



# **ST2.1: Essential Skills in Cardiothoracic Surgery**

**18<sup>th</sup> – 19<sup>th</sup> September 2023**

Nottingham City Hospital  
Postgraduate Education Centre

## **Programme**

### **Directors:**

#### **Keng Ang**

Consultant Thoracic Surgeon  
Freeman Hospital, Newcastle

#### **Betsy Evans**

Consultant Cardiac Surgeon  
Leeds General Infirmary

## Faculty List

<b>Cardiac Surgery Faculty</b>	
Mr Sendhil Balasubramanian	Consultant Cardiac Surgeon University Hospital, Coventry
Mr Tony Walker	Consultant Cardiac Surgeon Blackpool Victoria Hospital
Mr Haytham Sabry	Locum Consultant Cardiac Surgeon Liverpool Heart & Chest Hospital
Mr Eshan Senanayake	Consultant Cardiac Surgeon Queen Elizabeth Hospital, Birmingham
Mr Usman Shah	Senior Clinical Fellow Cardiothoracic Surgery Liverpool Heart & Chest Hospital
Ms Jasmina Djordjevic	Surgical Assistant John Radcliffe Hospital, Oxford
<b>Thoracic Surgery Faculty</b>	
Mr Mohammad Hawari	Consultant Thoracic Surgeon Nottingham City Hospital, Nottingham
Mr Nilanjan Chaudhuri	Consultant Thoracic Surgeon St. James University Hospital, Leeds
Mr Mehmood Jadoon	Consultant Thoracic Surgeon Nottingham City Hospital
Mr Silviu Buderu	Consultant Thoracic Surgeon, Royal Brompton Hospital
<b>Guest Speakers (TBC)</b>	
Ms Elizabeth Belcher	SAC Member, Consultant Thoracic Surgeon & SCTS Education Secretary, John Radcliffe Hospital, Oxford
Ms Carin Van Doorn	Consultant Congenital Cardiac Surgeon Leeds General Infirmary

## Day One

Time	Session	Faculty	Room
<b>08:30 - 08:45</b>	<b>Registration and Refreshments</b>		
08:45 - 09:00	Welcome & Rules and regulations	Betsy Evans, Keng Ang & Sarah Hutton	Reception
09:00 - 09:35	<b>Cardiac Anatomy:</b> Cardiac chambers & valves	Cardiac faculty	Lecture Theatre
09:35 - 10:15	<b>Thoracic Anatomy</b>	Thoracic faculty	Lecture Theatre
<b>10:15 - 10:30</b>	<b>Refreshments</b>		
10:30 - 11:30	Skill stations I - II (60 mins each)		
	I: <b>Cardiac:</b> Saphenous vein harvesting (including endoscopic technique) – Group 1	Cardiac faculty	Skills Lab 2
	II: <b>Thoracic:</b> Chest drainage, VATS port placement and stapling – Group 2	Thoracic faculty	Skills Lab1
<b>11:30 - 11:45</b>	<b>Refreshments</b>		
11:45-12:45	Skill stations III - IV (60 mins each)		
	III: <b>Cardiac:</b> Radial artery harvesting – Group 1	Cardiac faculty	Skills Lab 2
	IV: <b>Thoracic:</b> Thoracotomy, principles of lung dissection – Group 2	Thoracic faculty	Skills Lab 1
<b>12:45 - 13:30</b>	<b>LUNCH</b>		
13:30 -14:00	A: <b>Cardiac</b> Scenarios	Cardiac faculty	
14:00 – 14:30	B: <b>Thoracic</b> Scenarios	Thoracic faculty	
<b>14:30 - 14:45</b>	<b>Refreshments</b>		
14:45 - 16:10	Skill stations V - VI (90 mins)		
	V: <b>Cardiac:</b> Median sternotomy & LIMA harvest Coronary Anastomosis; dissection of heart - Group 1	Cardiac Faculty	Skill Lab 1
	VI: <b>Thoracic:</b> Bronchoscopy; Simulation training for cardiothoracic surgery, VATS skills and drainage management, - Group 2	Thoracic Faculty	Skill Lab 2
<b>16:10 - 16:25</b>	<b>Refreshments</b>		
16:25 - 16:55	<b>Cardiac</b> Pre-operative assessment and risk stratification	Cardiac Faculty	Lecture Theatre

16:55 - 17:25	<b>Thoracic</b> Pre-operative assessment and risk stratification	Thoracic Faculty	Lecture Theatre
17:25 - 17:40	Summary, feedback and close		Lecture Theatre
<b>19:30 - Course Dinner</b>			

## Day Two

Time	Session	Faculty	Room
08:00 - 08:20	Registration and Refreshments		
08:20 - 08:30	Re-Introduction to skill stations I	Betsy Evans & Keng Ang	Reception
08:30 - 09:30	Skill stations I - II (60 mins each)		
	I: <b>Cardiac</b> : Saphenous vein harvesting (including endoscopic technique) – Group 2	Cardiac Faculty	Skills Lab 2
	II: <b>Thoracic</b> : Chest drainage, VATS port placement and stapling- Group 1	Thoracic Faculty	Skills Lab 1
<b>09:30 - 09:45</b>	<b>Refreshments</b>		
09:45 - 10:45	Skill stations III - IV (60 mins each)		
	III: <b>Cardiac</b> : Radial artery harvesting – Group 2	Cardiac Faculty	Skills Lab 2
	IV: <b>Thoracic</b> : Thoracotomy, principles of lung dissection – Group 1	Thoracic Faculty	Skills Lab 1
<b>10:45 - 11:00</b>	<b>Refreshments</b>		
11:00 - 12:30	Skill stations V - VI (90 mins)		
	V: <b>Cardiac</b> : Median sternotomy & LIMA harvest Coronary Anastomosis; dissection of heart - Group 2	Cardiac Faculty	Skills Lab 1
	VI: <b>Thoracic</b> : Bronchoscopy; Simulation training for cardiothoracic surgery, VATS skills and drainage management, - Group 1	Thoracic Faculty	Skills Lab 2
<b>12:30 - 13:30</b>	<b>Lunch</b>		
13:30 - 14:00	Guest Lecture: Congenital Cardiac Surgery	Miss Carin Van Doorn	Lecture Theatre
14:00 - 14:30	Guest Lecture: Training, Curriculum, Assessment, Examination, ARCC and the role of SAC	Ms Elizabeth Belcher	Lecture Theatre
14:30 - 14:45	Questions and Answers		

14:45 - 15:00	Refreshments		
15:00 - 16:00	Workshops (30 mins each)		
	C: Cardiopulmonary Bypass Group 1: 15:00 - 15:30 Group 2: 15:30 – 16:00	Cardiac Faculty	
	D: Thoracic Imaging Group 1: 15:00 - 15:30 Group 2: 15:30 – 16:00	Thoracic Faculty	
16:00 – 16:30	Summary, reflection, feedback	All	

## Learning objectives

### Cardiac Anatomy

1. Understand the surface anatomy of the heart, cardiac valves and great vessels.
2. Describe the anatomy of the coronary arteries, including the location, normal course, branches, dominance and variants.
3. Understand how to identify the coronary arteries when performing bypass grafting surgery
4. Define the anatomy of the coronary venous system, including the location and accompanying arteries.
5. Describe the anatomy of the cardiac valves, including contribution of sub-valvular apparatus and aortic root to valve competency.
6. Understand the anatomy of the conduction system, including the location and blood supply of nodes, bundles and Purkinje fibres, and where to avoid during surgery.
7. Define the anatomy of the cardiac chambers, including embryological origin.
8. Describe the anatomy of the pericardium, including the location of the oblique and transverse sinuses.
9. Describe the anatomy of the great vessels, including thoracic aorta, pulmonary artery and vena cavae.
10. Understand the embryological origin of the heart, including formation of the atrial septum

### Conduit Anatomy

1. Describe the anatomy of the left internal mammary artery, including the location, course, branches and nearby structures
2. Discuss the difference between a pedicled and skeletonized internal mammary artery
3. Define the anatomy of the long saphenous vein, including the location, course, landmarks and nearby structures
4. Understand how to identify the sapheno-femoral junction
5. Describe the anatomy of the short saphenous vein, including the location, course, landmarks and nearby structures
6. Understand the anatomy of the cephalic vein
7. Define the anatomy of the radial artery, including the location, course, branches and nearby structures
8. Understand the principles of an Allen's test, including palmar arch anatomy
9. Briefly describe the anatomy of the inferior epigastric artery and gastro-epiploic artery

10. Describe the anatomical differences between the internal mammary artery, radial artery and saphenous vein, especially in relation to long-term patency

**Thoracic Anatomy**

1. Define the surface anatomy of the thorax and understand its relevance to clinical practice.
2. Understand the muscular anatomy of the chest wall in relation to ventilation and thoracic incisions.
3. Define the boundaries of the thoracic cavity.
4. Define the divisions of the thoracic cavity in relation to mediastinal pathology.
5. Describe tracheobronchial anatomy and its variations in relation to single lung ventilation and bronchoscopy.
6. Describe the structures of the hilum of both lungs.
7. Compare and contrast the gross and segmental anatomy of the right and left lung.
8. Describe the relative position of other major structures in the thorax including heart, great vessels, oesophagus, thoracic duct and major nerves.
9. Understand the anatomy of lymph nodes in relation to lung cancer staging.
10. Describe the origin, insertion, innervation, functions and various openings of the diaphragm.

**Thoracic Pathology**

1. Describe the classification and management of lung tumours.
2. Discuss the role of surgery in the diagnosis of interstitial lung disease and the management of COPD.
3. Describe pulmonary infections including empyema, lung abscess, TB and fungal infection of the lung.
4. Describe benign and malignant conditions of the pleura.
5. Understand the importance of the anatomy of the mediastinum in relation to the classification of mediastinal pathology.
6. Demonstrate understanding of benign and malignant conditions of the oesophagus.
7. Discuss the management of pathology of the chest wall including congenital conditions, trauma, primary and secondary tumours.
8. Discuss the management of chest trauma.
9. Discuss benign and malignant disorders of the diaphragm.
10. Describe the commonest congenital conditions of the chest.

**Pre-operative assessment and risk stratification: Cardiac Surgery**

1. Understand the important components of a cardiac history, including symptoms, cardiac risk factors and indications for surgery
2. Describe how to perform a cardiac examination, including assessment of conduits for bypass grafting
3. Define the important investigations that need to be performed prior to a patient undergoing cardiac surgery, including blood tests, chest radiograph, electrocardiogram, echocardiogram and coronary angiogram
4. Describe which patients may require further investigation with lung functions tests, arterial blood gases, computed tomography scanning and carotid duplex scanning
5. Understand the importance of documentation in the pre-operative assessment process of cardiac surgical patients
6. Define the important components of the consent process, including an explanation of the underlying disease, treatment options, risks and benefits of surgery (including risk score)
7. Describe the risk scores currently used in clinical practise, including the additive Euroscore, logistic Euroscore, Euroscore II and STS score
8. Understand the indications for surgery for coronary artery bypass grafting, including AHA and European guidelines

9. Understand the indications for valve surgery, including AHA and European guidelines
10. Understand the indications for thoracic aortic surgery, including AHA and European guidelines

### **Cardiopulmonary bypass**

1. Understand the principles of cardiopulmonary bypass
2. Describe the important components of a cardiopulmonary bypass circuit
3. Discuss the principles of arterial cannulation, including the advantages and disadvantages of the different options
4. Discuss the principles of venous drainage, including the advantages and disadvantages of the different options available for venous cannulation
5. Understand the principles of myocardial protection
6. Describe the advantages and disadvantages of the different cardioplegia options, including antegrade vs. retrograde, warm vs. cold, blood vs. crystalloid
7. Understand the principles of venting and effects of LV distension
8. Describe the management of anticoagulation on bypass, including ACT and protamine reactions
9. Discuss the important factors to be considered before weaning a patient from cardiopulmonary bypass
10. Understand the side effects of cardiopulmonary bypass, including coagulopathy, haemodilution and systemic inflammatory response

### **Pre-operative assessment and risk stratification: Thoracoscore**

1. Demonstrate familiarity with the British Thoracic Society guidelines for the radical management of patients with primary lung cancer.
2. Understand the principles of the tripartite system of assessment for the radical treatment of primary lung cancer.
3. Describe the principles of segment counting for the assessment of risk of post-operative dyspnoea following anatomical resection for primary lung cancer.
4. Discuss the role of the revised cardiac index in the assessment of cardiac risk in thoracic surgery.
5. Describe risk-scoring systems in current practice.
6. Discuss the usefulness and limitations of the Thoracoscore risk assessment system.
7. Describe the risks of current smoking at time of operation in relation to mortality and morbidity.
8. Demonstrate familiarity with alternatives to surgery for patients with primary lung cancer - short and long-term advantages and limitations.
9. Discuss the risk assessment of patient undergoing operation for benign disease (lung volume reduction surgery, pneumothorax, lung biopsy).
10. Discuss the assessment of the risks of morbidity of thoracic surgery.

### **Cardiothoracic incisions and access**

1. Discuss the importance of latissimus dorsi muscle in the classification of thoracotomy incisions.
2. Understand the surface anatomy of the chest wall in relation to thoracotomy incisions.
3. Discuss procedure specific thoracotomy choice.
4. Discuss principles of thoracotomy.
5. Describe the principles of VATS port placement.
6. Describe the principles of safe conversion to thoracotomy from a VATS procedure.



7. Discuss choice of incision for open conversion of VATS procedure.
8. Discuss the peri-operative analgesic adjuncts - paravertebral versus epidural.
9. Discuss the choice of drains - number, size, suction versus no suction and time to drain removal.
10. Recognise incision specific complications.

**Median sternotomy and left internal mammary artery harvest**

1. Describe the anatomy of the sternum and overlying tissues.
2. Describe the anatomy of the sternum and overlying tissues.
3. Demonstrate the ability to identify the surface landmarks to define the extent of the sternotomy skin incision.
4. Understand the principles of identifying the midline and its importance to reduce the risk of sternal dehiscence
5. Discuss the different mechanical saws used for sternotomy and principles of how to use them safely
6. Discuss the merits of using bone wax for sternal haemostasis
7. Describe the anatomy of the left internal mammary artery (and its branches) and surrounding structures, including the phrenic nerve and brachiocephalic vein
8. Discuss the principles of identifying the left internal mammary artery, including neurovascular plane
9. Understand the principles in dissecting the left internal mammary artery, including the use of diathermy, ligaclip application and blunt dissection
10. Demonstrate the principles of left internal mammary artery preparation following harvest, including the use of paparevine
11. Understand the principles of haemostasis during sternal opening and left internal mammary artery harvest

**Thoracic surgery and chest drainage**

1. Discuss the principles of multi-disciplinary team management.
2. Demonstrate the approach to surgical staging of patients with primary NSCLC.
3. Demonstrate a logical and flexible approach to anatomical resection.
4. Describe the definition of systematic nodal dissection and completeness of resection.
5. Define the triangle of safety and the prerequisites of safe chest drain insertion
6. Demonstrate familiarity with options for chest drainage - number, size, position and time to drain removal.
7. Discuss the principles of underwater seal drainage systems.
8. Demonstrate familiarity with portable suction drainage systems.
9. Demonstrate familiarity with portable valved drainage systems.
10. Describe the indications and principles of chest drain removal.

**Saphenous vein harvest**

1. Describe the anatomy of the long saphenous vein
2. Demonstrate the surface landmarks to help identify the long saphenous vein, including distally (medial malleolus), mid-point (behind patella) and proximally (near sapheno-femoral junction)
3. Discuss the factors determining choice of harvest site (ankle, knee, thigh)
4. Understand the principles of harvesting the long saphenous vein, including dissection, branch ligation and distraction

5. Demonstrate the principles of knot tying
6. Be able to determine appropriate quantity and quality of the vein harvested
7. Demonstrate the principles of long saphenous vein preparation following harvest
8. Demonstrate principles of wound closure following vein harvest
9. Discuss the factors that determine whether a drain needs to be inserted following vein harvest
10. Understand the principles of short saphenous vein harvesting

**Bronchoscopy, VATS port placement and stapling**

1. Discuss safe management of the shared airway.
2. Be able to identify of the components of a rigid bronchoscope.
3. Demonstrate safe passage of a bronchoscope and identify the anatomy at each stage.
4. Describe the complications of bronchoscopy and strategies for avoidance.
5. Demonstrate the principles of safe port placement.
6. Discuss factors influencing choice of port.
7. Discuss procedure specific port placement.
8. Demonstrate principles of stapling technology.
9. Describe factors influencing choice of stapler.
10. Discuss factors influencing staplers versus hand-sewn technique.

**Radial artery harvest**

1. Describe the anatomy of the radial artery
2. Understand the advantages and disadvantages of using a radial artery as a bypass conduit
3. Discuss in which patients a radial artery would be used
4. Describe the principles of the Allen's test
5. Demonstrate the surface landmarks to help identify the radial artery and the incision used for radial artery harvest
6. Understand the principles of harvesting the radial artery, including dissection, branch ligation and distraction
7. Discuss the importance of using vessel loops / radial artery spasm
8. Demonstrate the principles of radial artery preparation following harvest
9. Demonstrate principles of wound closure following radial artery harvest
10. Discuss the evidence for the use of a radial artery, including RAPS and RAPCO trials

**Aortic cannulation and decannulation**

1. Understand the factors that determine the site of aortic cannulation (especially in relation to calcification, top ends, aortotomy, aortic cross-clamp and aortic arch surgery)
2. Describe the steps required before performing aortic cannulation
3. Demonstrate the principles of placing the aortic purse strings
4. Demonstrate the principles of inserting and securing the aortic cannula
5. Demonstrate the principles of connecting the aortic cannula to the CPB circuit
6. Discuss the signs of aortic cannula malposition
7. Discuss the signs of iatrogenic aortic dissection following aortic cannulation and how to manage it
8. Understand the significance of high line pressures following aortic cannulation

9. Understand the factors that determine the timing of aortic decannulation
10. Demonstrate the principles of aortic decannulation

**Angiography**

1. Understand the principles of performing coronary angiography, including the different projections
2. Describe the standard views of the left coronary arterial system
3. Describe the standard views of the right coronary arterial system
4. Define a flow-limiting or significant coronary artery lesion, including an explanation of luminal diameter versus cross-sectional area
5. Define the different grades of TIMI coronary flow
6. Understand the principles of fractional flow reserve (FFR)
7. Understand the principles of intravascular ultrasound (IVUS)
8. Demonstrate the principles of assessing global and regional wall motion abnormalities using a ventriculogram
9. Understand the principles of assessing the severity of mitral regurgitation using a ventriculogram
10. Demonstrate the principles of assessing the presence of proximal aortic pathology and the severity of aortic regurgitation using an aortogram

**Echocardiography and electrocardiography**

1. Understand the principles of performing echocardiography, including 2D, M-mode, Doppler and 3D
2. Describe the standard 2D echocardiographic views, including parasternal long axis, parasternal short axis, apical 4 chamber, apical 5 chamber, apical long axis 2 chamber, subcostal and suprasternal views
3. Understand the difference between continuous wave and pulsed wave Doppler, including the principles of aliasing and colour flow Doppler
4. Demonstrate the principles of assessing global and regional wall motion abnormalities on echocardiography, including normal echocardiographic values for cardiac chamber size and function
5. Understand the principles of quantifying valvular stenosis and regurgitation, including Bernoulli equation, Continuity equation, pressure half-time, vena contracta, PISA, AHA guidelines
6. Describe the standard trans-oesophageal echocardiographic views
7. Understand the principles of performing electrocardiography
8. Describe the important components when assessing an ECG, including rate, rhythm, axis and the individual components of the ECG trace
9. Understand the principles of assessing arrhythmias on ECG, including heart block, bundle branch block, atrial / ventricular tachycardia / fibrillation
10. Recognize the signs of myocardial ischaemia and infarction on ECG

**Chest x-rays**

1. Discuss the characteristics of PA versus AP CXR.
2. Understand the terms inspiration, penetration, and rotation as they apply to determining a technically adequate film.
3. Understand basic anatomy of the fissures of the lungs, heart borders, bronchi, and vasculature visible on a chest x-ray.
4. Develop a consistent and thorough technique for the interpretation of a CXR.

5. Understand how the silhouette sign can aid in identification of pathology.
6. Appreciate the difference in findings of atelectasis and pneumonia.
7. Recognise pleural effusions and pneumothorax on a CXR.
8. Recognise the signs of COPD.
9. Recognise the signs of interstitial lung disease.
10. Understand the CXR features of benign versus malignant nodules.

**Cardiothoracic imaging (CT, MRI, PET, Thallium)**

1. Discuss the principles of computed tomography (CT) imaging
2. Discuss the role and limitations of CT in the management of cardiothoracic surgical conditions, including primary lung cancer and thoracic aortic disease
3. Discuss the role and limitations of FDG PET in the diagnosis and staging of primary lung cancer.
4. Understand the importance of tissue diagnosis in staging of primary lung to maintain benefit of doubt staging principles.
5. Demonstrate familiarity with the BTS and ESTS guidelines for the diagnosis and management of primary lung cancer.
6. Describe the role of imaging in measuring response to treatment (RECIST criteria) and in follow-up
7. Describe the indications for EUS in the staging of paraoesophageal lesions.
8. Discuss the principles of magnetic resonance imaging (MRI)
9. Describe the indications for MRI in the management of cardiothoracic surgical conditions, including cardiac and neurogenic tumours
10. Discuss the role and limitations of different imaging modalities available to demonstrate ischaemia and viability, including thallium scanning, MRI and stress echocardiography

**Cardiac intensive care unit management**

1. Understand the principles of monitoring a patient following cardiac surgery in the intensive care unit
2. Describe the principles of inserting a pulmonary artery flotation (Swan Ganz) catheter and demonstrate an understanding of the derived measurements, including cardiac index, systemic vascular resistance and mixed venous saturations
3. Recognise the signs and understand the underlying causes of low cardiac output
4. Understand the principles of managing a patient with low cardiac output, including when to use which inotropes
5. Describe the indications and mechanism of action of an intra-aortic balloon
6. Describe the causes and management of a patient with right ventricular failure
7. Understand the criteria for extubation following cardiac surgery
8. Describe the aetiology and management of a patient with hypoxia following cardiac surgery
9. Understand the aetiology and management of a patient with oliguria following cardiac surgery
10. Describe the principles and indications of renal replacement therapy

**Re-exploration for bleeding & tamponade**

1. Recognise the signs of tamponade and bleeding following cardiac surgery
2. Define the aetiology of mediastinal bleeding following cardiac surgery, including surgical sites and coagulopathy
3. Understand the principles of assessing a patient with mediastinal bleeding to help distinguish surgical causes from

## coagulopathy

4. Be able to interpret and understand the limitations of coagulation studies and thromboelastogram (TEG)
5. Understand the importance and limitations of echocardiography in a patient with mediastinal bleeding or tamponade
6. Describe the principles of managing a patient with mediastinal bleeding or tamponade
7. Describe the indications and principles of using platelets, fresh frozen plasma, cryoprecipitate and packed red blood cells
8. Discuss the use of pharmacological agents, including tranexamic acid, aprotinin and desmopressin
9. Discuss the indications for re-sternotomy for bleeding or tamponade
10. Describe the operative steps performed when re-opening a patient for bleeding or tamponade

**Oxygenation and ventilation**

1. Understand the principles of jet ventilation during rigid bronchoscopy.
2. Identify types and sides on double lumen endobronchial tubes and endobronchial blockers
3. Demonstrate the principles of single lung ventilation.
4. Describe the pathophysiology of one-lung ventilation.
5. Describe strategies for management of hypoxia during single lung ventilation.
6. Describe the incidence, definition and management of Acute Lung Injury and ARDS.
7. Discuss the management of respiratory complications.
8. Understand the role of physiotherapy in reducing and treating postoperative respiratory complications.
9. Discuss the indications, technique and complications of tracheostomy.
10. Describe the indications and technique of minitracheostomy.

**Thoracic post-operative management**

11. Understand the importance of informed consent and communication in the anticipation of complications.
12. Discuss the assessment of postoperative bleeding and its management.
13. Describe the prevention, diagnosis of thromboembolic disease.
14. Describe the incidence and management of post-operative cardiac events.
15. Describe the definition, prevention, incidence, management and complications of post-operative air leak.
16. Describe the differential diagnosis of post-operative hypoxia.
17. Discuss the incidence, prevention and treatment of perioperative dysrhythmias.
18. Describe pulmonary complications following thoracic surgery.
19. Discuss the clinical and radiological features, differential diagnosis and management of bronchopleural fistula.
20. Discuss the optimisation of post-operative analgesia, incidence of post thoracotomy syndrome.