothoracic surgery is undergoing its first major overhaul since 2007. There are ongoing discussions with the General Medical Council (GMC) about how the curriculum will look from August 2019 onwards but this has yet to be finalised. The GMC has outlined how it would like to see curricula developed, with particular reference to compliance with the principles described in the report from the Shape of Training steering group published in March 2017. The major driver of change in the specialty is the recognition that UK consultants are no longer being appointed into cardiothoracic surgery but rather into cardiac or thoracic posts (and a few into congenital surgery).

The Intercollegiate Surgical Curriculum Programme was first launched in 2007. At that time, it was expected that trainees would acquire ‘the clinical knowledge, the surgical expertise and the professional skills necessary for consultant practice in the UK’. This included ‘competence in the management of patients presenting with [...] conditions as specified in the core syllabus for the specialty of cardiothoracic surgery’. In particular, there was an expectation that a trainee would become competent in both cardiac and thoracic surgery. It was specified that this would have to be demonstrated for surgical skills, not just clinical knowledge. However, it was also recognised that many trainees would want to develop a special interest in one of the many branches of the specialty (such as congenital, transplantation, oesophageal or academic surgery).

It has been apparent for many years that demonstrating advanced technical skills in both cardiac and thoracic surgery to the level

required for independent consultant practice is not realistic for most trainees in the current training environment. It is also clear that very few (if any) jobs in mixed practice cardiothoracic surgery are likely to be advertised in anything other than small, geographically isolated units.

Selection into training posts

At present, trainees may enter training via two different routes and this is likely to continue. Those following a ‘run through’ programme will enter cardiothoracic surgery training via a national selection process at ST1 and will follow the core surgery curriculum for the first two indicative years. Trainees following a ‘decoupled’ programme will enter cardiothoracic surgery training via a national selection process at ST3, having first completed the core surgery curriculum. The curriculum that is currently under consideration has proposed that the training is split into two phases.

Cardiothoracic Surgery training is outcome-based rather than time-based. However, it will normally be completed in an indicative time of seven years (three years for phase 1 and four years for phase 2) for those entering run through training at ST1 (formerly eight years in the 2015 curriculum) and six years for uncoupled trainees entering at ST3 (two years in phase 1 and four years in phase 2).

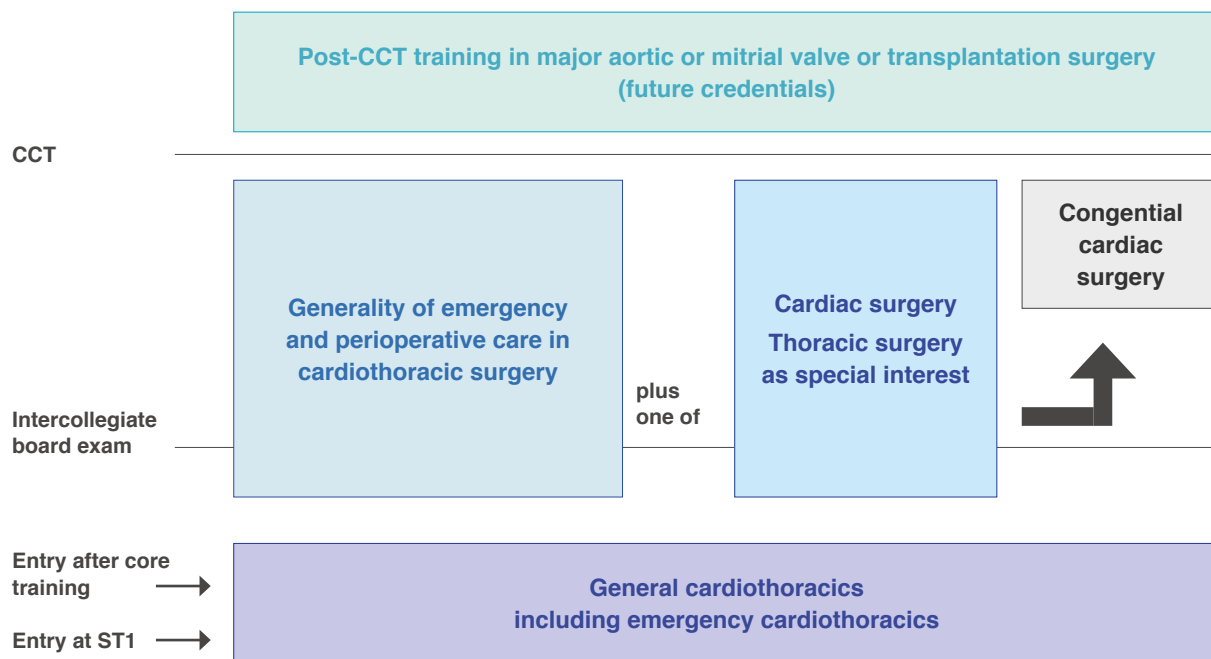
The programme will be divided into two phases:

Phase 1 of training

Phase 1 will take an indicative time of three years to complete for run-through trainees, during which trainees will gain many of the GPCs and

Figure 20

The proposed training pathways



*Congenital cardiac surgery training: competitive entry via national selection process after passing ICB exam

the knowledge, clinical and technical skills in both cardiac and thoracic surgery, as defined in the syllabus. Uncoupled trainees should have acquired generic skills, both technical and non-technical, during core training, and it is anticipated that an indicative time of two years after entry into cardiothoracic training will be required to achieve competencies required for completion of phase 1. At the end of phase 1 there is a critical progression point for phase 2 entry, assessed at the Annual Review of Competence Progression (ARCP), where trainees will demonstrate competencies in knowledge, clinical skills and professional behaviours commensurate with the syllabus and GPCs.

By the end of phase 1, trainees will follow a special interest in either cardiac or thoracic surgery after discussion with the Training Programme Director (TPD). The special interest choice will be facilitated based on the needs of the service, the preference of the trainee, the trainee's skills and the ability of the programme to support the trainee in that special interest. Where a programme cannot facilitate the agreed special interest needs of trainees, Out

of Programme Training (OOPT) can be used. In exceptional cases, and with specific TPD and deanery or LETB support, cardiothoracic surgery may be chosen as the special interest. Trainees will need careful counselling before following this route as it is likely to require extra training time. There are few geographical areas within the UK requiring such surgeons and central monitoring of these posts will be undertaken by the SAC and the Society for Cardiothoracic Surgery to ensure supply matches demand.

Phase 2 of training

Phase 2 will take an indicative time of four years to complete, during which trainees will train predominantly in either cardiac or thoracic surgery, with the exception of a small number who may train in cardiothoracic surgery to fulfil local requirements.

During phase 2 of training it is expected that trainees will continue to be involved in the care of both cardiac and thoracic patients while on call to continue gaining the knowledge and clinical skills in the generality of cardiothoracic surgery. Trainees will continue to develop GPCs

and knowledge, clinical and technical skills in their special interest as described in the CiPs and the syllabus.

To apply for a first sitting of the Joint Committee Intercollegiate Exam in Cardiothoracic Surgery a trainee will have demonstrated the knowledge and clinical and professional skills of a day-one consultant in cardiothoracic surgery as defined by the syllabus. It is anticipated that most trainees will reach this level within two years of entering phase 2 of the curriculum.

Training in congenital cardiac surgery will be available during phase 2 for a small number of trainees, who will be able to apply through a national selection process after passing the Intercollegiate Board Exam in Cardiothoracic Surgery. Training in the subspecialty of congenital cardiac surgery will take an indicative time of two years (total time in phase 2 will still be four years).

In this outcomes-based curriculum, some trainees may reach the end of phase 2 in less than the indicative time. On completion of phase 2 trainees will be eligible for certification and for recommendation to enter the specialist register. Trainees who do not meet the requirements of phase 2 within four years may require an extension of training time in accordance with the Gold Guide.

Certification

By certification (CCT), a newly appointed consultant cardiothoracic surgeon will be able to assess, investigate, diagnose and manage (up to the point of operation) patients presenting with all surgical conditions of the thorax and its contents requiring elective or emergency treatment. The difference compared with the current curriculum will be that the surgeons will only be expected to be able to perform the operative interventions within their own chosen interest or subspecialty (cardiac, thoracic or congenital). Of note, the specialty will continue to be recognised at CCT as cardiothoracic surgery by the GMC (and not as two separate new subspecialties of cardiac and thoracic surgery).

At present, most centres providing

cardiothoracic surgery have separate consultant on-call rotas for cardiac and thoracic surgery. In a number of centres, however, a consultant may be required to be on call for both cardiac and thoracic surgical emergencies. In most cases, this is for a cardiac surgeon to cover thoracic emergencies. For more complex cases, this is usually up to the point of operative intervention if the case can wait until a consultant specialising in thoracic surgery becomes available. A lot of simpler emergencies (such as chest stabbings or pneumothoraces) are well within the remit and capabilities of a cardiac surgeon.

It would be unusual for a thoracic consultant to be on call for cardiac emergencies as these tend to require specialist input much more quickly and, in general, are far more common. In particular, a lot of cardiac out-of-hours operating relates to complications and bleeding from operations performed earlier that day, and these cannot be delayed until specialist input arrives.

The proposed curriculum would require trainees to be on call for both thoracic and cardiac emergencies throughout most of their training so as to gain experience, knowledge and skills in both special interests. This arrangement is what exists currently and would suit most training centres as it would usually be very difficult to staff two separate on-call rotas at junior (national training number) level.

Training in cardiothoracic surgery

The curriculum will continue to allow training in the joint special interests of cardiac and thoracic surgery to CCT/consultant level. It is expected that the training time will need to be extended to allow this. Trainees wishing to pursue this route will need very careful counselling by their TPD and the annual review of competence progression panel at the end of phase 1 of training as well as by the deanery and most likely the Specialty Advisory Committee as very few consultant jobs are likely to be available in the joint special interests at the end of training (with the exception of a handful of small, geographically remote units).

Credentialling

The GMC is proposing to bring in 'credentialling', which is defined as 'a process which provides formal accreditation of competencies (which include knowledge, skills and performance) in a defined area of practice, at a level that provides confidence that the individual is fit to practise in that area'. The details of this have yet to be agreed but the current suggestion is that a credential may be 'broad' or 'narrow' and at either pre- or post-CCT level.

In due course, the special interests of cardiac surgery and thoracic surgery could each become broad credentials obtained prior to award of the CCT. This would enable formal recognition of the training pathway followed and skills acquired for the reassurance of the public and employers. It would also allow flexibility and formal recognition for established consultants who wish to change their area of practice within the specialty.

In addition, a small number of trainees will train in the subspecialty of congenital cardiac surgery. The curriculum also permits a limited number of trainees to train in the special interests of both cardiac and thoracic surgery after full discussion with the AES, TPD, Head of School and Postgraduate Dean.

Congenital cardiac surgery is currently a formal subspecialty. In time, it could become a pre-CCT credential. As a credential, it would be open to established consultants who wished (and were required by the service) to develop skills in this area during their careers.

Other areas that would be suitable for narrow credentials include transplantation, major aortic surgery, mitral valve surgery, transcatheter aortic valve implantation, pulmonary thromboendarterectomy, mesothelioma surgery, tracheal reconstruction and robot assisted thoracic surgery. These could all be achieved within the final year of training or following award of the CCT (as a specialist credential).

Controversies

Oesophageal cancer was often the domain of the thoracic surgeon historically but it now usually sits within an upper gastrointestinal cancer

multidisciplinary team, the surgery largely being performed by general surgeons with a special interest in upper gastrointestinal surgery. Very few newly appointed thoracic surgeons have the time to commit to oesophageal surgery and training in oesophageal surgery for cardiothoracic trainees does not currently exist in most regional training programmes. It is no longer thought sustainable to expect training or competence in oesophageal surgery for cardiothoracic trainees. It is proposed to remove oesophageal surgery from the new curriculum as this now forms part of the general surgery curriculum. It is possible that oesophageal surgery will become a joint specialist credential within the upper gastrointestinal and cardiothoracic curriculum for those wishing to pursue this area in the future.

At present, the duration of training in cardiothoracic surgery is eight years (if two years of core training time are included). The GMC has proposed a pilot of reducing training time to seven years in total for those entering 'run through' training at ST1. This will be achieved by reducing phase 1 to just three years, followed by four years at phase 2. Trainees entering 'decoupled' training at ST3 will continue to require eight years (two years to complete phase 1 followed by four years in phase 2). This would be contingent on splitting the training into just one of the two special interests of thoracic or cardiac surgery during phase 2 of training and also on the introduction of credentialling in many of the superspecialist areas at the post-CCT stage (and these skills would therefore be removed from the curriculum).

For this to be feasible, time in cardiothoracic attachments at core level will need to be increased from the current 6–12 months to probably 12–18 months. This, however, would need agreement from the core training programmes (owing to the impact on other parts of core rotations). It would also probably necessitate concentrating trainees in units where case numbers and delegation rates for operative procedures are high enough to gain the necessary operative competencies within the suggested timeframe.

The cardiothoracic exam

Background

In order to obtain specialist registration in the UK, it is necessary to have demonstrated a level of knowledge equivalent to that required for the specialty fellowship examination. This exam is designed to test candidates to the level of a 'day 1 consultant' in the generality of the specialty.

The exam is administered by the four surgical royal colleges through the Joint Committee on Intercollegiate Examinations (JCIE). Each surgical specialty has a representative board that sits as a subcommittee of the JCIE, and manages the running and development of the exam with the assistance of the JCIE secretariat. Oversight of the performance of the examination is provided through an independent assessment arm of the JCIE, known as the Internal Quality Assurance Committee (IQA). The IQA, along with the exam board for each specialty, ensures the examinations are valid, reliable and fair.

Structure of the cardiothoracic exam

Part 1

This takes the form of a 'written' paper and is undertaken remotely, currently through the Pearson VUE® test centre network. The questions are posed in 'extended matching items' and 'single best answer' format. Each examination is blueprinted to the curriculum to ensure the breadth of the specialty is scrutinised.

Once the exam has been taken, the 'eligibility to proceed' mark of the part 1 exam is determined at a standard setting exercise, with

a panel of examiners using the Angoff method. Successful candidates are invited to the oral examination (part 2).

Part 2

This takes the form of an oral examination over two days. The first day is conducted with patients; it takes the form of short and long cases in both cardiac and thoracic surgery. The second day involves a viva voce in both cardiac and thoracic surgery. Prior to the commencement of the examination, examiners spend some time determining the appropriate standard for the clinical and viva sections of the exam. Examiner standards and behaviour are assessed independently by a panel of exam assessors.

The exam costs £1,849 (as at November 2018). This fee includes both parts 1 and 2.

Proposed developments

Looking forwards, the examination is likely to change with the proposed amendments to the curriculum. It is possible that there will be an additional viva voce in the candidate's chosen subspecialty (i.e. cardiac or thoracic surgery). This will allow a greater breadth of the specialty to be examined. Currently, there are no proposals to alter the level of the exam.

Furthermore, in the future, the sign-off and eligibility arrangements for NTN and non-NTN exam applicants may be harmonised. There are different requirements for these groups at present.

Education in cardiothoracic surgery

Background

The SCTS delivers education to all multidisciplinary practitioners involved in cardiothoracic surgery, including consultant surgeons, nationally appointed specialty registrars (surgical trainees), non-nationally appointed registrars (fellows), and allied health professionals such as nurses, advanced nurse practitioners, surgical care practitioners and physiotherapists. Education is delivered through a wide variety of opportunities, such as training courses, webinars and an operative video library, to impart knowledge and teach practical skills, as well as travelling fellowships, to enable practitioners to develop a new way of working and delivering care.

Courses portfolio

The SCTS offers a portfolio of 12 curriculum-aligned, simulation-based training courses for cardiothoracic trainees (Figure 21). It encompasses their entire cardiothoracic surgery syllabus, and involves small group interactive teaching sessions, wet lab technical skills sessions and (uniquely) live operating. These courses are delivered free of charge to the trainees (including registration, travel and accommodation) through financial support from industry.

This is the only portfolio of curriculum-aligned, simulation-based cardiothoracic surgery training courses that exists throughout the world and no such portfolio of courses exists in any other surgical specialty. In 2016 it won the Association of Surgeons in Training surgical education

and training prize, and it has been presented at major international conferences (European Association for Cardio-Thoracic Surgery and American Association for Thoracic Surgery) as well as in a paper in the *Journal of Thoracic and Cardiovascular Surgery* (in December 2017), with two supportive accompanying editorials. Research assessing the outcomes of the courses has demonstrated a significantly positive impact in terms of reaction (Figure 22), learning (Figure 23) and behaviour (Figure 24), three of the four levels of Kirkpatrick's model of training evaluation. There has also been significant improvement in the FRCS(CTh) examination pass rates following implementation of the courses (95% vs 76%).

Other educational initiatives

In addition, the SCTS runs leadership and professional development courses for consultant surgeons; clinical update, professional development and wet lab courses for non-national training number trainees; practical skill-based courses for nurses and allied health professionals; and the SCTS-Ionescu University programme for all cardiothoracic surgical practitioners.

Travelling fellowships (provided by the generosity of Mr Marian Ionescu and educational grants from industry) are awarded by competitive application. These offer all practitioners of cardiothoracic surgery the opportunity to travel to another cardiothoracic surgical institute to learn a new technique. The goal is to enhance the specialty of cardiothoracic

Figure 21
Portfolio of curriculum-aligned, simulation-based training courses

	ST2 (Dec)	ST3 A (Nov)	ST3 B (May)	ST4 A (Dec)
CARDIAC	Essential Skills in Cardiothoracic Surgery <ul style="list-style-type: none"> » Cardiac anatomy » Conduit anatomy » Cardiac preoperative assessment / risk stratification » Cardiopulmonary bypass » Sternotomy and LIMA harvest » Saphenous vein harvest » Radial artery harvest » Aortic cannulation and decannulation » Angiography » Echocardiography / ECG » Re-exploration for bleeding and tamponade » Basic ITU management 	Introduction to Specialty Training in Cardiothoracic Surgery <ul style="list-style-type: none"> » Cardiopulmonary bypass » Myocardial protection » CPB emergencies » Aortic cannulation and decannulation » Venous cannulation and decannulation » Proximal coronary anastomosis » Distal coronary anastomosis » Aortic valve replacement » Angiography » Echocardiography (TTE) » Cardiac surgery scenarios 	Cardiothoracic Intensive Therapy and Surgical Access <ul style="list-style-type: none"> » Live animal operating: median sternotomy » IMA harvest » Aortic / venous cannulation » Cardioplegia cannulation » RSPV / apical vent placement » Sternal closure » Emergency re sternotomy » Cardiothoracic ITU management and monitoring » Cardiac Advanced Life Support (CALS) protocols » ECG, arrhythmias and pacemakers » Hypotension, low cardiac output syndrome and inotropes » Oliguria and renal support » IABP insertion » Management of postoperative bleeding (including TEG) » Haemostasis 	Core Cardiothoracic <ul style="list-style-type: none"> » Mitral valve » Tricuspid » Atrial fibrillation » Atrial septal » Infective endocarditis » Pericardial » Cardiac » Massive » Redo cardiac » Femoral » Cardiac » Advanced
	THORACIC <ul style="list-style-type: none"> » Thoracic anatomy » Thoracic pathology » Thoracic pre-operative assessment / risk stratification » Cardiothoracic incisions and access » Chest drainage, VATS port placement and stapling » Thoracotomy » Chest x-rays » Cardiothoracic imaging (CT, MRI, PET) » Bronchoscopy and ventilation » Thoracic postoperative management 			ST4 B (June) Core Thoracic <ul style="list-style-type: none"> » VATS techniques » Bullectomy » Resection » Pulmonary » Pneumothorax » Lung cancer » Solitary pulmonary nodule » Pulmonary » Mediastinal » Pleural effusion » Pneumothorax » Mesothelioma » Empyema » Chemotherapy » Mediastinal » MRI / PET » Lung function
PROFESSIONAL DEVELOPMENT	<ul style="list-style-type: none"> » National selection: <ol style="list-style-type: none"> 1. Interviewer's perspective 2. Interviewee's perspective » Life as a day 1 ST3 	<ul style="list-style-type: none"> » Life as a specialty trainee » Expectations of a consultant 		

ST5 A (Jan)	ST6 AB (Feb)	ST7 A (March)	ST8 A (April)	
<p>Cardiac Surgery Course</p> <ul style="list-style-type: none"> » Coronary artery disease » Valvular disease » Infective endocarditis » Thoracic aortic disease » Angiography » Echocardiography » ECG » CT scans (aorta / tumours) » MRI – viability » Cardiothoracic ITU scenarios » Congenital cardiac surgery 	<p>Cardiothoracic Surgery Sub-Specialty Course</p> <ul style="list-style-type: none"> » Off-pump coronary artery bypass grafting » Advanced mitral valve repair » Minimally invasive AVR, including hemisternotomy and TAVI » Thoracic aortic surgery » Aortic dissection surgery » Heart transplantation » Ventricular assist devices » Extracorporeal membrane oxygenator (ECMO) 	<p>Revision / Viva Course for FRCS(CTh)</p> <ul style="list-style-type: none"> » Coronary artery disease » Aortic valve disease » Cardiopulmonary bypass » Cardiac ITU management » Mitral / tricuspid valve disease » Arrhythmia surgery » Heart failure, cardiac tumours, pericardial disease and trauma » Thoracic aortic disease » Congenital cardiac disease 	<p>Cardiac Surgery Pre-Consultant Course</p> <ul style="list-style-type: none"> » Aortic dissection » Aortic arch surgery » Post-infarct VSR, PM rupture, LV rupture » Aortic transection » Infective endocarditis » Emergency CABG » CPB emergencies » Cardiac trauma » Decision making / scenarios 	
			<p>ST8 A (April)</p>	
<p>Thoracic Surgery Course</p> <ul style="list-style-type: none"> » Lung cancer » Mesothelioma » Pneumothorax » Pleural effusion » Empyema » Mediastinal masses » Airway management » Postoperative care of a thoracic surgical patient » Pulmonary disease » Lung function tests » CT / PET / MRI/ VQ scans » Thoracic instruments 	<p>Thoracic Surgery Pre-Consultant Course</p> <ul style="list-style-type: none"> » VATS lobectomy » Sleeve resection » Tracheal surgery » Emphysema surgery – LVRS / EBV » Pectus surgery » Chest wall reconstruction » Lung transplantation » Oesophageal surgery » Oesophageal investigations – manometry / pH / EUS / BaS 	<p>Thoracic anatomy / radiological imaging</p> <ul style="list-style-type: none"> » Thoracic anatomy / radiological imaging » Oesophageal physiology / function tests » Thoracic physiology / PFTs » Mediastinal masses » Pleural diseases » Oesophageal disease » Lung cancer » Pulmonary parenchymal disease » Thoracic instruments 	<p>Thoracic Surgery Pre-Consultant Course</p> <ul style="list-style-type: none"> » Bronchopleural fistula » Massive haemoptysis » Oesophageal perforation » Airway emergencies » Thoracic trauma » Decision making / scenarios 	
	<p>ST5 B (July)</p>		<p>ST7 B (Sep)</p>	<p>ST8 B (Oct)</p>
<p>Non-Technical Skills for Surgeons (NOTSS) Course</p> <ul style="list-style-type: none"> » Decision making » High performance team working » Situation awareness » Task management » Leadership » Communication skills 		<p>Clinical Examination Course for FRCS(CTh)</p>		<p>Leadership and Professionalism Course</p> <ul style="list-style-type: none"> » Leadership » Consultant interviews » Personal effectiveness » Delivering excellence in healthcare » Medicolegal issues » Duty of candour » Good clinical practice

Figure 22

Improvement in reaction (level 1 of Kirkpatrick's model of training evaluation) demonstrated by quantitative assessment of teaching sessions, faculty, content and materials, and organisation/facilities, using a five-point Likert scale (1 = poor, 5 = excellent)

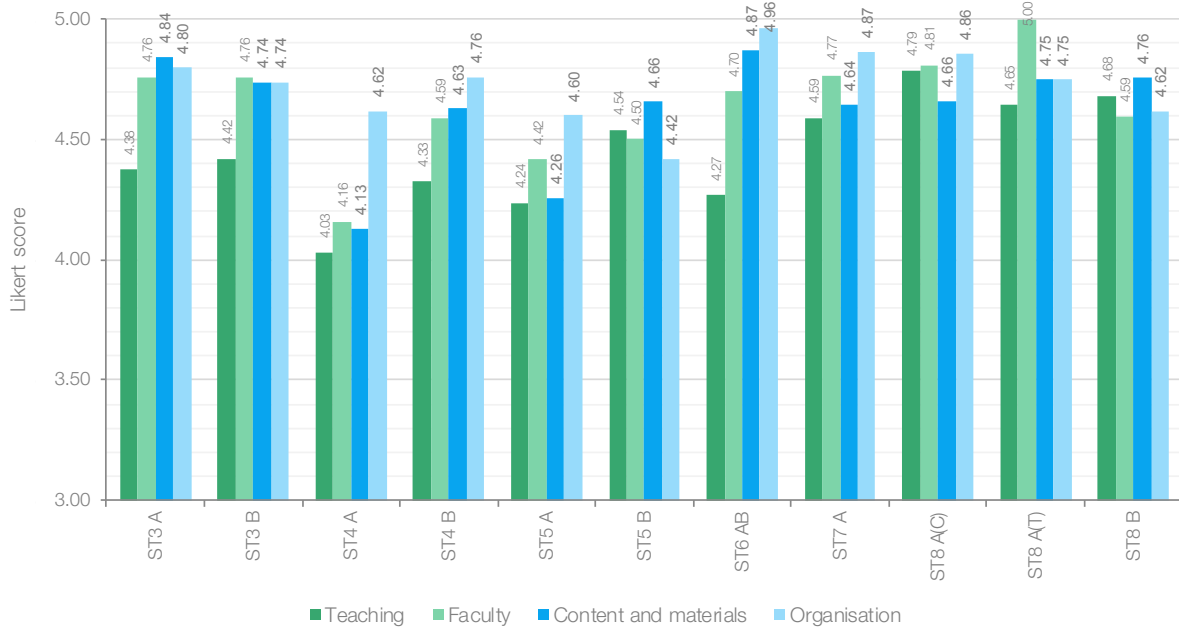
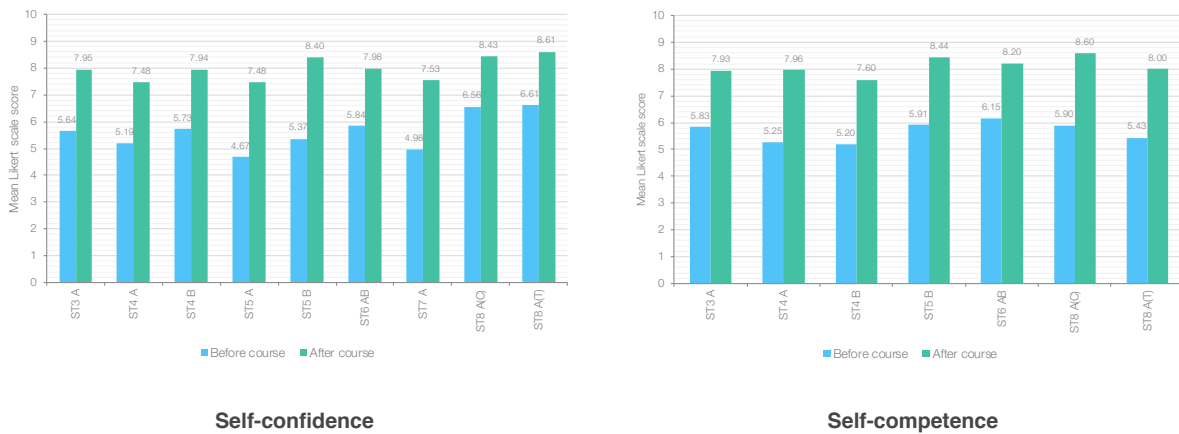


Figure 23

Improvement in learning (level 2 of Kirkpatrick's model of training evaluation) demonstrated by an increase in post-session self-confidence and self-competence levels compared with pre-session levels, using a ten-point Likert scale (1 = not confident/competent, 10 = extremely confident/competent)



surgery in the UK and Ireland.

The SCTS also provides a number of opportunities to attract driven and enthusiastic core trainees, foundation doctors and medical students into the specialty of cardiothoracic surgery. This is achieved by running introductory skills courses, student engagement courses

and internships as well as awarding travelling fellowships.

The SCTS Education operative video prize empowers trainees to become involved in their own training and develop teaching skills by envisaging what they would have wanted to know when learning a procedure so as to include

Figure 24

Improvement in behaviour (level 3 of Kirkpatrick's model of training evaluation) demonstrated by significant increase in performance of cardiopulmonary bypass and pulmonary wedge resection following attendance at the ST3 A course (assessed by objective structured assessment of technical skills), using a five-point Likert scale (1 = poor, 5 = excellent)



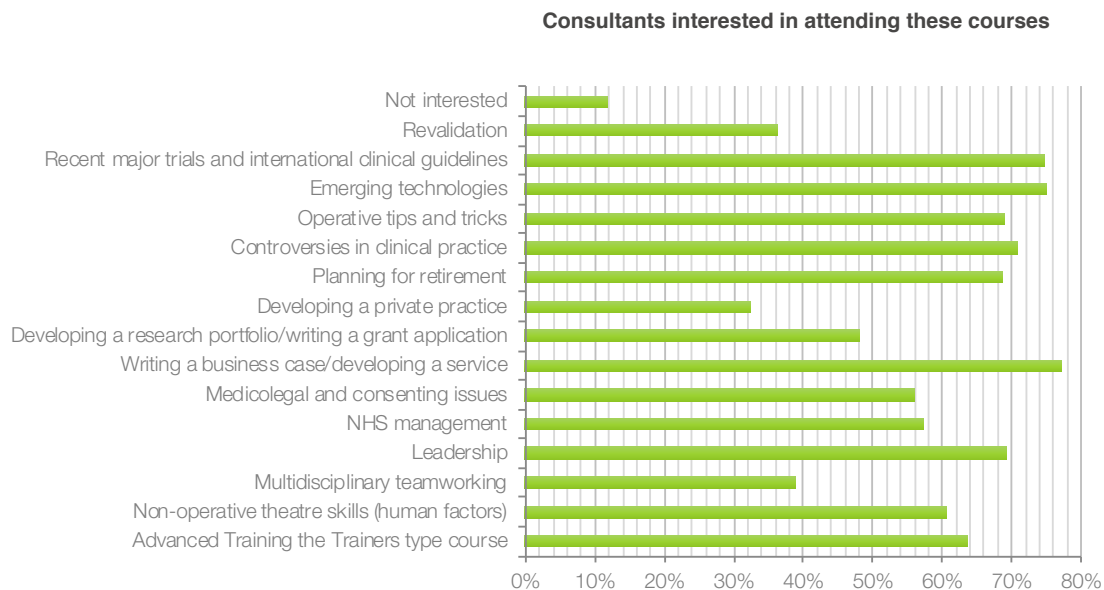
all of these aspects when producing the video to teach those more junior than themselves. The long-term aim is to build up a comprehensive library of all cardiac and thoracic surgical procedures so that any trainee can view a video (from a quality assured source) of an operation or part of an operation the day before performing or assisting with that procedure.

Future developments

The SCTS is keen to develop multidisciplinary educational opportunities for practitioners of cardiothoracic surgery. As the specialty of cardiothoracic surgery is delivered by a team, educational opportunities may be best delivered to the team as a whole. This philosophy is evol-

Figure 25

Results of consultant survey of educational and professional development requirements



ing, with new courses and fellowships being designed. An example will be multidisciplinary theatre courses, where consultant surgeons, surgical registrars, cardiothoracic anaesthetists, perfusionists, surgical care practitioners and scrub nurses will be invited to attend the course as a team to be taught clinical skills (e.g. those needed in emergency cardiopulmonary bypass scenarios) but also human factors skills (e.g. leadership, communication, situation awareness and teamworking). These non-technical skills have been cited as a common cause of serious incidents and educational opportunities such as these courses would be one approach to address this.

In addition, SCTS–Ionescu Consultant Team Fellowships will be offered. These will allow any member of the multiprofessional team to seek support for their team as a whole to enhance their skills or acquire new knowledge and implement innovative practice within their unit. This again promotes the concept that excellence in cardiothoracic surgery is achieved by a team of multidisciplinary professionals.

The SCTS believes it is important to measure the success of the education being delivered. While the beneficial effects in terms of reaction, learning and behaviour (levels 1–3 of Kirkpatrick’s model of training evaluation)

have already been demonstrated, it is also necessary to evaluate the impact of the training on direct patient care and patient-related outcomes (results, level 4 of Kirkpatrick’s model). In partnership with the Specialty Advisory Committee, the SCTS is assessing the impact of its education and training on progress as a consultant following appointment. The patient outcome measures will include nationally available morbidity and mortality data from the National Institute for Cardiovascular Outcomes Research and the *Lung Cancer Clinical Outcomes Publication*.

The project will also assess consultants’ involvement in service development (introducing a new service), leadership and management (positions of responsibility), research (publications and grant applications) and education (taking on the role of faculty member on training courses or becoming an educational supervisor). The aim is to determine whether improvement in training and education results in improved patient care, and the project will complete the holistic evaluation of the educational opportunities offered by the SCTS and the Specialty Advisory Committee. It will allow the SCTS to continually review the content and methodology used to deliver knowledge and skills (especially with regard to the development

of newer, high fidelity simulation models).

The SCTS is continuously reconsidering which data are collected from the training courses as part of the ongoing educational research to improve the courses. The Head of Education of the Royal College of Surgeons of Edinburgh has had input into the educational aspects as well as the research. The SCTS is also planning to develop an educational fellow programme, where those successful will be able review this invaluable source of data.

In view of the recent changes regarding revalidation and monitoring of consultant surgical outcomes, the SCTS will be expanding the education programme. Learning is a lifelong process. Currently, cardiothoracic consultants are offered an educational update through the SCTS–Ionescu University programme, which is a robust review of contemporaneous practice from world leaders, as well as a leadership development programme. In an attempt to provide consultants with better educational opportunities, SCTS members were surveyed to establish their requirements (Figure 25).

In response to this, sessions on operative tips and tricks, novel innovations, recent clinical guidelines and major trials, and debates on controversial areas of practice were included in the most recent SCTS–Ionescu University programme. In addition, a *Training the Trainers* course was delivered to support the course directors and faculty who teach on the SCTS Education course, and a new series of professional development courses for consultants will soon be introduced. As part of delivering education through different media, the SCTS will also be launching an advanced operative techniques video library, where world leaders in the field of cardiothoracic surgery have offered SCTS Education the opportunity to use a series of their operative videos to teach innovative surgical operations (e.g. advanced aortic valve repair techniques).

One of the challenges for the future will be to ensure sufficient financial support to deliver a high quality education programme. The SCTS has been very fortunate to have received considerable support (both financially and with logistics) from multiple industry partners, including Ethicon, and Mr Marian Ionescu.

In order to ensure the long-term sustainability of the programme, the SCTS is seeking collaboration with a wider variety of industry partners so that education can be offered free of charge to all multidisciplinary members of the SCTS. To this effect, the SCTS is very grateful to everyone who has contributed to the rapid expansion and great success of the SCTS Education programme over the past few years, including the Specialty Advisory Committee, the education department at the Royal College of Surgeons of Edinburgh, Mr Marian Ionescu, industry partners, and (most importantly) the course directors and faculty members, who impart their knowledge and skills voluntarily, without any financial remuneration, simply for the privilege of teaching the future generation of cardiothoracic surgical practitioners.

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