



European Association of Cardiothoracic Anaesthesiology (EACTA) Cardiothoracic and Vascular Anaesthesia Fellowship Curriculum: First edition

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1. Introduction

Cardiothoracic and vascular anesthesia is a subspecialty of anesthesiology devoted to the perioperative care of patients undergoing cardiac, thoracic and vascular surgery and related procedures. The European Association of Cardiothoracic Anesthesiology [EACTA] supports a well-grounded training in cardiothoracic and vascular anesthesia in the form of the Cardiothoracic and Vascular Anesthesia [CTVA] Fellowship Program, which comprises basic and advanced training in EACTA-accredited educational facilities. The aim of EACTA's CTVA Fellowship Program is to improve the quality of perioperative patient care by promoting and harmonizing training and education in cardiovascular and thoracic anesthesia.

2. Curriculum design and certification

The CTVA curriculum is open to all physicians irrespective of their country of origin, religion, gender or sexual orientation. Before being accepted as a Fellow, candidates must provide evidence of a valid license to practice medicine and a specialist degree examination in anesthesiology at their national level. Candidates must be EACTA members in good standing. Appropriate language skills as defined by the host centers are required in accordance with national and international regulations (generally level B2). The CTVA Fellowship Program has two sequential and complementary levels of training, referred to as basic and advanced. Each level comprises 12 months of continuous training, resulting in a CTVA Fellowship Program with an overall duration of 24 months.

2.1. CTVA Basic Training Programme

The basic training period focuses on the anesthetic management of patients undergoing cardiac, thoracic and vascular surgery and related procedures. This includes preoperative patient



assessment - with special focus on cardiac, thoracic and vascular diseases - and the familiarization with surgical techniques, procedures and associated problems. In the course of the basic CTVA program period, Fellows should optimize their ability to determine perioperative morbidity and establish an appropriate perioperative management plan which carefully considers patient- and procedure-related factors.

Basic CTVA training include modules related to cardiac anesthesia, thoracic anesthesia, vascular anesthesia, postoperative care (postanesthesia care unit [PACU] and/ or intensive care unit [ICU]) - with a focus on cardiac, thoracic and vascular surgery - as well as modules related to adult transesophageal echocardiography [TEE], interventional cardiology procedures (e.g., transcatheter aortic valve replacement [TAVR], MitraClip), and to techniques of extracorporeal circulation (Table 1). The basic CTVA Fellowship training also includes active and passive participation in scientific rounds such as interactive seminars, case discussions, morbidity and mortality conferences, journal club meetings, and multidisciplinary team discussions. Participation in clinical and experimental research is encouraged but is not considered an essential part of basic training.

The basic training period is completed under the close supervision of a mentor who is the local CTVA Program Director or a designated member of the department. The Program Director and faculty members involved in the training program should be EACTA members in good standing. The mentor must personally provide the Fellow with one-on-one clinical supervision during the first three months of the period of basic training. Supervision of the Fellow by the mentor should then become more indirect, however, with the mentor available within a reasonable period of time.



2.2. CTVA Advanced Training Programme

The advanced training period is offered in a similar structure to the basic program in order to comply with the differing national health care needs and requirements of the 36 countries represented in EACTA. Host centers and Fellows have the option to adapt the advanced part of the training period to match the local conditions at their training facilities, as well as the personal career plans of the Fellows.

Primarily, the advanced training period is intended to deepen and to extend the clinical and non-technical skills that Fellows have acquired during their basic CTVA Fellowship training. The advanced training period can also be used for training in different but complementary subareas and associated disciplines, provided that they align with the core intention of the CTVA Fellowship Program. The advanced training period should deliver a high level of training in specific aspects of cardiac, thoracic and vascular anesthesia. Further modules - complementary to clinical training - can be included but are not the focus in the advanced training period (Table 2.) However, such modules must be completed in not more than six months in total and must be individually accredited with an official agreement between Fellows and their host centers.

If appropriate facilities are lacking, or host centers cannot guarantee sufficient numbers of patients in a selected patient group (e.g., heart transplantations in advanced training with cardiac anesthesia focus) to fulfill the CTVA Fellowship training requirements, the CTVA Fellowship Program allows for collaboration between certified host centers to exchange Fellows for predetermined periods of the advanced cardiothoracic and vascular anesthesia training program. Alternatively, host centers can be accredited to offer only training in either cardiac, cardiothoracic, cardiac and vascular or thoracic and vascular anesthesia. These solutions apply for the basic as



well as the advanced CTVA Fellowship Program. Figure 1. illustrates the different fellowship pathways.

A compound training plan involving more than one host center should be discussed with all parties involved before the Fellowship is initiated and must be approved by the Chair of the EACTA Educational Committee.

2.3. Intraoperative transoesophageal echocardiography

Interpretation and communication of (pathological) findings related to adult TEE is an integral part of cardiac anesthesia. Thus, EACTA and the CTVA Fellowship Program Directors consider the acquisition of advanced TEE knowledge and skills an obligatory requirement for CTVA Fellows with core training in advanced cardiac anesthesia. The CTVA Fellowship Program with focus on cardiac anesthesia can only be completed when all prerequisites for official TEE Certification Exam as defined by the EACVI council, have been fulfilled including passing the theoretical TEE Certification Exam (preferably during basic training) and acquisition of a case e-logbook (at the end of advanced cardiac training period at the latest).

2.4. CTVA Certification

The CTVA Fellowship Program starts with 12 months of broad-based training in adult cardiac, thoracic and vascular anesthesia. EACTA will recognize this period of training with certification for a *BASIC EACTA Fellowship*. Basic certification is a pre-requisite to enter the advanced training program. Fellows can then continue for the advanced training period either at the same host center where basic training was completed or at any of the other EACTA-accredited institutions. After completion of the (cardiac based) advanced training and the certification process



for the EACVI TEE Certification Exam, Fellows become eligible to be certified for an *ADVANCED EACTA Fellowship*. If advanced training focused on thoracic and/or vascular anesthesia only, the Fellow does not require completion of the EACVI TEE Certification Exam.

The CTVA Fellowship Program should be completed in a 24-month period of training and uninterrupted by frequent and/or prolonged periods of absence because of illness or personal circumstances. Absence from training for sick leave or personal circumstances requires proportionate extension of the training period. Annual and maternity leave are regulated in accordance with local contractual requirements. Documentation of 12 or 24 months of training is a mandatory requirement for certification of Basic and Advanced CTVA Fellowship Programs. Appeals for exceptional circumstances because of illness or personal circumstances that have resulted in repeated or prolonged interruption of training will be reviewed by the Chair of the EACTA Education Committee or forwarded to his/her delegates for arbitration.

2.5. Maintenance of competence after the Fellowship Program

EACTA undertakes indirect measures for (1) quality assurance after completion of the Fellowship Program including the collection of feedback from all graduates, (2) a graduate survey to facilitate the search for suitable post-graduate job opportunities, and (3) re-accreditation of host centers every 4 years to ensure maintenance of the required educational level.



3. Relevant competencies

In accordance with the CanMEDS competency framework [1-3], relevant competencies for general and specific medical and non-medical skills are defined as follows:

Medical expert (defined in accordance with [4-5])

The Fellow

- has gained general and specific knowledge of anatomy and the pathophysiology of all cardiac, thoracic and vascular diseases.
- is able to adequately plan the anesthesia and perioperative care for patients scheduled for a cardiac, thoracic, or major vascular surgery, including individual risk estimation.
- is able to safely provide anesthesia to patients undergoing cardiac, thoracic, or major vascular procedures.
- is competent in basic and advanced vascular access techniques as well as basic and advanced hemodynamic monitoring.
- is able to interpret the results of common diagnostic tools including imaging (radiographic, computerized tomography scanning, magnetic resonance), standard and point-of-care laboratory testing including biochemistry, hematology, conventional coagulation parameters, thromboelastography/thromboelastometry, electrocardiogram, echocardiography and coronary angiography.
- is familiar with the principles of intraoperative neurophysiological monitoring including bispectral index (BIS), near-infrared spectroscopy (NIRS), motor evoked potentials (MEP), somatosensory evoked potentials (SSEP), and intracerebral pressure monitoring (ICP) in procedures with cerebrospinal fluid (CSF) drainage.



- is competent in airway management, including techniques of lung isolation and one-lung ventilation.
- is familiar with the principles and guidelines of patient blood management (PBM).
- is familiar with the principles of extracorporeal circulation and in particular, cardiopulmonary bypass (CPB) and other forms of mechanical cardiocirculatory and respiratory support systems.
- is competent in the assessment of patients who are to undergo cardiac, thoracic and vascular surgery in a pre-operative clinic. In addition, the Fellow can provide a competent consultation at the request of colleagues from his/her own or other disciplines.
- is able to perform a comprehensive TEE examination and pass the EACVI TEE Certification Exam at the end of the advanced CVTA Fellowship training.

Communicator

The Fellow

- communicates clearly and competently both with patients and with other professionals.
- accurately elicits and synthesizes relevant information and perspectives of patients and their families, medical colleagues, and other healthcare professionals.
- effectively communicates information about patients verbally and in writing.

Collaborator

The Fellow

- can discuss perioperative management and patient-related decisions comprehensively within a multi-disciplinary environment.
- works effectively with other healthcare professionals to prevent, negotiate and resolve professional and interdisciplinary conflicts.[6]



Academic Scholar

The Fellow

- has knowledge of innovations and developments in cardiac, thoracic and vascular medicine and is dedicated to updating this knowledge.
- can critically evaluate medical information and its sources and apply this appropriately to practice decisions, as medical decisions should be based on the best available evidence.
- actively participates in and promotes clinical research as well as supporting related basic research.
- develops a teaching portfolio by delivering lectures at cardiac, thoracic and vascular anesthesia educational meetings.

Professional

The Fellow

- acts professionally with respect to the institutional, national and international rules and laws.
- acts professionally with respect to ethical standards.
- demonstrates a commitment to physician health (including awareness of burnout syndrome) and sustainable practice.

Manager and leader

The Fellow

- demonstrates management and leadership skills in daily practice.
- remains composed when under pressure, demonstrating effective leadership and supporting other team members.
- contributes to the improvement of health care delivery in teams, organizations, and systems.
- works efficiently and engages in the stewardship of available health care resources.



- develops an understanding of adult cardiac, thoracic and vascular anesthesia in the greater context of cardiac, thoracic and vascular care within the hospital, community and country. [6]

Health advocate

The Fellow

- responds to individual patients' health needs and issues as part of patient care.
- gives high priority to all aspects of patient safety, both inside and outside of the operating room.



4. Learning objectives [Supplement A]

On completion of the basic training period, Fellows will be competent in cognitive and practical skills required to undertake cardiac (with or without thoracic and vascular) anesthesia and will be qualified to work as anesthesiologists. The minimum duration required for completion of the basic training is 12 months of full-time employment. Successful completion of the basic program entitles the candidate to enter the advanced program. For each domain, learning objectives are divided into the knowledge, skills and attitudes that are deemed necessary to achieve the required level of competence [Supplement A], as defined by the Union Européenne des Médecins Spécialistes [2-3]:

- A: observer level (has knowledge of, describes).
- B: performs, manages, demonstrates under direct supervision.
- C: performs, manages, demonstrates under distant supervision.
- D: performs, manages, demonstrates independently

To ensure that all content and skills can be trained sufficiently during the Fellowship, EACTA recommends a minimum number of procedures/patients treated per domain. The candidate must have met these minimum requirements before applying for the final assessment.

5. Learning and teaching methods

5.1. **Adult cardiac, thoracic and vascular anesthesia education**

Regular attendance at subspecialty educational meetings is expected, including lectures, interactive conferences, hands-on workshops, morbidity and mortality reviews, cardiology and echocardiography conferences, cardiac, thoracic and vascular surgery conferences, journal review clubs, and research seminars offered by the training facility.



5.2. Active participation

Active participation in adult cardiac, thoracic and vascular anesthesia will be incorporated into the planning and production of educational activities. The faculty will lead in the majority of sessions.

5.3. Attendance

Attendance at multidisciplinary conferences, particularly in cardiovascular medicine and cardiothoracic surgery, will be encouraged.

5.4. Academic assignment

The Fellow will complete a minimum of one academic assignment. Academic projects may include presentations at grand rounds, writing and publication of review articles, book chapters, and manuals for teaching or clinical practice, clinical research investigation or other scholarly activities. The project selection will require the advance approval of their Program Director. An oral or scientific poster presentation at an international or national meeting by a Fellow from every host center each year is required as evidence of scientific engagement/training.

5.5. Exchange with other training facilities

Fellows may participate in exchange programs with other institutions, in order to gain specific clinical exposure for specific subareas which are underrepresented in their host centers for example, anesthesia for heart transplantation. Such exchanges are at the discretion of the Program Director, but there should be prior communication with, and approval by the EACTA Education Chair.



6. Assessment

6.1. General principles of assessment

Faculty members responsible for teaching Fellows will provide the CTVA Program Director with critical evaluations of each Fellow's progress and competence at three-month intervals using a standardized form. The evaluations will assess essential and acquired character attributes, level of knowledge, clinical judgment and psychomotor skills, as well as specific procedural skills needed for patient management and critical analysis of clinical situations.

The CTVA Program Director or a designate will provide feedback to Fellows on their evaluations at least, every 3 months during their training, identifying areas in need of improvement, and document the communication in writing. Fellows must obtain a satisfactory overall evaluation on completion of their basic training in order to receive certification.

6.2. Assessment of Fellows

The elements listed below will form part of the assessment of the Fellow during their training.

In addition to evaluation by faculty members and EACTA Representative(s), it will be essential for the Fellow to learn from reflection on their training experiences.

Following assessment tools should be used:

- Evaluation discussions held every three months
- During discussions with Fellows, the tutor or Head of Training will address:



- Results of 360-degree evaluations* and clinical skills evaluations**
- Personal reports from the faculty (if available).
- Reflection and self-assessment by the Fellow.
- Learning goals for the next 3 months.
- Feedback from Fellows on the quality of the education and any aspects of the curriculum that are not being addressed by their training.

*360-degree evaluation (of CanMEDS competencies): 360-degree feedback is a diagnostic tool that helps the candidate to improve his/her personal competencies and supports the self-assessment. During the basic Fellowship at least one 360-degree feedback must include at least 5 persons invited to submit an evaluation of the competencies of the candidate. Feedback is restricted to internal sources (supervising anesthetists, surgeons, nurses) using a standardized questionnaire based on existing multi-source feedback forms [7].

** Clinical skills evaluation (CSE) or Direct Observation of Procedural Skills (DOPS): Clinical skills evaluation (CSE) is intended to give feedback to the Fellow about his ability to plan and perform various clinical tasks. CSE is to be performed by a supervisor, the head of training, or another appropriate person (cardiothoracic anesthetist) based on a standardized form which can be based on already existing forms [8].

The mandatory tasks that must be evaluated during the Fellowship are:

- Pre-anesthetic evaluation including risk.
- Induction of anesthesia in adult patients undergoing cardiac, thoracic and vascular surgery.
- Placement of central venous lines with or without ultrasonic imaging.
- Placement of arterial lines with or without ultrasonic imaging.
- Management of weaning from CPB.
- Placement/insertion of pulmonary artery balloon catheters.
- Lung isolation techniques and fiberoptic bronchoscopy.



6.3. Documentation

Fellows are required to maintain a record of their training in the form of a logbook during their Fellowship. If available, an electronic system such as a computer database may be used. The required information to be documented in the logbook is as follows:

- Anonymized record of patients managed by Fellows during their fellowship. The data set recorded for each case must include a minimum of age, gender, ASA, type of surgery, anesthetic procedure(s), relevant co-morbidities, and if applicable, EuroSCORE II.
- Reports of TEE exams which must comply with the EACVI reporting requirements.
- Summaries of their three-monthly evaluations and related discussions.
- Results of their clinical skills evaluations.
- 360-degree multi-source feedback.

6.4. External evaluation/assessment

At the end of the Fellowship the logbook and all its contents (except the 360-degree multi-source feedback) will be sent to the Chair of the Education Committee. The Chair of the Education Committee will forward it to two EACTA representatives who are external to the host center, for assessment. In addition, Fellows are required to undergo an exit interview by an Advisory Committee formed by two external assessors and the Program Director from the host center. Fellows can apply for the interview once they have met the requirements for number of procedures, required internships outside the operating room, and CSE and 360-degree evaluation. The external evaluation / assessment is scored pass / fail or yes / no (360-degree evaluation). A average score of 70% or above required to pass [Supplement B; EACTA Evaluation



Form]. The Advisory Committee should provide feedback to the Fellow, describing both the strengths and weaknesses of their documentary evidence. Fellows will be awarded certification if they obtain a 'pass' mark on CSE and complete all other assessment tools (e.g., 360-degree evaluation). If this is not the case, training will be deemed incomplete and the Fellow cannot be awarded certification in the EACTA Fellowship Program. These Fellows will have to be enrolled for an additional period of training at the host center under either direct or remote supervision in order to satisfactorily fulfill the requirements. Fellows who feel they were unfairly denied certification may appeal the Advisory Committee's decision within seven days of the day following the interview. The appeal must be submitted in the form of a signed and dated letter to the Chair of the Education Committee and sent by registered mail within the expiration period. The decision of the Advisory Committee regarding the appeal will be communicated to Fellows within twenty calendar days following that on which the appeal was received.

6.5. Program assessment

6.5.1 There will be regular opportunities for Fellows to provide confidential written evaluations of the faculty and program to the EACTA Education Chair.[6]

6.5.2 A Fellow who experiences difficulty during the training period may turn for advice to the Program Director, faculty members, and the head of the department at the host center. A Fellow who feels unable to approach any of these people should contact the Chair of the EACTA Education Committee. The chair can provide confidential, neutral, independent, and informal advice to help Fellows address their concerns. The Chair of the EACTA Education Committee can accompany the Fellow in discussions of problems or issues with



faculty or administrators, and act as an informal mediator between the trainee and the faculty or administrators. The Chair can also help effect positive change by providing feedback on patterns in problems and complaints submitted to the Program Director. Fellows can contact the Chair of the EACTA Education Committee with general questions either via email, telephone or in person.

6.5.3 Periodic evaluation of patient care (quality assurance) is mandatory. Subspecialty trainees in cardiac, thoracic, and vascular anesthesia will be involved in continuing quality improvement and risk management.[9]

6.5.4 Trainees in cardiac, thoracic and vascular anesthesia will actively participate in the periodic evaluation and reassessment of the Fellowship training goals and objectives.[6]

6.5.5 Should unforeseen circumstances arise, such as a personal conflict between a Fellow and one or more tutors, this should be reported immediately to the Chair of the Education Committee. The Board of Directors (BoD) then has the right to appoint an independent EACTA officer as a “mentor” to assist and to help resolve the circumstances as well as to protect both parties.

6. Conclusion

Currently, EACTA continues to develop its Fellowship Program to ensure high-quality, standardized training in CTVA. Consensus is required between centers hosting Fellowship Programs as to the knowledge, skills and competency necessary to master cardiac, thoracic and vascular anesthesia and critical care medicine. The EACTA Curriculum includes requirements for, and certification of basic and advanced training, educational objectives, relevant competencies, as well as learning and teaching methods. Further assessments of both the



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Fellows and the CTVA Fellowship Program are essential to test the efficacy of the current curriculum. The goal of the EACTA Fellowship is to produce highly trained and competent perioperative physicians who are able to care for patients undergoing cardiac, thoracic and vascular anesthesia. The curriculum should be further developed in order to include training for pediatric cardiothoracic and vascular anesthesia.



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8. Tables

Table 1: Basic CTVA Fellowship Rotation Schedule

BASIC PROGRAM	12 months
<i>Modules*</i>	<i>Minimum requirements*</i>
Cardiac anesthesia Intraoperative adult transesophageal echocardiography (TEE) <ul style="list-style-type: none"> • Basic and advanced theory of peri-operative cardiac echocardiography according to EACVI. • Intraoperative training in TEE according to EACVI standards and performance of a comprehensive examination. 	7 months A minimum of 100 cases with CPB (30% not CABG). Candidates must succeed in passing the theoretical part of the EACVI TEE Certification Exam.
Thoracic anesthesia	1.5 months Minimum of 25 thoracic cases
Vascular anesthesia	1 month Minimum of 25 major vascular cases
Post-operative care (PACU) Intensive care (ICU)	1 month Focus on postoperative care of patients who undergone cardiovascular or thoracic surgery
Adult transthoracic echocardiography (TEE) <ul style="list-style-type: none"> • Training in TEE according to EACVI 	0.5 month Training provided by cardiologists.
Interventional cardiology	0.5 month



	In hybrid operating room or cardio laboratory
Extracorporeal perfusion	0.5 month Training provided by perfusionists

Abbreviations: CPB, cardiopulmonary bypass; CABG, coronary artery bypass grafting; TEE, adult transesophageal echocardiography; EACVI, European Association of Cardiovascular Imaging; PACU, post-anesthesia care unit; ICU, intensive care unit.

*Fellows trained for Basic Fellowship in Cardiothoracic and Vascular Anesthesia must complete all modules - according to the time specified. Fellows trained in for Basic Fellowship without cardiac anesthesia (e.g., thoracic and vascular anesthesia) must complete other modules correspondingly longer.



Table 2: Advanced CTVA Fellowship Rotation Schedule

ADVANCED PROGRAM	12 months
<p>Advanced Cardiac Anesthesia Fellowship</p> <p>Main topics:</p> <ul style="list-style-type: none"> • Advanced hemodynamic monitoring. • Management of patients with cardiomyopathy, left heart failure, valve diseases, pericardial diseases. • Heart transplantation. • Mechanical circulatory support, e.g. IABP, LVAD, RVAD, Impella, ECMO. • Pulmonary hypertension, RV failure • Fast-track heart surgery. <p>Intraoperative transesophageal echocardiography</p> <ul style="list-style-type: none"> • Accomplishment of the recommended number of TEE studies according to EACVI. • Assessments of cardiac pathologies related to main topics (above). 	<p>Cardiac anesthesia forms the main topic in the advanced training program in cardiac anesthesia.</p> <p>Candidates must succeed in passing the practical part (e-logbook) of the EACVI TEE Certification Exam.</p> <p>Passing both parts (theoretical and practical) and completion of the certification process by the end of the advanced program is obligatory for granting the Advanced CTVA Fellowship certificate.</p>
<p>Advanced Thoracic Anesthesia Fellowship</p> <p>Main topics:</p> <ul style="list-style-type: none"> • Protective one-lung ventilation. • Selective lobar collapse using bronchial blockers. • Lung and lung isolation airway management (double-lumen endobronchial tubes and bronchial blockers) and fiberoptic bronchoscopy). <p>Regional analgesic techniques for thoracic surgery, e.g., paravertebral block, thoracic epidural block and truncal nerve blockades.</p>	<p>Thoracic anesthesia forms the main topic in the advanced training program in thoracic anesthesia.</p>



<ul style="list-style-type: none"> • Ultrasound-guided blocks. 	
<p>Advanced vascular anesthesia Fellowship</p> <p>Main topics:</p> <ul style="list-style-type: none"> • Preoperative assessment, risk stratification and medical management of vascular patients. • Elective and emergency open aortic surgery. • Endovascular interventional procedures (EVAR, TEVAR, angioplasty). • Carotid artery interventions. • Pain management in vascular patients, with particular reference to critical limb ischemia. 	<p>Vascular anesthesia forms the main topic in the advanced training program in vascular anesthesia.</p>
<p><i>Further modules (optional as an addition)</i></p>	
<p>Intensive and/or intermediate care of adult cardiothoracic and vascular patients</p> <p>Main topics:</p> <ul style="list-style-type: none"> • Circulatory failure (heart failure, shock, cardiorespiratory arrest, cardiac arrhythmias, ischemic heart disease, pulmonary embolism, bleeding complications, vasoplegia). • Respiratory failure (ARDS), pulmonary edema, pneumothorax, pneumonia). • Gastrointestinal failure (peritonitis, pancreatitis, liver failure, NOMI). • Neurological failure (delirium and coma, cerebral ischemia and bleeding). • Airway and chest injuries. • Aortic injuries. • Infectious diseases (SIRS) and sepsis including a sepsis bundle strategy). • Coagulation disorders (DIC), heparin resistance, heparin-induced thrombo- 	<p>3 – 6 months as part of advanced training in cardiac or thoracic and vascular anesthesia.</p>



<p>cytopenia, severe bleeding, transfusion reaction.</p> <ul style="list-style-type: none"> • Equipment and apparatus (equipment design, physics, standards, limitations; e.g. non-invasive and invasive postoperative ventilation, continuous renal replacement therapy devices, non-invasive and invasive hemodynamic monitoring). • Indication, contraindication, drug selection, complications for sedation, anesthesia, analgesia, neuromuscular relaxation, nutrition in the ICU. • Weaning and extubation criteria. • Transfer and discharge criteria. • Extracorporeal circulation for cardiac and/or respiratory support (e.g., ECMO). • Respiratory support including endotracheal suction, bronchoscopy (lavage, sampling), percutaneous tracheotomy, invasive and non-invasive ventilation techniques, ventilation in prone position, weaning. • Hemodynamic management and stabilization, including advanced cardiovascular monitoring, positive inotropic and vasoactive therapy, basic and advanced life support, defibrillation, cardioversion, pacing. • Fluid substitution, intra-vascular volume management. • Correction of coagulopathy, patient blood management, blood product transfusion. • Acute kidney injury and renal replacement therapy. 	
<p>Organizational or research module</p> <p>Main topics:</p>	<p>3–6 months.</p>



- Communicating effectively with surgical colleagues and other members of the team.
- Summarizing a case for critical care staff.
- Understanding how to communicate with the intubated patient in intensive care.
- Recognizing the need for senior help when appropriate.
- Maintaining accurate clinical records.
- Presenting material at departmental meetings and participating in clinical audits.

Skills

- Full participation in multi-disciplinary clinical audits.
- Commitment to continued professional development.

Abbreviations: IABP, intra-aortic balloon counterpulsation; LVAD, left ventricular assist device; RVAD, right ventricular assist device; ECMO, extracorporeal membrane oxygenation; RV, right ventricle; TEE, transesophageal echocardiography; (T) EVAR, (thoracic) endovascular aortic/aneurysm repair; EACVI, European Association of Cardiovascular Imaging; ARDS, adult respiratory distress syndrome; NOMI, nonocclusive mesenteric ischemia; SIRS, systemic inflammatory response syndrome; DIC, disseminated intravascular coagulopathy; ICU, intensive care unit

Table 3: Common and different aspects between the basic and advanced training periods

	Basic Training	Advanced Training
Requirement	Obligatory	Optional
Duration	12 months	12 months
Rotations / Modules	Fixed rotations in different areas.	Modular rotations
Prerequisites for entry	Appropriate language skills (B2) License to practice medicine and a specialist degree examination in anaesthesiology at national level	Completion of basic EACTA training
EACVI TEE Certification Exam (only for cardiac anaesthesia Fellows)	Theoretical part	Practical part – eLogbook
Number of procedures, 360-degree evaluation and clinical skills evaluation	Reviewed by the end of training	Reviewed by the end of training
Exit exam	No	No
Exit interview	Required at the end of basic training	Required at the end of advanced training



9. Supplements

- Supplement A

Basic training (in accordance with [1]) [1-5]

1.1 General patient assessment and risk estimation

Relevant knowledge (generally *Level A*)

- Physiology of the heart, the circulatory system and the respiratory system. Basic knowledge of embryological development of cardiac, thoracic and vascular structures.
- Pre-operative invasive and non-invasive assessment of cardiac diseases and interpretation of results including electrocardiogram (ECG), chest X-ray, echocardiography, cardiac stress testing, coronary angiography, cardiac magnetic resonance imaging (cMRI), and computer tomography (CT).
- Pre-operative pulmonary evaluation and interpretation of the results, including arterial blood gas and acid-base analysis, pulmonary function tests, oximetry and thoracic imaging.
- Patient information and informed consent including medico-legal aspects, appraisal of discernment and consent capacity.
- Principles of risk and outcome assessment and relevant scoring systems (e.g., EuroSCORE).

Skills

- Assessment of patients based on physical examination and history with use of appropriate laboratory tests and examinations. [1] *Level C*
- Scores evaluation, e.g., physical status in accordance with American Society of Anesthesiologists (ASA). [1] *Level D*
- Airway evaluation. *Level C*



- Interpretation and limitations of peri-operative monitoring, including invasive and non-invasive cardiac function tests, pulmonary function tests, blood gas analysis, common radiological imaging, coagulation tests, liver and renal function tests, endocrine function tests, and drug monitoring. *Level C*
- Selection and planning of the individual anaesthesia technique. *Level C*
- Postponement or cancellation of surgery decision making. [1] *Level C*
- Participation in multi-disciplinary (morbidity) conferences. *Level C*
- Pre-operative fasting, pre-medication and adaptation of pre-operative drug therapy. *Level C*

1.2 Anaesthesia management – cardiac surgery

Relevant knowledge (generally *Level A*)

- Knowledge of anesthetic agents and their effects on cardiac function and in patients with cardiac diseases.
- Principles of intraoperative pharmacology and relevant medication, including positive inotropes, chronotropes, vasoconstrictors, vasodilators, and anti-arrhythmic agents.
- Principles of patient blood management, including specific diagnostic tools, application of relevant medication and blood products.
- Principles of basic haemodynamic monitoring and relevant techniques, such as arterial pressure measurement, central venous pressure.
- Principles of relevant neuromonitoring techniques (e.g., processed electro-encephalography (pEEG), near-infrared sonography (NIRS), somato-sensible evoked potentials (SSEP), motor evoked potentials (MEP).



- Principles of conventional cardiopulmonary bypass techniques. Principles of myocardial preservation. Effects of cardiopulmonary bypass on human physiology, organ function, and pharmacology.
- Basic principles of common procedures in cardiac surgery, such as coronary artery bypass grafting (CABG).

Skills

- Workplace preparation following environmental safety measures and checklists. [1] **Level C**
- Use of technical and medical equipment, inclusive advanced haemodynamic monitoring, neuromonitoring, coagulation monitoring and basic peri-operative TOE. **Level C**
- Provision of safe induction, maintenance, and emergence from anaesthesia. **Level C**
- Defibrillation, cardioversion. **Level D**
- Transvenous pacemaker insertion and modes of action; use of a temporary pacemaker. **Level C**
- Central and peripheral venous (ultrasound-guided) access and peripheral arterial catheterization, pulmonary artery catheterization, arterial blood gas collection, and gastric tube insertion.
[1] **Level D**
- Blood salvage and transfusion. **Level D**
- Organ systems and homeostasis maintenance throughout cardiac surgery procedures. **Level C**
- Interpretation of point-of-care coagulation monitoring such as rotational thromboelastometry (ROTEM) and thromboelastography (TEG). **Level C**
- Management of patients on cardiopulmonary bypass. **Level C**
- Diagnosis and management of intraoperative critical incidents including. **Level C**
 - allergic reactions, anaphylaxis,
 - gas embolism, aspiration pneumonia and pneumothorax,



- hypoxia, hypercarbia, hypoventilation, hyperventilation, high ventilator peak inspiratory pressures,
 - hypertension (systemic / pulmonary), hypotension, arrhythmias, myocardial ischemia, cardiac failure, cardiopulmonary resuscitation,
 - oliguria, anuria,
 - intra-operative blood gas and electrolyte disturbances,
 - intra-operative awareness,
 - adverse blood products transfusion reaction,
 - coagulopathy and excessive bleeding,
 - systemic inflammatory response syndrome (SIRS) / postoperative vasoplegic syndrome (PVS).
- Management of patient transport to and from the intensive care unit (ICU). **Level C**
 - Consideration of ethical and medico-legal aspects. **Level C**

1.3 Anaesthesia management – thoracic surgery

Relevant knowledge (generally **Level A**)

- Principles of pulmonary evaluation as described previously, and basic knowledge in the interpretation of results from pulmonary function tests, lung perfusion testing and CT.
- Knowledge of the bronchial anatomy.
- Knowledge about relevant anesthetic agents and their effects in patients with lung diseases.
- Principles of intraoperative pharmacology and relevant medication, including bronchodilators and steroids.
- Basic principles of common procedures in thoracic surgery (mediastinoscopy, video-assisted thoracoscopic surgery (VATS), open lung resection, pneumonectomy).



- Basic principles of endoscopic pulmonary procedures, such as bronchial stenting and endoscopic lung volume reduction (ELVR).

Skills

- Bronchoscopic examination to verify the position of a lung-separation device and to confirm the correctness of the bronchus to be stapled and the patency of the other bronchi. **Level C**
- Provision of safe induction, maintenance, and emergence from anaesthesia in patients undergoing thoracic surgery of varying complexity, including airway management, the decision of which drug to use, one-lung ventilation technique, and management of intraoperative adverse events. **Level C**

Management of most common peri-operative critical incidents and complications including:

Level C

- bronchospasm,
 - hypoxemia, hypercapnia,
 - pneumothorax,
 - pulmonary hypertension.
- One-lung ventilation with a double-lumen tube. **Level C**
 - One-lung ventilation with other techniques (e.g., Arndt blocker, EZ blocker). **Level B**
 - Postoperative pain management, including epidural and paravertebral analgesia. **Level C**
 - Additional techniques in pain management (e.g., epidural analgesia, truncal blocks, multimodal analgesic techniques). **Level B**



1.4 Anaesthesia management – major vascular surgery

Relevant knowledge (generally *Level A*)

- Knowledge of peri-operative management for vascular patients undergoing vascular interventions, including anesthetic choices, perioperative monitoring, and risk identification.
- Basic principles of the peri-operative management of lumbar drainage for aortic interventional procedures.
- Basic principles of spinal cord protection during surgical and interventional aortic procedures.
- Basic principles of neuromonitoring.

Skills

- Pre-operative assessment, risk stratification and medical management of vascular patients.

Level D

- Provision of safe induction, maintenance, and emergence from anaesthesia in patients undergoing vascular surgery of varying complexity, including airway management, the decision of which drug to use, haemodynamic management, and management of intraoperative adverse events. *Level C*

- Management of the most common perioperative critical incidents and complications including

Level C

- acute kidney injury,
- neurological insults,
- paraplegia,
- post-reperfusion syndrome.

- Management of elective and emergency open abdominal aortic aneurysms (AAA) and AAA repair. *Level D*

- Management of carotid endarterectomy, angioplasty, or stenting. *Level D*



1.5 Post-operative care/ Critical care

Relevant knowledge (generally *Level A*)

- Scoring systems in the ICU (e.g. the Sequential Organ Failure Assessment (SOFA), the Simplified Acute Physiology Score (SAPS), the Confusion Assessment Method (CAM)-ICU).
- Etiology, pathophysiology, diagnosis and treatment plans / bundles according to international standards for specific critical conditions in cardiothoracic and vascular surgery patients. [1]
- Circulatory failure (heart failure, shock, cardiorespiratory arrest, cardiac arrhythmias, ischemic heart disease, pulmonary embolism, bleeding complications, vasoplegia).
- Anaphylaxis.
- Respiratory failure, including adult respiratory distress syndrome (ARDS), pulmonary edema, pneumothorax, pneumonia.
- Acute kidney injury and failure.
- Gastrointestinal failure, peritonitis, pancreatitis, liver failure, non-occlusive mesenteric ischemia (NOMI).
- Neurological failure (delirium and coma, cerebral ischemia and bleeding).
- Airway and chest injuries.
- Aortic injuries.
- Infectious diseases (systemic inflammatory response syndrome (SIRS) and sepsis, including sepsis bundle strategy).
- Coagulation disorders (disseminated intravascular coagulopathy (DIC), heparin resistance, heparin-induced thrombocytopenia, severe bleeding, transfusion reaction).
- Equipment and apparatus (equipment design, physics, standards, limitations; e.g. non-invasive and invasive postoperative ventilation, continuous renal replacement therapy devices, non-invasive and invasive haemodynamic monitoring). [1]



- Indication, contraindication, drug selection, complications: sedation, anaesthesia, analgesia, neuromuscular relaxation, nutrition. [1]
- Multimodal and pre-emptive analgesia concepts. [1]
- Weaning and extubation criteria. [1]
- Transfer and discharge criteria. [1]
- Indications for and application of extracorporeal circulation in intensive care patients for cardiac and / or respiratory support (e.g., ECMO).

Skills

- Physical examinations and patient assessment (e.g., respiratory and peristaltic sounds, temperature gradient capillary refill). **Level D**
- Applying sedation, general anaesthesia, multimodal analgesia. **Level D**
- Management of the airways, inclusive of emergency intubation. **Level D**
- Central venous, peripheral venous, arterial catheters, and pleural drains insertion using aseptic techniques. **Level D**
- Gastrointestinal tube insertion. [1] **Level D**
- Airway maneuvers inclusive of suction of endotracheal secretions, tracheotomy (percutaneous), bronchoalveolar lavage and sampling. **Level B**
- Invasive ventilation including prone position ventilation and weaning strategies. **Level B**
- Delivery of continuous positive pressure ventilation and non-invasive ventilation. **Level B**
- Haemodynamic stabilization and management, inclusive of pacing, cardioversion, defibrillation, advanced and basic life support, vasoactive and inotropic therapy, advanced cardio-vascular monitoring. **Level B**
- Volaemia management and fluids administration. **Level D**



- Management of blood product transfusion and coagulopathies correction. **Level D**
- Renal replacement therapy and acute renal failure. **Level B**
- Identification of relevant pre-existing co-morbidities. **Level D**
- Responding to trends in physiological variables. **Level D**
- Patient transportation inter- and intra-hospital. **Level B**
- Arterial and central venous line cannulation (ultrasound-guided). **Level D**
- Myocardial infarction, pulmonary embolism, tamponade, hypovolemia. **Level D**
- Assessment of intravascular volume status. **Level C**
- Recognition of substantial pericardial or pleural effusion. **Level B**

1.6 Basic peri-operative echocardiography

Relevant knowledge (generally **Level A**)

- Principles of basic theory of peri-operative cardiac echocardiography according to the European Association of Cardiovascular Imaging (EACVI) / EACTA process of certification for TOE. [5]

Skills

- Basic levels of peri-operative TOE and lung and vessel ultrasonography as performed in the operating room. **Level C**
- Performance of the recommended number of peri-operative echocardiography exam according to EACVI / EACTA certification guidelines. [5] **Level D**

1.7 Anaesthesia management – interventional procedures in cardiology

Relevant knowledge (generally **Level A**)

- Basic principles of common procedures in interventional cardiology, such as coronary angiography, ablation, transcatheter aortic valve replacement (TAVR), and mitral / tricuspid clipping with relevant complications.



- Procedural sedation guidelines from the European Board of Anaesthesiology (EBA)/ European Society of Anaesthesiology (ESA).[1]
- Monitoring and capnography use according to the safety recommendations from EBA. [1]

Skills

- Safe induction of, maintenance of, and emergence from anaesthesia in patients undergoing interventional cardiac procedures, including the decision of which drug to use, ventilation techniques, management of airways and management of intraoperative adverse events. **Level C**
- Sedation for invasive procedures in cardiology. **Level D**
- Sedation and anaesthesia outside the operating theatre, also considering the local organisation and the specific patients and procedures. **Level D**

1.8 Extracorporeal perfusion management

Relevant knowledge (generally **Level A**)

- Basic principles of extracorporeal perfusion.
- Types of extracorporeal circuits, e.g., cardiopulmonary bypass (CPB), extracorporeal membrane oxygenation (ECMO).
- Types, composition and mechanisms of cardioplegic solutions.
- Cardioprotective measures.
- Safety recommendations for extracorporeal circulation from the European Board of Cardiovascular Perfusion (EBCP).

Skills

- Providing the theoretical background of extracorporeal circulation and associated subject areas, including:
 - Anticoagulation monitoring and management. **Level D**
 - Cardioprotective measures (cardioplegia, hypothermia). **Level D**



- Acid-base management (alpha-stat vs. pH-stat). **Level D**
- Management of complications, e.g., air entry, CPB failure. **Level D**

Advanced training [1-5]

In cooperation with the local Programme Director, after the completion of the basic training, the fellow can design the advanced training to include any or a combination of the following options.

2.1 Anaesthesia management – cardiac surgery

Relevant knowledge (generally **Level A**) as described previously, as well as the followings:

- Principles of advanced haemodynamic monitoring and relevant techniques, such as use of the pulmonary artery catheter, continuous cardiac output monitoring and measurement.
- Principles of modified cardiopulmonary bypass (minimized CPB, left-heart CPB) and the off-pump revascularization technique.
- Principles of advanced procedures in cardiac surgery and clinical management of affected patients (valve surgery and thoracic aortic surgery, including ascending, transverse, and descending aortic surgery with circulatory arrest).
- Principles and state of the art of mechanical support including intra-aortic balloon pumps, and extracorporeal membrane oxygenation.
- Current state of temporary and long-term mechanical circulatory support (ventricular assist devices, total artificial hearts).
- Principles of use of inhaled pulmonary vasodilators (nitric oxide (NO), prostaglandins).
- Principles of fast-track surgery.

Skills as described previously, as well as the followings:

- Clinical management of patients with pericardial diseases. **Level D**



- Management of cardiomyopathy patients and of those with congenital and acquired valvular heart disease, electrophysiological disturbances, congenital heart disease, heart failure, infectious and neoplastic cardiac diseases. **Level D**

2.2. Anaesthesia management – thoracic surgery

Relevant knowledge (generally **Level A**) as described previously, as well as the followings:

- Principles of common procedures in thoracic surgery (open and thoracoscopic lung resections, robotic lung resection, lung volume reduction surgery, mediastinoscopy, pneumonectomy).
- Principles of diagnostic and interventional bronchoscopic surgery (lung volume reduction, bronchopulmonary lavage; endoscopic, rigid fiber optic and laser resection; bronchial stenting and sealing).
- Principles of peri-operative management of esophageal surgery for varices, neoplastic, colon interposition, foreign body, stricture, and tracheoesophageal fistula.

Skills as described previously, as well as the followings:

- Alternative ventilation techniques in thoracic surgery (e.g., jet ventilation). **Level D**
- Principles of postoperative chronic pain management. **Level D**

2.3. Anaesthesia management – major vascular surgery

Relevant knowledge (generally **Level A**), as described previously as well as the followings:

- Knowledge of perioperative management of TEVAR and EVAR.
- Knowledge of the principles of perioperative management of lumbar drainage for aortic interventional procedures.
- Excellent knowledge of the principles of spinal cord protection during surgical and interventional aortic procedures.
- Excellent knowledge of the principles of cerebral function monitoring.



Skills as described previously, as well as the followings:

- The use of rapid ventricular pacing (RVP) during deployment of the stent for TEVAR. **Level B**
- Pain management for patients undergoing vascular procedures. **Level B**
- Anaesthesia for peripheral vascular procedures. **Level C**
- Care of patients undergoing limb amputation. **Level D**
- Pain management, with particular reference to critical limb ischemia. **Level B**

2.4. Post-operative management/ Critical care

Relevant knowledge (generally **Level A**), as described previously as well as the followings:

- Knowledge of cardiac and thoracic physiology.
- Postoperative cardiac critical care, including analgesia, sedation and ventilation.
- Postoperative care and analgesia after thoracic surgery.
- An understanding of the management of cardiac pacing modes.
- An understanding of extracorporeal membrane oxygenation and other devices used for mechanical circulatory support.

Skills as described previously, as well as the followings:

- Interpretation of invasive and non-invasive cardiovascular monitoring. **Level D**
- Use of inotropes and vasodilators. **Level D**
- Management of intra-aortic balloon counter pulsation and other mechanical circulatory support devices. **Level C**
- Detection of problems occurring with extracorporeal circulation management. **Level C**
- Anaesthesia for procedures in intensive care, including emergency re-sternotomy, re-intubation, tracheostomy or cardioversion. **Level D**



- Principles and management of chest drains. *Level D*

2.5. Advanced perioperative echocardiography

Relevant knowledge (generally *Level A*), as described previously the followings:

- Advanced level of knowledge in peri-operative cardiac echocardiography according to the EACVI/EACTA process of certification guidelines. [5]

2.6. Heart and/or lung transplantation

Relevant knowledge (generally *Level A*)

- Understanding of the physiology and clinical presentations of end-stage heart and lung disease and surgical options for their management.
- Understanding of the principles of heart transplantation and clinical management of affected patients.
- Knowledge of current limitations of organ transplantation and efforts to increase the suitable donor pool.
- Understanding of the multidisciplinary nature of patient evaluation and listing for transplantation.
- Knowledge of the principles of donor optimization, management and allograft retrieval.
- Knowledge of the principles of ex-vivo heart and lung perfusion.
- Understanding of the physiology of the denervated organ.
- Understanding of the surgical conduct of heart transplantation and knowledge of intra-operative and immediate postoperative care, including stability of induction, ventilation, oxygenation, haemodynamic support, and allograft and noncardiac organ protection.



- Understanding of primary graft dysfunction and indications for mechanical circulatory support.
- Understanding of the surgical options for lung transplantation, including minimally invasive lung transplantation and various intraoperative extracorporeal support mechanisms.
- Knowledge of intra-operative and immediate postoperative care, including protective ventilation, oxygen delivery, haemodynamic support, indications for inhaled NO and other pulmonary vasodilators, allograft and non-pulmonary organ protection.
- Knowledge of the principles of primary lung dysfunction and conservative and extracorporeal treatment options, including indications for and techniques of ECMO
- Understanding of immunosuppressive regimens and the role of postoperative infections and sepsis.

Skills

- Central venous pressure invasive arterial monitoring, pulmonary artery catheter insertion and interpretation. **Level D**
- TOE for monitoring of left and right ventricular function and diagnosis of primary graft dysfunction / failure. **Level C**
- Insertion and management of thoracic epidurals **Level D**

2.7. Organisational module

Skills

- Communicating effectively with patients and their families. [2] **Level D**
- Communicating effectively with surgical colleagues. [2] **Level D**
- Communicating with the intubated patient. **Level D**



- Recognizing the need for senior help. *Level D*
- Maintaining accurate clinical records. *Level D*
- Presentations at departmental meetings. *Level D*
- Participation in multi-disciplinary clinical audits. *Level C*
- Commitment to continued professional development. *Level D*

2.8. Research module

Relevant knowledge (generally *Level A*)

- Principles of clinical trials, including design, end points, inclusion / exclusion criteria, reporting requirements.
- Understanding of Good Clinical Practice (GCP) requirements for clinical research involving patients.
- Understanding of European and specific national ethics frameworks, including research ethics applications, clinical regulatory frameworks and hospital site-specific assessment.
- Principles of sample size and study power determinations and basic statistical evaluation.
- Principles of patient and data confidentiality agreements.
- Understanding tools for data collection, analysis and reporting.
- Principal international basic science priorities in the field of cardiac anaesthesia.
- Ethics and practicalities of biological sample collection, storage and biobanking
- Principles and ethics of scientific publishing.

Skills

- Ability to help design a clinical or basic science research project or part of it as a member of the investigative team. *Level D*

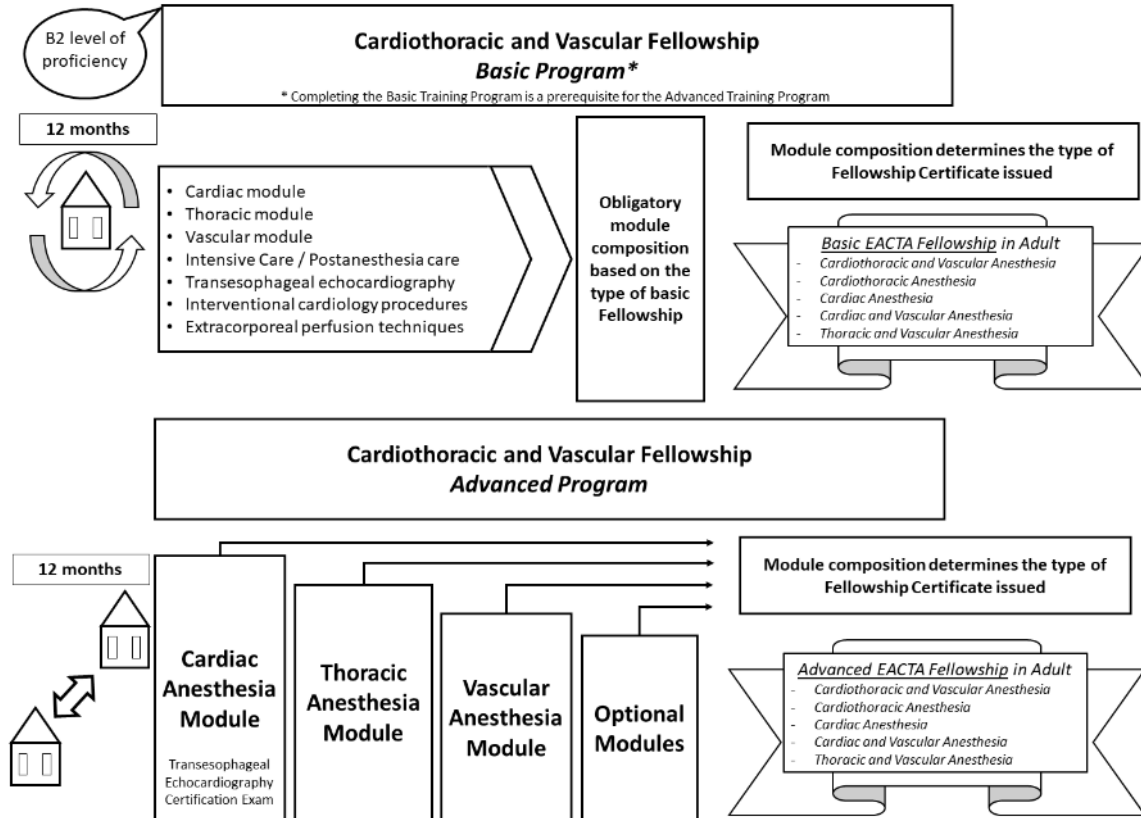


- Ability to help complete an ethics application. *Level C*
- Ability to discuss basic statistical approaches. *Level C*
- Ability to consent, recruit, and follow up research participants according to regulatory frameworks. *Level C*
- Ability to help analyse data. *Level C*
- Ability to contribute to disseminating study results in abstracts, presentations and publications. *Level C*

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5. The EACVI (European Association of Cardiovascular Imaging) and EACTA (European Association of Cardiothoracic Anaesthesiology) joint process of certification in TEE (Transoesophageal Echocardiography). Available at: <http://www.eacta.org/education/eacvi/accreditation-process/>. Accessed on August 9, 2019.

- Supplement B: Types of EACTA Fellowships





- Supplement C: EACTA Evaluation Form

Fellow's Name: _____

EACTA Fellowship in Cardiothoracic and Vascular Anaesthesia

The final evaluation consists of four assessment tools that are graded by the Advisory Committee: (1) number of cardiac, thoracic, and vascular procedures and TEE/TTE performed, (2) number of internships outside the operating room (OR), (3) results of 360-degree evaluation, and (4) results of clinical skills evaluation (CSE). These documents will be submitted to the Advisory Committee at least two weeks before the interview to give adequate time to review. These evaluation tools are scored by each member of the Advisory Committee, with an average score of 70% or above required to pass. The literature review is scored pass/fail, and a passing grade is required by at least 2 members of the Committee. The Committee should provide feedback to the Fellow, describing both the strengths and weaknesses of each document.

	PROPOSAL	REVIEW
SCORES: 1	<u>Number of procedures</u>	PASS / FAIL
2	<u>Number of internships outside the OR</u>	PASS / FAIL
3	<u>Results of 360-degree evaluation</u>	YES / NO
4	<u>Results of clinical skills evaluations</u>	PASS / FAIL
AVERAGE		

EACTA Education Chair *Date*

Committee Member *Date*

Program Director *Date*