



## CHAPTER 2

# Training and certification in intensive and acute cardiovascular care

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### Summary

Acute cardiovascular care (ACVC) is now a complex and technical subspecialty of cardiology. Specific training in ACVC is warranted, in addition to skills acquired during the initial phase of cardiology training. Data are available that show that this training brings benefits to patients and improves their outcome.

The Association for Acute CardioVascular Care (ACVC) of the European Society of Cardiology (ESC) offers a comprehensive postgraduate programme in ACVC. This programme is in line with the three levels of expertise described for intensive cardiac care unit organization. A curriculum focused on initial training is also available through the American College of Cardiology. Both curricula are competency-based. Teaching practical knowledge and skills through simulation should be integrated throughout training in ACVC. To measure specific and overall achievement in competencies, different and complementary tools are available. Diffusion of the certification process, like the one provided by the ESC-ACVC, is important for ACVC to be recognized as a cardiology subspecialty.

### Introduction

ACVC is now a well-defined, complex field. A typical ICCU is a collaboratively managed multidisciplinary unit, admitting a wide range of patients with acute cardiovascular conditions and comorbidities [1–3]. Acute cardiovascular conditions managed in ICCUs, such as acute heart failure (AHF) or ACS, are most often the acute expression of a CVD that will require long-term follow-up in a specialized cardiovascular setting. In addition to managing patients' immediate presenting clinical issues and prevention of adverse events (AEs), ICCUs should contribute to the initiation of secondary prevention strategies. Care requirement for a given patient is a dynamic process that may change rapidly, depending on the success or failure of initial management strategies. Many cardiologists working in ICCUs have gained expertise and skills over time with experiential learning. Some have relevant additional training in other subspecialties of cardiology, in general critical care, or in acute cardiac care. As with other critical care specialties [4], there is evidence that a specialized environment for the initial management of acutely ill cardiovascular patients is related to better in-hospital and long-term outcomes [5–7]. Therefore, patients deserve

to be managed by appropriately trained physicians in the specialty, and beyond their general cardiology education, physicians working in an ICCU must have specific training in ACVC [7].

Cardiovascular societies should provide curricula that set standards for training in ACVC. Providing frameworks for certification is also of importance for ACVC to evolve as a subspecialty of cardiology.

## Training in acute cardiovascular care

Training in ACVC should provide cardiologists the appropriate knowledge and technical skills for managing confidently acute cardiovascular patients. In line with intensive care societies, the ESC has recently proposed a grading of ICCUs in three levels, according to the monitoring and care requirements of the patients they manage [8]. The three levels are presented in Table 2.1.

Not all physicians will have to master the techniques required to work in the most demanding ICCUs. A one-size-fits-all approach is not adapted to the challenges of training in ACVC. Expertise and technical skills should match the ICCU gradation. A stepwise approach in training is more appropriate. It should encompass the full spectra of expertise needed to manage acute cardiovascular patients for a given level of ICCU, as well as accompany the cardiologist during all his professional life.

For the sake of clarity and effectiveness, in line with the available curricula, training materials, and ICCU organization, training in ACVC will be presented following a three-step approach, each step with increasing expertise. Table 2.2 presents technical competencies for each step. This approach is a little arbitrary because the actual level of acuity and risk of a patient is not always known immediately. Moreover, the response to initial treatment might dramatically change the expertise needed for managing an acute clinical condition.

Beyond a common basis that provides the minimal expertise needed to manage level 1 patients and work in level I ICCUs,

additional training will allow for additional expertise and technical skills to care for more demanding acute cardiovascular patients managed in higher-level ICCUs [8–12].

### First step

The first step (Step 1) refers to the essentials in ACVC that should be common to all cardiologists. There is the need of a common basis in knowledge and skills in ACVC shared by all cardiologists. It enables them to approach the critically ill cardiac patient in a systematic fashion, understand the range of acute cardiovascular conditions and therapeutic options, and ensure appropriate referral is made where required. Therefore, this level of training should be done during the fellowship, as is advocated in the ESC general cardiology CC and the American College of Cardiology (ACC) Core Cardiovascular Training Statement 4 by Task Force 13 (COCATS 4-TF 13).

### Second step

This second step (Step 2) will provide for specific expertise in advanced ACVC. This level of training should be sanctioned by a qualifying examination that measures specific knowledge, skills, and competence. It supposes additional training after a fellowship, especially in some aspects of critical care. The full ESC-ACVC CC, complete with the practical assessment, fulfils this prerequisite [13]. Some university diplomas also do.

### Third step

The third step (Step 3) draws as much from acute cardiology as from critical care [7]. It focuses on complete autonomy and advanced expertise in specific fields, i.e. ventilator management, multiorgan dysfunction management, end-of-life care (EoLC), and assist devices. This level of expertise might be reached through advanced training in ACVC and additional education in critical care on top of what is already required in Step 2 [8–10, 14].

**Table 2.1** Level of intensive cardiac care units according to the ESC

Level I	<ul style="list-style-type: none"> <li>◆ Level I ICCUs are designed to manage patients with cardiovascular conditions demanding level 1 care, i.e. cardiovascular conditions requiring careful cardiac rhythm and non-invasive haemodynamic monitoring, as well as some specific treatments (vasoactive drugs, non-invasive bi-level positive airway pressure or continuous positive airway pressure, chest tube insertion, and monitoring)</li> <li>◆ These units mainly focus on the care of patients with ACS, congestive heart failure without shock (or rapidly improving patients with low cardiac output), or complex, not life-threatening arrhythmias. These units may also offer specific monitoring to patients post-structural and endovascular interventions</li> </ul>
Level II	<ul style="list-style-type: none"> <li>◆ Level II ICCUs are designed to manage level 1 and level 2 patients</li> <li>◆ Level 2 patients refers to those with acute cardiovascular conditions whose risk requires central venous access and/or an arterial line for monitoring central venous pressure and arterial pressure, respectively, and/or sampling of central venous or arterial blood, as well as continuous infusion of multiple cardioactive drugs (because of low cardiovascular output or compromised organ perfusion)</li> <li>◆ Additional relevant interventions considered as level 2 include temporary transvenous pacing, percutaneous cardiac assist device (intra-aortic balloon pump or percutaneous axial pump), and pericardiocentesis. Level II ICCUs should provide initial evaluation and management of severe or high-risk patients with congestive heart failure and/or low cardiac output complicating acute or chronic cardiac conditions</li> </ul>
Level III	<ul style="list-style-type: none"> <li>◆ Level III ICCUs are designed to care for level 3 patients who have acute cardiac conditions that are severe enough to require, or be at high risk of needing, invasive mechanical ventilation, renal replacement therapy, extracorporeal life support, emergent heart surgery, or surgical cardiovascular assistance</li> </ul>

Source data from Bonnefoy-Cudraz E, Bueno H, Casella G, et al. Editor's Choice—Acute Cardiovascular Care Association Position Paper on Intensive Cardiovascular Care Units: An update on their definition, structure, organisation and function. *Eur Heart J Acute Cardiovasc Care*. 2018;7(1):80–95. doi:10.1177/2048872617742629.

**Table 2.2** Techniques with expected full competency according to training step

Step 1 training	Step 2 training	Step 3 training
<ul style="list-style-type: none"> <li>◆ All non-invasive clinical parameter monitoring</li> <li>◆ 24/7 echocardiography and thoracic ultrasound</li> <li>◆ Direct current cardioversion</li> <li>◆ Non-invasive ventilation</li> <li>◆ Transcutaneous temporary pacing</li> <li>◆ Chest tubes</li> </ul>	<ul style="list-style-type: none"> <li>◆ All invasive haemodynamic monitoring</li> <li>◆ Ultrasound-guided central venous line insertion</li> <li>◆ Pericardiocentesis</li> <li>◆ Transvenous temporary pacing</li> <li>◆ Transoesophageal echocardiography</li> <li>◆ Pulmonary artery catheterization/right heart catheterization</li> <li>◆ Percutaneous circulatory support (intra-aortic balloon pump, Impella®)</li> <li>◆ Targeted temperature management</li> </ul>	<ul style="list-style-type: none"> <li>◆ Extracorporeal life support</li> <li>◆ Mechanical circulatory support expertise (left ventricular assist device, biventricular ventricular assist device)</li> <li>◆ Renal replacement therapy</li> <li>◆ Mechanical ventilation</li> </ul>

## Curricula in acute cardiovascular care

The ESC and ACC provide curricula on Step 1 training in ACVC [12, 13]. These curricula use a well-defined, competency-based framework that comprehensively describes individual aspects of training in the subspecialty and presents the requirements for training institutions and trainers. The ESC-ACVC presents a specific curriculum for Step 2 training in ACVC that is associated with a certification process and defines the minimum requirements to qualify as a cardiovascular intensivist.

## Competency-based training

Training in ACVC is well suited for competency-based curricula [15]. Competency-based education states that a trainee is ready to graduate from the training programme only after mastering the knowledge (core competencies) and specific skills (or actions, decisions, and activities) called ‘entrustable professional activities’, or EPAs, of a specialty [16, 17]. In theory, a curriculum based on learning objectives permits flexibility in the duration of training, allowing for personalized and/or adjusted training pathways. Competency-based curricula allow to insert competencies drawn from curricula of other specialties. This is of interest in ACVC where many fields imply cross-sectional knowledge and multidisciplinary collaboration [18]. As EPAs are observable and measurable, this allows formal and objective assessment.

However, this training model is demanding. It requires generating a comprehensive list of EPAs, disciplined and rigorous assessment/self-assessment, and potentially difficult and comprehensive evaluation by the faculty. EPAs can be relatively difficult to define and even more difficult to assess. That is why it might be interesting to base this training on available training materials like the ones provided by the ESC-ACVC.

## Simulation for training in acute cardiovascular care

Clinical hours can be substituted, in part, with simulation [19]. The simulation world has expanded. Components of a successful simulation programme—faculty members trained in simulation pedagogy, experts providing debriefing, and simulation settings

that create a realistic environment—are now well defined and becoming largely available [20, 21]. Beyond procedural skills, there is strong evidence that simulation is effective in teaching communication and teamworking skills that are so important in ACVC [22].

Simulation-based training and education should be integrated throughout the ACVC programme and must be consistent with the curriculum vision and end-of-programme outcomes [23]. Therefore, it is important to review the end-of-programme outcomes and map the simulation courses to the curriculum. This allows for simulation training to coincide with the level of the learner and to precisely determine how the simulation courses are expected to contribute to the overall development of trainees graduating from the ACVC curriculum [21].

## Acute cardiovascular care EPA in the ESC core curriculum for the general cardiologist

A general cardiologist should be able to work and take night-time duties in a level I ICCU. Training in ACVC of such a physician is described in the Acute Cardiovascular Care section of the ESC General Cardiology Core Curriculum. It consists in the following EPAs:

- ◆ Managing pharmacologic agents.
- ◆ Advanced diagnostic and therapeutic techniques in the ICCU.
- ◆ Acute complications of chronic cardiac conditions and patients with complications of invasive cardiovascular procedures.
- ◆ Cardiac patients in the context of critical illness and organ dysfunction.
- ◆ Patients with haemodynamic instability and shock.

It also emphasizes multidisciplinary teamwork skills and coordination of care in the ICCU, as well as participating in decision-making and end-of-life issues.

## The ESC-ACVC acute cardiovascular care curriculum

The ESC-ACVC curriculum concerns primarily cardiologists who have already completed advanced training in cardiology to the level required for certification as a cardiologist at a national

level. It is relevant to those board-certified or country-recognized cardiologists who wish to be certified in acute cardiac care. Therefore, it is Steps 2 to 3 training that presents the range of knowledge, skills, behaviours, and attitudes required to independently manage cardiovascular emergencies and critically ill cardiac patients and their comorbidities in level II and level III ICCUs. It emphasizes the importance of a step-up and step-down strategy from the ICCU and teamworking. Beyond recommendations for training of those intending to be expert in acute cardiac care, it provides a framework for continuing education of those already practising in the area.

The ESC-ACVC curriculum is divided into around 20 acute cardiovascular critical care topics. Each topic presents a list of objectives, knowledge, skills, behaviour, and attitude. The curriculum is closely related to ESC teaching resources. The ESC-ACVC's *ESC Textbook of Intensive and Acute Cardiovascular Care* maps the knowledge, skills, and professional domains of the subspecialty. Therefore, it is at the core of the theoretical knowledge required in the curriculum. Other learning tools available for training are the current ESC guidelines, the ESCeL programme, and other teaching materials from the different and relevant associations and working groups of the ESC.

The ESC-ACVC curriculum puts special emphasis on practical training. Beyond a precise description of skills and behaviours, it asks for rotations in specific environments that will provide a cardiologist with the competencies to work in a level II or III ICCU.

The first part covers 9 months in general cardiology training (3 months in general intensive care, 6 months in an ICCU), with on-call/night-time/weekend duties with the equivalent of at least 1 night per week for at least 3 years. This will give the physician in training the autonomy in managing patients in a level II ICCU. Additional training of 12 months post-residency as a junior attending physician [6 months in a level II or III ICCU, 6 months in a post-operative cardiovascular intensive care unit (ICU) or general medical critical care ICU] will allow the physician to be fully in charge of a level II ICCU and contribute confidently to the management of patients in a level III ICCU.

## The ACC COCATS 4-TF 13

The ACC states that the essentials in ACVC should be integrated in the cardiovascular disease fellowship training programme [3 years in the United States (US)]. The COCATS 4-TF 13 is a competencies-based curriculum in ACVC that focuses on Step 1 competencies. The minimum duration of practical training is 8 weeks in ICCUs over the course of the first 24 months of training. Many knowledge and skills relevant to ACVC will be acquired through other rotations, especially in electrophysiology, cardiac catheterization, imaging, and heart failure. As in most documents on training provided by the ACC [24], training in ACVC addresses the six general competencies promulgated by the Accreditation Council for Graduate Medical Education (ACGME)/American Board of Medical Specialties (ABMS). This allows for consistencies between training for ACVC and other

training recommendations provided by the ACC. These general competencies are: (1) medical knowledge; (2) patient care and procedural skills; (3) practice-based learning and improvement; (4) systems-based practice; (5) interpersonal and communication skills; and (6) professionalism (see Box 2.1) [25].

For each competency and domain, the document provides milestones with the stage of fellowship training by which a trainee should achieve the designated level. Contrarily to the ESC-ACVC curriculum, there are no specific guidelines for advanced training in ACVC beyond suggesting an additional 3–6 months of clinical training within the 3-year cardiovascular medicine fellowship.

## Assessment of competencies

For the practical part of the training, there is a consensus that learning outcomes are preferred to recommendations based solely on the amount of time spent in a department and/or on the number of procedures performed [24]. In Europe, practical training in ACVC also depends upon the training pathways in cardiology already in place throughout the ESC member states.

As in many medical fields, statements on what is practical competencies achievement are mainly based on expert experience and opinion [26]. The methods and tools used to assess competency in ACVC training are in line with those recommended in acute and critical care [27].

Assessment and validation processes need to be under the control of the programme director or his/her equivalent [12, 13]. They are responsible for confirming experience and competence

### Box 2.1 ACGME core competencies

- ◆ *Patient care*—that is compassionate, appropriate, and effective for treating health problems and promoting health
- ◆ *Medical knowledge*—about established and evolving biomedical, clinical, and cognate (e.g. epidemiological and social-behavioural) sciences and application of this knowledge to patient care
- ◆ *Practice-based learning and improvement*—that involve investigation and evaluation of a fellow's patient care, self-appraisal, and assimilation of scientific evidence and improvements in patient care
- ◆ *Interpersonal and communication skills*—that result in effective information exchange and teaming with patients, their families, and other health professionals
- ◆ *Professionalism*—as manifested by a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient population
- ◆ *Systems-based practice*—as manifested by actions that demonstrate an awareness of, and a responsiveness to, the larger context and system of health care and the ability to effectively call on system resources to provide care that is of optimal value

**Box 2.2** Evaluation tools

- ◆ Direct observation by instructors
- ◆ In-training examinations
- ◆ Case logbooks
- ◆ Conferences
- ◆ Case presentations
- ◆ Multisource evaluations
- ◆ Trainee portfolios
- ◆ Simulation

and for reviewing the overall progress of individual trainees. The clearer and more precise the process, the easier it will be for the programme director to assume this role. Defining representative curricular milestones during training will help in identifying trainees and areas that require additional focused attention.

Most curricula state that trainees should maintain records of participation and advancement in the form of a logbook that summarizes predefined pertinent information. Some evaluation tools that may be part of this logbook are presented in Box 2.2.

Competency to perform procedures should be based on evaluation by a supervising physician [28].

There are some controversies on the need of defining the number of procedures required to achieve technical competencies [12, 13, 24]. The number of procedures performed (as well as the length of exposure) are uncertain proxies of proficiency and outcome. When they exist, these numbers are based on consensus about the educational needs and progress of typical trainees and are intended as general guidance, not absolute thresholds. In some cases (e.g. central venous access, echocardiography), more robust evidence exists [29].

Procedural volume targets are not provided by the ACC, but it suggests anyway the completion of a logbook. The ESC-ACVC curriculum does not provide specific numbers either but suggests the numbers of procedures are made available for those preparing for the ACVC certification exam as a guidance.

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## Certification in acute cardiovascular care

Ideally, any curriculum in ACVC should lead to a process of formal certification.

Step 1 training that is part of the fellowship, as with the COCATS 4-TF 13 curriculum or the ESC general cardiology CC, does not suppose formal dedicated certification.

The full ESC-ACVC certification process provides an example of a Step 2 certification in ACVC. Certification consists of two parts: (1) demonstration of theoretical knowledge; and (2) demonstration of competence. The first part is validated through an MCQ-based exam. The second part, which is demonstration of competence, is validated through a logbook confirming the procedures undertaken and countersigned by the trainee's educational supervisor (or equivalent) to confirm they have met the required levels of competence. It should also show that the required training programme (9 or 21 months) has been undertaken and evidence of ongoing training and assessment during the training period. The whole certification is presented in detail [30]. The ESC-ACVC certification is prestigious and, in some cases, nationally recognized. That it does not yet confer recognized additional privilege is mainly related to the absence of a recognized ACVC subspecialty in most European countries. The ESC-ACVC certification provides important standards of knowledge and skills in ACVC and a clear roadmap to reach these standards. Such standards should help national cardiology societies to promote training and education in ACVC, thereby improving the quality of care and outcomes of patients with acute CVD.

Level III ICCUs are highly specialized cardiovascular critical care units. Physicians managing patients in such environment should demonstrate advanced expertise in ACVC, as well as competencies in critical care. There is evidence that these specific competencies improve patient care [5]. Provided full practical training (21 months) has been validated, the ESC-ACVC certification is the nearest to Step 3 training, drawing from both critical care and ACVC. Other options are available at national levels. Some universities provide a diploma after validating the specific training in ACVC they organize [11]. A dual certification in cardiology and critical care is possible in some European countries and the US [9, 10, 14, 31, 32]. The training consists of a full curriculum in cardiology and at least 12 additional months in critical care, allowing the certification process of both specialties to be validated.

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## Personal perspective

- ◆ How many physicians will be willing to focus their practice in this field, and will it justify the development and multiplication of national programmes?
- ◆ Moreover, there is a large gender disparity in this field (only 3.3% of dual-certified critical care cardiologists are women) [7]. It has been suggested that improved mentorship for women considering critical care cardiology and ongoing diversity task force implementation will aid in closing the gender gap [7, 33].
- ◆ Lifelong education in ACVC.

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