

# Acute Cardiovascular Care Association Position Paper on Intensive Cardiovascular Care Units: An update on their definition, structure, organisation and function

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## Abstract

Acute cardiovascular care has progressed considerably since the last position paper was published 10 years ago. It is now a well-defined, complex field with demanding multidisciplinary teamworking. The Acute Cardiovascular Care Association has provided this update of the 2005 position paper on acute cardiovascular care organisation, using a multinational working group. The patient population has changed, and intensive cardiovascular care units now manage a large range of conditions from those simply requiring specialised monitoring, to critical cardiovascular diseases with associated multi-organ failure. To describe better intensive cardiovascular care units case mix, acuity of care has been divided into three levels, and then defining intensive cardiovascular care unit functional organisation. For each level of intensive cardiovascular care unit,

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this document presents the aims of the units, the recommended management structure, the optimal number of staff, the need for specially trained cardiologists and cardiovascular nurses, the desired equipment and architecture, and the interaction with other departments in the hospital and other intensive cardiovascular care units in the region/area. This update emphasises cardiologist training, referring to the recently updated Acute Cardiovascular Care Association core curriculum on acute cardiovascular care. The training of nurses in acute cardiovascular care is additionally addressed. Intensive cardiovascular care unit expertise is not limited to within the unit's geographical boundaries, extending to different specialties and subspecialties of cardiology and other specialties in order to optimally manage the wide scope of acute cardiovascular conditions in frequently highly complex patients. This position paper therefore addresses the need for the inclusion of acute cardiac care and intensive cardiovascular care units within a hospital network, linking university medical centres, large community hospitals, and smaller hospitals with more limited capabilities.

## Keywords

Acute cardiovascular care, intensive cardiovascular care units, ICCU

## 1) Introduction

The mission of the Acute Cardiac Care Association at the European Society of Cardiology (ESC) is 'to improve the quality of care and outcomes of patients with acute cardiovascular diseases'. Central to this mission is the provision of high quality facilities for the management of cardiovascular patients throughout Europe.

In 2005, a task force of the ESC Working Group on Acute Cardiovascular Care was set up to give the first comprehensive recommendations concerning the structure, organisation, and function of an intensive cardiovascular care unit (ICCU).<sup>1</sup> It presented the need for specially trained cardiologists and cardiovascular nurses, the optimum number of staff, the desired architecture of the units, their relations to the other facilities in the hospital and the required equipment.

The purpose of the current document is to update the 2005 position paper, as numerous factors have led to changes in workload and practice of acute cardiology. The traditional coronary care unit role of caring for patients in the immediate aftermath of thrombolysis and with post-myocardial infarction (MI) complications has largely disappeared. The changing patient population requires the ICCU to deliver acute cardiovascular care to a wider variety of cardiovascular conditions.<sup>2,3</sup> Further, the changing demographic of the population across Europe, with increasing numbers of elderly patients presenting acutely with cardiovascular problems such as acute heart failure, valvular heart disease and atrial fibrillation, is also significant. The development and widespread use of high sensitivity troponins have increased the frequency of diagnosis of non-ST-elevation myocardial infarction (NSTEMI) and the in-patient workload.<sup>4,5</sup> Therefore, a typical ICCU nowadays will admit patients with complicated and uncomplicated acute coronary syndromes, worsening heart failure and cardiogenic shock, severe valvular heart disease especially endocarditis, high-grade conduction disturbances, major ventricular arrhythmias, high and intermediate risk pulmonary embolism, cardiac tamponade, aortic dissection, out of and in-hospital cardiac arrest, complications of

invasive procedures and other iatrogenic complications including infection of devices.<sup>3</sup>

In addition, these conditions rarely exist alone but are complicated by additional acute or chronic non-cardiovascular co-morbidities, which may, on occasion, take on greater significance for the management of the patient than the cardiovascular disease. Thus, traditional coronary care units have evolved to become ICCUs. For the purposes of this position paper, this term, that encompasses and describes the full range of admissions to these units, will be used throughout, and is synonymous with the cardiac intensive care unit (CICU).

Healthcare system organisation is heterogeneous throughout Europe and this has significant consequences for the delivery of acute cardiovascular care between different countries.<sup>6</sup> Hospital size, distribution and technical capabilities, historical development of the speciality of acute cardiovascular care and the interaction with other specialties such as general critical care, cardiothoracic intensive care, internal medicine, and emergency medicine varies considerably. There is no clear evidence that any particular established organisational model is better than another. Therefore, we will address the large heterogeneity in units' expertise and clinical management structure and the differences between hospital settings (large, tertiary and/or university vs community hospitals); in addition to emphasising what resources should be available according to the range of conditions to be treated.

This document does not intend to provide definitive answers to the issue of ICCU organisation but rather to contribute to an ongoing reflection of this rapidly changing field.<sup>3,7-9</sup>

## 2) What is an ICCU?

An ICCU is a physically and administratively identified hospital unit dedicated to and specialised in the management of acute cardiovascular conditions. It serves as the primary site of care in that hospital for patients with these

conditions,<sup>1,8</sup> and has continuous ECG and multi-parametric monitoring capabilities and a medical/nursing staff body trained in cardiovascular emergencies. It should have a well-defined organisational model providing 24/7 expertise in acute cardiovascular care in close cooperation with cardiovascular and non-cardiovascular specialties both in and out of the hospital. Further, it actively contributes to the organisation of the review, triage, and outreach management of acute cardiovascular patients outside the geographically defined unit.

A specialised cardiovascular environment for the initial management of cardiovascular patients is closely related to in-hospital and long-term patient follow-up and outcome.<sup>10–12</sup> Acute cardiovascular conditions managed in ICCUs, such as acute heart failure or acute coronary syndromes, are most often the acute expression of a cardiovascular disease that will require long-term follow-up in a specialised cardiovascular setting. Therefore, in addition to managing patients' immediate presenting clinical issues and prevention of adverse events, ICCUs may contribute to mid- and long-term cardiovascular treatment and to the initiation of secondary prevention strategies.

The immediate objectives of the ICCU are the monitoring and support of failing vital functions in acute and/or critically ill cardiovascular patients. All ICCUs must have appropriate diagnostic facilities available to inform delivery of pharmacological and invasive treatment according to the current guidelines.

The ICCU should be under the full medical responsibility of a dedicated cardiovascular team, with a cardiology director, coordinating the care for all patients. The ICCU director should be appropriately trained and qualified in acute cardiovascular care and ICCU management.<sup>1,9</sup> The situation where the non-ICCU physician admitting the patient retains responsibility for orchestrating and implementing care for this patient is not compatible with the objectives of a current ICCU.<sup>13–15</sup> Responsibility for patients' management should be transferred to the dedicated ICCU team. However, the ICCU team must liaise with patients' primary care providers to include them where possible in important discussions such as the appropriateness of high-risk procedures and end-of-life decisions.<sup>7,8</sup>

### 3) Grading the demand of care for acute cardiovascular diseases

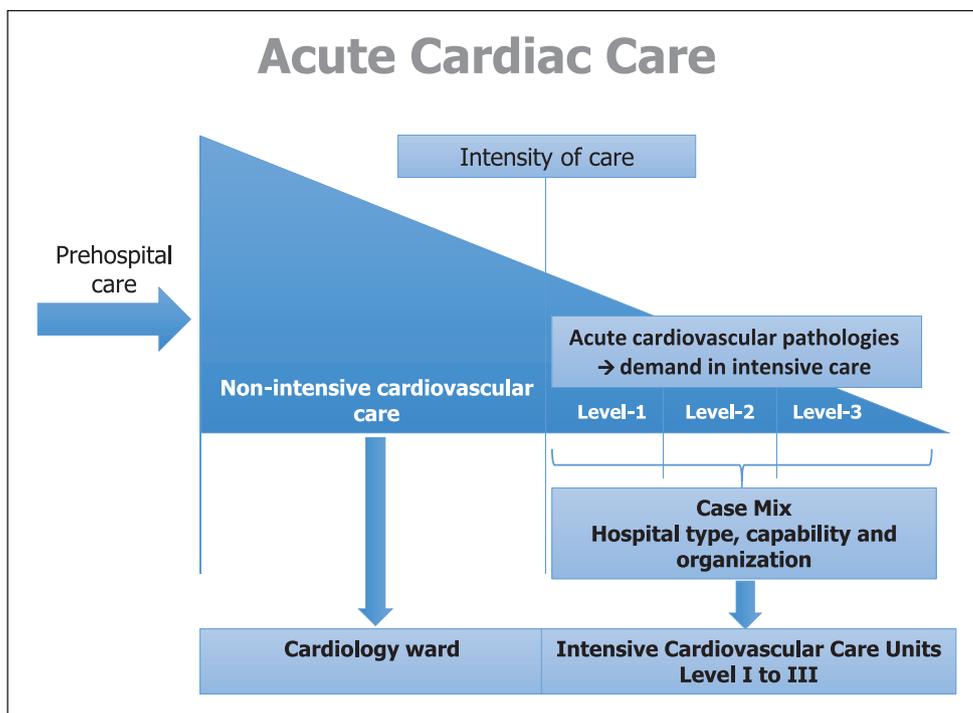
Acute cardiovascular patients will present with different levels of acuity and requirements for care<sup>2,3,9,16</sup> (Figure 1 and Table 1). The level of care (in term of nurses, physician, techniques, environment) to manage a given acute cardiovascular condition may be defined and graded. This grading system was originally developed for trauma centres, and then extended to most specialities of critical care.<sup>17–19</sup> In critical care, partitioning pathologies into risk

and levels of care has led to a better understanding of patients' management, a more efficient allocation of resources and improvements in outcome, including mortality rate and hospital length of stay.<sup>20,21</sup> In addition, describing centres according to their available resources combined with grading the care required for different critical conditions enhances the networking between tertiary/university and district/community hospitals and facilitates the most efficient use of resources.<sup>22</sup>

This process can be adapted and applied to acute cardiovascular care, whereby the full spectrum of acute cardiovascular conditions is classified according to levels of care required by the patient. In acute cardiology there may be some arbitrariness in grading the level of acuity and care required across all acute cardiovascular conditions, as not only are there a large range of conditions to grade, but comorbidities may complicate management and add to the overall risk of a patient. Scoring systems might help to combine all these factors and define the risk more rigorously.<sup>23</sup> The care requirement for a given patient is also a dynamic process that may change rapidly depending on the success or failure of initial management strategies. In many cases, the favourable response to initial treatment will allow stabilisation and rapid improvement of the clinical condition. If not, demand in care may rapidly increase to much higher levels than those initially provided.

Although these problems complicate any system for grading levels of care, defining the requirements for patients with specific acute cardiovascular conditions is essential in terms of classification and organisation of ICCUs. It allows description of the essential equipment, staffing levels and the technical environment within an ICCU for the management of acute patients of every level of acuity. It is additionally an useful tool with which to follow the changes in care over the years for any acute cardiovascular condition. As an example, acute coronary syndromes are now managed rapidly through fast and efficient PCI with few complications whereas acute heart failure is much more demanding with more highly specialised and complex treatment needs. Defining the risk and requirements for care of patients with acute cardiovascular conditions is a continuing process that will help to better define and update ICCU capabilities.

Table 1 presents a grading of patients with acute cardiovascular diseases into three levels according to their monitoring and care requirements. Acute cardiac care includes some patients with relatively common pathologies with a low level of demand in care and others with a very high level. Some conditions, mainly clinical 'modifiers' like low cardiac output, congestion, sepsis, arrhythmias may develop as complications or be associated with different acute cardiovascular diseases and considerably modify disease severity, thereby steeply increasing the demand of care.



**Figure 1.** From demand in care of acute cardiac conditions to level of intensive cardiovascular unit.

All intensive cardiovascular care units (ICCU) provide a higher degree of care in relation to other cardiology units up to a telemetry cardiovascular ward. Level of intensive cardiovascular care refers to both the quantity and expertise of medical and paramedical care being provided for management of a given cardiovascular condition. A given ICCU will present a case mix of acute cardiovascular patients with conditions needing different intensity of care. The level of expertise and technical requirements of an ICCU will depend on this case mix along with external factors mainly its hospital's type, capability and organisation.

### Level-1 care

Level-1 refers to patients with acute cardiovascular pathologies whose needs cannot be met through care provided by a general cardiology ward because they are at risk of their condition deteriorating, and demand special expertise or additional facilities, or need a higher level of observation (Table 1). Patients with these cardiovascular conditions mainly require careful cardiac rhythm and non-invasive haemodynamic monitoring, as well as some specific treatment (vasoactive drugs, non-invasive bi-level positive airway pressure or CPAP, chest tube insertion and monitoring). Table 2 presents monitoring and techniques that are considered level-1 care.

### Level-2 care

Level-2 refers to patients with acute cardiovascular conditions whose risk requires more advanced observation and monitoring than level-1 (Table 1). This may include 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) should be considered at this level.<sup>2</sup>

Additional relevant intervention considered of level-2 include temporary transvenous pacing, percutaneous cardiac assist device (IABP or percutaneous axial pumps) and pericardiocentesis (Table 2).

### Level-3 care

Level-3 refers to patients with acute cardiovascular conditions commanding a level of care or intervention that is equivalent to critical care (Table 1). Included in level-3 are cardiogenic shock demanding advanced cardiovascular support and/or acute cardiovascular diseases requiring invasive mechanical ventilation, renal replacement therapy and/or extracorporeal life support. Techniques defining level-3 care are presented in Table 2.

## 4) Functional criteria of ICCUs

Despite advances in defining the sub-specialty, acute cardiovascular care in Europe remains diverse, in terms of resources, physicians' specialty status and training, processes and outcomes of care.<sup>24,25</sup> ICCU roles, functional organisation and requirements are different between university medical centres, large community hospitals, and smaller hospitals with limited resources. Beyond the

**Table 1.** Grading of patients with acute cardio-vascular diseases into three levels of care according to their monitoring and care requirements (see web table for details).

	Overall demand in care
<b>ACUTE CONDITIONS acting as modifiers</b>	
Acute heart failure with venous congestion as dominant clinical expression	Level 1
Ventricular tachyarrhythmia with no hemodynamic complication	Level 1
Acute heart failure with hypoperfusion as dominant clinical expression	Level 2
Acute renal failure with oliguria	Level 2
Condition (sepsis, right ventricular dysfunction...) requiring IV vasopressor	Level 2
Cardiac arrhythmias with heart failure	Level 2
Cardiogenic shock	Level 3
Cardiac arrest with coma	Level 3
Ventricular tachycardia or fibrillation with electrical storm	Level 3
<b>ACUTE CORONARY SYNDROMES</b>	
Uncomplicated STEMI after initial cathlab admission and successful reperfusion	Level 1
Low risk type I NSTEMI before transfer to the cathlab	Level 1
NSTEMI type 2 - no complication	Level 1
Ischemic complication of PCI	Level 2
Acute ST-segment elevation AMI with no or unsuccessful reperfusion	Level 2
High-risk NSTEMI before PCI	Level 2
NSTEMI/STEMI complicated by congestive heart failure - no shock	Level 2
<b>ACUTE CARDIOVASCULAR PATHOLOGIES</b>	
Acute heart failure with pulmonary oedema and high systolic arterial pressure	Level 1
Acute third degree atrio-ventricular block	Level 1
Atrial fibrillation or supraventricular arrhythmias complicated by heart failure	Level 1
Myopericarditis uncomplicated	Level 1
Myocarditis or peripartum cardiomyopathy no/minimal EF alteration	Level 1
Large pulmonary embolism - not high-risk	Level 1
Mitral stenosis complicated	Level 1
Patients post structural or endovascular interventions	Level 1
Acute pulmonary oedema with low arterial pressure	Level 2
Peripartum cardiomyopathy or myocarditis with reduced EF with no symptom of heart failure	Level 2
Primary pulmonary hypertension with right heart failure	Level 2
High-risk pulmonary embolism at risk of or requiring thrombolysis	Level 2
Non-complicated type B aortic dissection	Level 2
Cardiac tamponade	Level 2
Aortic stenosis with heart failure - initial management	Level 2
Acute mitral regurgitation with heart failure - initial management,	Level 2
Heart transplant patient with suspected acute rejection and left ventricular dysfunction	Level 3
Mechanical complication of acute myocardial infarction	Level 3
Type A aortic dissection	Level 3
Acute prosthetic valve thrombosis with or without heart failure	Level 3
Acute endocarditis with heart failure	Level 3
Acute aortic regurgitation with heart failure	Level 3
<i>Any condition considered as level-2 care that does not respond rapidly to treatment, stabilise or improve</i>	Level 3

**Table 2.** Techniques that contribute to define the level of care for acute cardiovascular conditions.

Techniques that contribute to define level-1 case	Techniques that contribute to define level-2 case	Techniques that contribute to define level-3 case
<ul style="list-style-type: none"> <li>• Need of continuous observation based on clinical condition</li> <li>• Need of observation because of serious risk of aspiration pneumonia</li> <li>• Need of continuous oxygen therapy because of clinical hypoxaemia</li> <li>• Need for frequent daily respiratory physiotherapy to treat/ prevent respiratory failure</li> <li>• Need of bi-level positive airway pressure or CPAP</li> <li>• Need of chest drain</li> <li>• Need of intravenous rhythm controlling drug(s) to support or control supraventricular arrhythmias</li> </ul>	<ul style="list-style-type: none"> <li>• Need of a central venous access line for monitoring of central venous pressure</li> <li>• Need of an arterial line for monitoring the arterial pressure and/or sampling of arterial blood</li> <li>• Need of central venous access to deliver titrated fluids to treat hypovolaemia, for boluses or continuous infusion of intravenous drugs</li> <li>• Need of single intravenous vasoactive drug to support or control arterial pressure cardiovascular output or organ perfusion</li> <li>• Need of a temporary cardiovascular pacemaker</li> <li>• Need of percutaneous cardiac assist device (IABP, axial pumps...)</li> <li>• Need of pericardiocentesis or myocardial biopsies</li> </ul>	<ul style="list-style-type: none"> <li>• Need of invasive mechanical ventilator support</li> <li>• Need of renal replacement therapy for an acute condition</li> <li>• Need of targeted temperature management</li> <li>• Need of surgically implanted mechanical circulatory support</li> <li>• Need of extracorporeal life support</li> </ul>

hospital's technical capabilities, the case mix of an ICCU is influenced by the distribution of acute cardiovascular patients between the ICCU and the general critical care units or other specialised units within the hospital. In some cases, level-3 care can only be provided in the general critical care unit. In others, however, acute cardiovascular care patients who require highly specialised monitoring or treatment (i.e. extracorporeal life support (ECLS)) are better managed when transferred to highly specialised high volume units instead of the local ICCU. Therefore, the relation between the case mix of acute cardiovascular patients in a hospital and that of its ICCU may not be immediately apparent.

Whatever the country and the functional organisation of a hospital, the ICCU has the responsibility to provide services and personnel that ensure optimal patient care. Its role should be linked to that of the hospital, and the range of services it provides, but also be included in a broader local and regional clinical network. The functional level of an ICCU must therefore match its case mix. More specifically it should be tailored to the level of care of the most demanding or severe patients that it is required to manage. With an organisation based on cardiac intensivist-directed care, an ICCU will deliver the best care for acute cardiovascular patients.<sup>12</sup>

#### 4.1 Level I ICCU (first level; enhanced cardiovascular care units)

Level I ICCUs are designed to manage patients with cardiovascular conditions demanding level-1 care (Table 1). They mainly focus on the care of patients with acute coronary syndromes, 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.

**Staffing.** A level I ICCU should be directed by a cardiologist. As in any ICCU, continuity of medical activity must be provided 24/7. A level I ICCU should provide round-the-clock echocardiography and expertise for acute cardiovascular conditions in its hospital. Night shifts could potentially be provided by a physician or a fellow trained in cardiology and techniques (see Table 2) needed for level-1 acute cardiovascular conditions.

A nursing team leader with managerial responsibility for maintaining the quality of care is required. Since most of these patients are acutely ill but stable, a minimum of one nurse to four patients is acceptable.<sup>26</sup>

As in the previous position paper,<sup>1</sup> it is recommended that for the first 12 beds, there should be one physician for every six beds; if more than 12 beds: one physician for every eight beds.

**Equipment.** A level I ICCU should be fully equipped for the needs of level-1 patients. Suggested equipment is presented in Table 3. Level I ICCUs should provide all type of non-invasive monitoring. They should have the expertise and the means to administer non-invasive ventilation for respiratory failure, inotropes for low cardiovascular output and provide immediate resuscitation of cardiovascular arrest.

**Network and connections.** A level I ICCU will offer specialised cardiovascular care in different hospital settings. In community hospitals, they will offer first line management

**Table 3.** Suggested monitoring and equipment according to intensive cardiovascular care unit (ICCU)'s level.

Level I ICCU	Level II ICCU	Level III ICCU
<ul style="list-style-type: none"> <li>• At least 2 ECG channels</li> <li>• Non-invasive blood pressure monitor</li> <li>• At least one invasive pressure channel</li> <li>• SpO2 metre</li> <li>• Electronic prescribing and chart access (advisable)</li> <li>• Nurse station to be used for central monitoring at least one ECG lead from each patient as well as relevant haemodynamic and respiratory data should continuously be present on a central screen.</li> <li>• Slave monitors to enable monitoring of patients from different sites of the unit</li> <li>• Working stations for retrospective analysis of index events</li> <li>• Volumetric pump/automatic syringes</li> <li>• CPAP delivery systems to use with face mask</li> <li>• At least one mechanical ventilator for the unit with non-invasive ventilation capacity</li> <li>• Biphasic defibrillators</li> <li>• At least one external pacemaker for the unit</li> <li>• Temporary VVI pacemakers and at least one DDD for the unit advisable</li> <li>• Mobile echocardiography machine</li> <li>• Glucose level measurement kits</li> <li>• If blood chemistry tests cannot come back from the central lab within 5 min: blood clot metre (ACT), blood chemical markers kits, blood gasses and electrolyte analyser, multiparametric blood analyser</li> </ul>	<p>Same as level I ICCU plus</p> <ul style="list-style-type: none"> <li>• Additional ECG channels</li> <li>• Invasive haemodynamic channels</li> <li>• End tidal CO<sub>2</sub></li> <li>• Non-invasive cardiovascular output</li> <li>• Non-invasive thermometers</li> <li>• Mechanical ventilators</li> <li>• Mobile echocardiography machine including TEE probe, vascular probe</li> <li>• At least one echography device for ultrasound guidance for central venous access line</li> <li>• Percutaneous circulatory assist devices (IABP; percutaneous axial pump)</li> <li>• X-ray system for fluoroscopy in the unit</li> <li>• Haemodialysis/haemofiltration machine through the nephrology department (advisable)</li> <li>• Hypothermia maintenance devices (advisable)</li> </ul>	<p>Same as level II plus all techniques and equipment that put this unit on par with a general critical care unit including:</p> <ul style="list-style-type: none"> <li>• Specific additional monitoring</li> <li>• Haemodialysis/haemofiltration machine</li> <li>• Mechanical ventilators</li> <li>• And more specifically</li> <li>• ECLS</li> <li>• Hypothermia maintenance devices</li> </ul>

ECLS: extracorporeal life support.

of many acute cardiovascular conditions. In hospitals with higher technical capabilities, level I ICCUs may also admit patients post PCI for ACS or post structural or endovascular interventions. They might be step-down units of level II or III ICCUs, sharing management and resources.

Even if level I ICCUs have the capability to manage invasive monitoring and mechanical haemodynamic support and some level-2 patients, most of their activity is directed to level-1 patients. Patients who fail to improve despite optimal management available in the level I ICCU, and those who need more advanced medical management not available on-site should be transferred promptly, ideally to an appropriate centre with a level II or III ICCU or to the local general ICU. Selection of the appropriate timing and destination of transfer for the patient with a refractory or too complex illness for a level I ICCU is an important aspect of patient management in these units. Hospitals with level I ICCUs should be part of a formalised network of hospitals with well-defined protocols for safe and rapid transfer of patients.<sup>27</sup>

#### 4.2 Level II ICCU (intermediate; cardiovascular high dependency units)

Level II ICCUs are designed to manage level-1 and level-2 patients. 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. Table 1 presents some common conditions that should be admitted to a level II ICCU. Level II ICCUs may provide initial admission for some level-3 patients but they should not manage these patients on a regular basis.

All invasive and non-invasive monitoring should be available. Some more advanced techniques, including invasive ventilation or institution of percutaneous mechanical circulatory support, should be available and the staff trained in their use even if patients will be transferred rapidly to a higher-level unit. Percutaneous circulatory support (IABP, percutaneous axial pumps) should be additionally available (see Table 4). In many centres, level II ICCUs will manage patients post-cardiac arrest undergoing Targeted Temperature Management.

Level II ICCUs require at least a hospital with immediate access to a 24/7 coronary interventional catheter laboratory. With round-the-clock service for percutaneous coronary revascularisation, level II ICCUs will usually be the hub of a STEMI network.

**Staffing.** Level II ICCUs must be directed and managed by a cardiovascular intensivist (section 6.2). Training of residents is an important component, as high quality education has been shown to be associated with high quality clinical care.

**Table 4.** Levels of intensive cardiovascular care units (ICCU). Technical capacities and expertise of the ICCU and of its hospital.

## Technical capacities and expertise of the ICCU

Level I ICCU Basic cardiovascular intensive care	Level II ICCU Advanced cardiovascular intensive care	Level III ICCU Cardiovascular critical care
<ul style="list-style-type: none"> <li>• All non-invasive clinical parameters 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> <li>• Nutrition support</li> <li>• Physiotherapy in ward</li> </ul>	<p><b>As in level I ICCU plus</b></p> <ul style="list-style-type: none"> <li>• Ultrasound-guided central venous line insertion</li> <li>• Pericardiocentesis</li> <li>• Transvenous temporary pacing</li> <li>• Transoesophageal echocardiography</li> <li>• Pulmonary artery catheter/right heart catheterisation</li> <li>• Percutaneous circulatory support (IABP, percutaneous axial pump)</li> <li>• Targeted temperature management (in many centres)</li> </ul>	<p><b>As in level II ICCU plus</b></p> <ul style="list-style-type: none"> <li>• Extracorporeal life support</li> <li>• Mechanical circulatory support expertise (LVAD, Bi-VAD)</li> <li>• Renal replacement therapy</li> <li>• Mechanical ventilation</li> </ul>

## Technical capacities and expertise that should be available in the hospital

For level I ICCU	For level II ICCU	For level III ICCU
<ul style="list-style-type: none"> <li>• Emergency department</li> <li>• Computed tomography scanner</li> <li>• Transoesophageal echocardiography</li> <li>• Palliative care programme</li> <li>• Ultrasound-guided central venous line insertion</li> <li>• X-ray system for fluoroscopy in the vicinity of the unit</li> <li>• 24/7 Chest radiographs</li> <li>• 24/7 Computed tomography angiography</li> <li>• 24/7 Blood gas analysis</li> <li>• 24/7 Biomarkers: acute coronary syndromes</li> <li>• 24/7 Biomarkers: acute heart failure</li> <li>• 24/7 Biomarkers: coagulation and thrombosis</li> <li>• 24/7 Biomarkers: renal and hepatic function/failure</li> </ul>	<p><b>As in level I ICCU plus</b></p> <ul style="list-style-type: none"> <li>• 24/7 Percutaneous coronary interventions</li> <li>• Pacing and cardiovascular resynchronisation therapy programme</li> <li>• Implantable cardioverter-defibrillator programme</li> <li>• Ablation therapy programme</li> <li>• Renal support therapy</li> <li>• Cardiovascular magnetic resonance</li> <li>• Post-cardiovascular arrest treatment</li> <li>• Neuromonitoring for prognostic evaluation</li> <li>• Endomyocardial biopsy</li> </ul>	<p><b>As in level II ICCU plus</b></p> <ul style="list-style-type: none"> <li>• Comprehensive cardiovascular surgery (coronary artery bypass graft surgery; surgical management of acute disorder of the aorta, valves and any other cardiovascular structure)</li> <li>• Interventional vascular radiology including expertise in complicated aortic dissection, embolisation and neuro-interventional radiology</li> <li>• Any percutaneous structural heart intervention, valvuloplasty and transcatheter aortic valve implantation</li> <li>• Donor organ and transplantation programme</li> </ul>

The 2005 position paper recommended a ratio of at least one resident clinician for every four patients.<sup>1</sup> In critical care some recommend that the senior physician or consultant/patient ratio should not exceed a range 1:8 to 1:15 and the ICCU resident/patient ratio should not exceed 1:8.<sup>17</sup> It is acknowledged however that requirements of senior physicians to provide direct clinical care in ICCUs varies greatly with the additional support provided by fellows and specialised nurses.

A nursing director should be designated, and nurse-to-patient ratios should be 1:2 to 1:3 for patients with level-2 acute cardiovascular conditions.<sup>28</sup>

A general critical care unit must be present on site and intensivists should be available 24/7 for consultation, co-management of complex patients and urgent support.<sup>17</sup>

**Number of beds.** A level II ICCU should have at least six beds but there is no definitive formula for the number of

ICCU beds needed by a hospital. It is of course important for the number to be commensurate with the workload and case-mix that the hospital treats.

Possible formulas for calculation are:<sup>1</sup>

- for each 100,000 inhabitants, four to five ICCU beds;
- for every 100,000 visits per year in the internal emergency department (ED), 10 ICCU beds.

Additional factors to be considered when devising the number of beds for an ICCU in a hospital include:<sup>29</sup>

- acute beds in the hospital (medical and surgical),
- previously calculated occupancy of wards, high dependency units and critical care units and target occupancy of the ICCU,

- history of refusals due to lack of capacity,
- number and location of other high-care areas in the hospital or in other hospitals in the catchment area,
- number of on-site operating theatres,
- presence of specialist services which may require cardiovascular support,
- ability to transfer patients to an off-site location

**Equipment and premises.** A level II ICCU must be fully equipped for the needs of level-2 patients. Suggested requirements are presented in Table 3. All equipment must conform to the relevant safety standards and be regularly serviced. All staff members must be appropriately trained, competent and familiar with the use of equipment.<sup>17</sup>

Recent documents in cardiology<sup>1,30</sup> and general critical care<sup>15,31–33</sup> provide detailed information on the specific design requirements and engineering requirements applicable to level II or level III ICCUs. Some facilities should be provided in all level II ICCUs: single (isolation) rooms, a central nurse station, a procedure room with X-ray and equipment for invasive monitoring, space for staff facilities, including restrooms, catering facilities, changing rooms, en-suite overnight accommodation for on-call (on-duty) staff, and education and training facilities. It is also important to anticipate support facilities for relatives and carers and the patient's right to privacy and dignity, strategies for noise reduction, and maximising natural light.

**Network and transfer.** Level II ICCUs should be part of a formalised network of hospitals that regulates the transfer and acceptance of patients in need of higher or lower intensity of care in each region.

Transfer to a level III ICCU should be considered for level-3 patients who have not rapidly recovered to lower intensity of care. Transfer should also be considered for patients with cardiovascular conditions demanding level-2 care that fail to improve or deteriorate after initial treatment. Similarly, patients must be transferred if they require a specific intervention not available in the hospital (e.g. in urgent need of valvular or coronary surgery) or high intensity care (i.e. patients requiring ECLS).

#### 4.3 Level III ICCU (highest level; cardiovascular critical care units)

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, ECLS, emergent heart surgery or surgical cardiovascular assistance (Tables 1 and 2).

**Staffing.** The director of the unit should be a cardiovascular intensivist with a recognised qualification and

appropriate experience. Given the emerging recognition of acute cardiovascular care as a specialty, an alternative option is co-directorship between a cardiologist and an intensivist.

Cardiovascular care in this setting has a high level of intensity, and primary responsibility for patient care should be from cardiovascular intensivists. If this is not possible, general critical care physicians working collaboratively with cardiologists can be an alternative option. All senior physicians working in the unit including during the on-call/on-duty period must have specialised skills in critical care.

In level III ICCUs, resident and/or fellow training programmes would usually be present, and there would typically be a commitment to perform clinical and translational research.

A nursing director should be in post, and nurse-to-patient ratios should be expected to be 1:1 or 1:2 for level-3 acute cardiovascular diseases.

Immediate access to interventional cardiology, anaesthesiology and cardiovascular surgical support is required.

**Equipment and hospital.** A level III ICCU should be fully equipped for the needs of level-3 patients. Suggested requirements are presented in Table 3. Level III ICCUs should have all forms of invasive and non-invasive monitoring capabilities, as well as invasive ventilation and renal replacement therapy. These units should be able to manage ECLS patients even if in some centres patients requiring ECLS may be cared for in specific units for efficiency reasons. Advanced technologies, such as mechanical circulatory assist devices, should also be available to support the cardiovascular system and manage patients with refractory shock or resuscitated cardiovascular arrest, even if once initiated, the patient is then transferred to a reference ECLS centre.

Level III ICCUs require a hospital environment that provides specific and highly specialised professionals required at times for the support of patients with advanced and severe acute cardiovascular conditions.

**Regulatory aspects, premises.** For most aspects of staffing and organisation, level III ICCUs should follow the rules that apply for general critical care units in the country. Pharmacy, clinical pharmacology, specialists in infective diseases, nutrition, and respiratory therapy services complete the multidisciplinary hospital team.

The same specific documents as for level II ICCUs may be used for construction guidance. Most countries have specific standards for these units and level III ICCUs must comply with national standards for general critical care units.

**Network.** Level III ICCUs are located in hospitals that are the higher echelon of the regional hospital network for acute cardiovascular care. The medical agreement that

regulates operations within the network should also clearly include the repatriation policy of patients from level III ICCU toward lower level II or I ICCUs.

## 5) Clinical governance and continuous improvement

ICCU must operate within established frameworks for clinical governance, including employment of established performance indicators that comply with local, regional and national requirements.<sup>34</sup> Within each unit a lead for clinical governance and quality improvement should be designated.

Uniform protocols and processes may reduce mortality and are recommended (e.g. care bundles, venous thromboprophylaxis, nosocomial infection, catheter-related bloodstream infections, STEMI management).<sup>35,36</sup>

Data collection on bed occupancy, diagnosis, mortality and morbidity are recommended. Measurement of additional relevant quality indicators is required and, when possible, data should be submitted to local or national databases.<sup>37,38</sup>

An audit programme, including compliance with guidelines (local, national, international) and quality indicators (i.e. out of hours transfer, readmission, morbidity and mortality vs risk stratification, nosocomial infection rates), should be implemented. Benchmarking against approved standards and outcomes is recommended, as well as participation in regional/national critical care networks.

Collected data should be also part of relevant national or international registries (e.g. Myocardial Infarction Registry, Extracorporeal Life Support Organisation, Myocardial Ischaemia National Audit Project).<sup>39</sup>

Data collection and clinical governance strategies should be sustainable, with appropriate administrative and technological support. Institutions should provide the adequate technical means and financing for any ICCU to provide high-quality clinical governance.

## 6) Education recommended for working in ICCUs

### 6.1 Formalised and standardised education in acute cardiovascular care

Despite European recommendations for training and education in acute cardiovascular care being available, as a relatively new speciality this has not yet been adopted on a national level in all European countries. Therefore, many cardiologists currently working in ICCUs do not yet have nationally approved specific education in acute cardiovascular care. Some have relevant additional education usually in different sub-specialities of cardiology and general critical care, however most have built their expertise and skills

over time as they contributed to the establishment of acute cardiovascular care as a subspecialty. However, as acute cardiovascular care is now a well-defined, complex field with clear patient benefits resulting from appropriate training of cardiologists, our patients deserve a structured and formalised educational and training structure that is becoming more widely adopted.

Physicians running an ICCU must be board-certified cardiologists. Beyond their general cardiology education, these physicians must have a specific education in acute cardiovascular care. Training in critical care cardiology has been described by the American and European Cardiovascular Societies.<sup>8,40,41</sup> The Acute Cardiovascular Care Association (ACCA) core curriculum for acute cardiovascular care provides a well-defined framework for this education. These guidelines comprehensively describe individual aspects of training in the sub-specialty, and present the requirements for training institutions and trainers.

The ACCA strongly recommends that National Cardiovascular Societies (NCS) in different countries of Europe and the ESC member states establish such a national curriculum in acute cardiovascular care. To do so, they should build the framework of their curriculum on the ACCA core curriculum. The ACCA curriculum should be considered an optimal rather than a minimum standard, that can be adjusted by NCS to their training system. To abide by the ACCA core curriculum will allow NCS to promote standards of training and education in acute cardiovascular care thereby improving the quality of care and outcomes of patients with acute cardiovascular disease.

Knowledge-based training is relatively easy to implement. The *ESC-ACCA textbook of intensive and acute cardiovascular care* is an excellent source of information.<sup>42</sup> Its content defines the knowledge, skills and professional domains of the subspecialty.

Practical training depends upon the training pathways already in place throughout ESC member states. The core curriculum emphasises the need of a clearly defined training programme with formal review and assessment. The ACCA suggests that the acquisition of competence in acute cardiovascular care cardiology requires a minimum of 12 months of full-time training after completion of the core cardiology training, although this may be more depending upon the content of the cardiology training programmes of the relevant national societies.

### 6.2 Cardiovascular intensivists and competence in intensive cardiovascular care

Any curriculum in acute cardiovascular care should lead to a process of formal certification. The ACCA core curriculum has a two-part certification process: demonstration of theoretical knowledge and competence. A similar approach could be chosen for the certification process of a national curriculum.

The first part should be common to all acute cardiovascular care physicians, the second, demonstration of competence, should have different levels according to the level of ICCU in which the acute cardiovascular care cardiologist is working.

Acute cardiovascular care is mainly a clinical field with additional expertise needed in a range of techniques. Not all acute cardiovascular care physicians will spend their professional life in ICCUs that require the full range of these techniques. Therefore, some flexibility should be in place for the certification process to define different categories of expertise.

Competence needed to qualify as a cardiovascular intensivist is defined in the ACCA core curriculum. In short, beyond the common theoretical part, he/she should undergo a total of at least 21 months of intensive care training over his/her whole training period: at least three months of general intensive care, six months of cardiovascular intensive care as part of general cardiology training plus 12 months as part of sub speciality training.

### 6.3 Requirements for cardiologists working in ICCUs

To work in a level I ICCU, cardiologists do not need to master all the techniques presented above, but it is vital that they understand the range of cardiovascular conditions and therapeutic options, in order to ensure appropriate referral is made where required. Moreover, their ICCU should be part of the regional hospitals network for acute cardiovascular conditions; hence the need for a common theoretical certification. To gain sufficient experience in managing patients of a level I ICCU, it is recommended that cardiologists in training spend a minimum of six months in ICCUs (including level II or III) during general cardiology training and an additional six months training as a junior attending physician (post-residency). It is recommended that any physician coordinating patients' care in a level I ICCU take the written exam of the ESC-ACC certification for individuals. Additionally, he/she should master all the techniques required in a level I ICCU. Physicians working in level I ICCU should keep up to date through continuous professional development and training organised in close relation to a level II or level III ICCU.

In a level II ICCU, the core team of cardiologists managing patients should all be cardiovascular intensivists as defined previously.

Few ICCUs are of level III. In some cases, physicians working in these units have built their expertise and skills over time and this should be acknowledged. It is however recommended that to work as a senior doctor/consultant in a level III ICCU, cardiovascular intensivists extend their skills in more specialised techniques, and obtain advanced training in critical care. The ACCA core curriculum recommends an additional year of training. Further,

cardiovascular intensivists may wish to proceed to work in centres with grown-up congenital heart disease and/or complex cardiovascular surgery including extracorporeal support and transplantation, in which case additional specific training will be required.

### 6.4 On-duty physicians

**Level I ICCU.** In level I ICCU, a physician trained in acute cardiovascular care should be available 24/7. He/she should be at least of the level of expertise required to work in a level I ICCU. He/she may fulfil other duties in relation to its acute cardiovascular specialist status (e.g. consultation in the ED, urgent echocardiography). This physician may not necessarily be a board-certified cardiologist. Indeed, the director of the unit might approve other physicians to cover the night shifts (including trainees and residents), who are able to deal with acute cardiovascular emergencies at their level of training. However, in such cases an attending member of the ICCU team must be available on call for senior consultation and assistance.<sup>1</sup>

**Level II ICCU.** In level II ICCU, the physician on-duty should be a cardiovascular intensivist based in the unit. The director of the unit might approve night cover from other cardiologists competent in the emergency techniques required in a level II ICCU. Some of these physicians may be residents in cardiology with the appropriate level of expertise.<sup>7</sup> A recent study in general critical care looking at the effect of night-time intensivist staffing found that adding a night-time intensivist to an ICU already staffed with physicians in training at night appeared to offer no marginal improvements in outcomes.<sup>43,44</sup> In such a case, it is recommended that an attending cardiovascular intensivist or an interventional cardiologist is available for senior consultation and assistance round-the-clock.

**Level III ICCU.** In ICCU III, the organisation of on-site 24/7 continuity of care should follow the regulations applicable in the country for general critical care units.<sup>17</sup> On-duty physicians should have both the advanced acute cardiovascular and critical care expertise that are required for working in a level III ICCU.

### 6.5 Nursing education to work in ICCUs

A culture of effective communication and collaboration between nursing and physician staff is a key aspect of optimal team-based care, especially for these most critically ill patients. High-quality nursing is the cornerstone of acute cardiovascular care. Nurses have 24/7 responsibility for co-ordinating and delivering the care of the acutely ill cardiovascular patient. The nurses' role is also to monitor the patient, evaluate the potential for complications or deterioration, and co-ordinate the communication within the interdisciplinary

team.<sup>45</sup> Over and above that undertaken by doctors, nurses also have a key role in establishing therapeutic relationships with the patient and their family, explaining complex treatments, managing symptoms and minimising psychological distress, particularly when patients deteriorate or are at end of life.<sup>46</sup> Beyond the nurse: patient ratio, the quality of nurse education and clinical experience has a direct impact on the quality of patient outcomes.<sup>26,47,48</sup>

The level of nurse education varies internationally, but to achieve quality outcomes nurses should have a specialist post-registration qualification in acute cardiovascular care and clinical expertise in this area. Advanced nurse practitioners should have a masters degree or at least postgraduate education, equipping them to undertake specialist roles, and these have been associated with improved efficiency and better patient satisfaction and long term outcomes.<sup>47,49</sup>

## 7) ICCUs and interaction with other specialties

The close relationship between the ICCU and other subspecialties of cardiology and other medical specialties is pivotal to running an excellent unit. Many admissions will require either specific technical cardiovascular interventions (interventional cardiology or heart surgery) or complex decisions in relation to comorbidities or associated conditions such as sepsis or renal failure. Also in many patients, the acute event will either reveal a chronic underlying cardiovascular disease or will be the turning point in a known cardiovascular disease with significant changes in subsequent follow up.

Thus, the specialised ICCU staff must collaborate closely with different sub-specialties of cardiology, ideally under a common leadership and also establish close relationships with non-cardiovascular specialties.<sup>50</sup> Frequently, the initial, sometimes lifesaving, interventions do not demand a multidisciplinary team meeting, however, following stabilisation and when planning ongoing care, the wider multidisciplinary and multiprofessional team will be required to plan, coordinate and manage a patient's care.<sup>51</sup> Typically specialists who collaborate on a regular basis with the ICCU team are cardiovascular surgeons, cardiovascular anaesthesiologists, critical care physicians, nephrologists, infectious disease specialists, clinical pharmacologists, palliative care teams and emergency physicians for the pre-cardiology part of patients' management,<sup>52,53</sup> but, depending on patient requirement, other allied healthcare professionals will be key to providing and directing ongoing care.

From an ICCU standpoint, implementation of a multidisciplinary approach provides logistical challenges, to gather all the participants may be difficult and the decision-making process less efficient. In some institutions, combined medical, surgical and other relevant specialties conferences are held weekly or more frequently for heart failure, coronary revascularisation, extracorporeal support and infectious

endocarditis.<sup>54</sup> These 'heart teams' are becoming more widespread because they are mandated by some guidelines and may be linked to procedural reimbursement.<sup>51</sup> ICCU patients with complex issues should be discussed during the relevant multidisciplinary specialist meetings, as well as the ICCU multidisciplinary team meetings.

Despite these challenges, implementation of a structured multidisciplinary approach coordinated by ICCU physicians should be routine part of ICCU practice, as well as part of the quality assessment of an ICCU.

Patients admitted to current ICCUs have increasingly advanced complex medical conditions and palliative care is an integral component of their care. Palliative care education and training must be a standard among clinicians who are involved in cardiovascular intensive care.<sup>55,56</sup>

Care of acute cardiovascular patients extends beyond the ICCU. The ICCU team should bring its expertise to other wards and other settings, typically providing acute cardiovascular care consultations to inpatients with a potential need for ICCU admission, overseeing and facilitating ICCU triage decisions, especially when ICCU resources are constrained. In critical care, critical care outreach services have had a positive impact on patient outcomes.<sup>57</sup>

## 8) Regional networks for acute cardiovascular pathologies and telemedicine

### 8.1 ICCUs as part of a regional hospital network for acute cardiovascular care

Developing ICCUs as part of a hospital network rather than as isolated units serving a limited area can provide good coverage of the population, optimising the management of acute cardiovascular patients across an entire region.<sup>58</sup> The recommendation is that all ICCUs participate in a formalised regional hospital network of acute cardiovascular care. These hospital networks should follow the hub and spoke model, with each level referring acute cardiovascular patients to the higher levels when needed.<sup>9</sup>

Research on STEMI and subsequent guidelines have helped in promoting pathways to allow the large majority of patients with acute AMI to benefit from primary PCI. Impact of primary PCI networks on other acute cardiovascular conditions is unknown but it may have facilitated the transfer of patients from hospitals with a lower level ICCU to hospitals with a higher level ICCU. The benefits observed in STEMI networks rely on the development of a well-established transfer protocol, shortening delays and standardising procedures between centres.<sup>59</sup> Extending the 'network integrated services' model far beyond STEMI may bring similar benefits to other acute cardiovascular diseases.<sup>9,59,60</sup>

The optimal ICCU network configuration for a region should be collectively and consensually organised on a

**Table 5.** Intensive cardiovascular care units (ICCU) – summary.

	Level I ICCU	Level II ICCU	Level III ICCU
Population and disease	Level-1 patients (Table 2), monitoring of patients post structural and endovascular interventions (see Table 2 and text)	Level-1 and level-2 patients (Tables 1 and 2); severe or high risk patients with congestive heart failure and/or low cardiac output complicating acute or chronic cardiac conditions	Mainly level-3 patients, some level-2 patients; acute cardiac conditions needing invasive mechanical ventilation, renal replacement therapy, ECLS, emergent heart surgery or surgical cardiovascular assistance
Technology and therapy in ICCU	<ul style="list-style-type: none"> <li>All non-invasive clinical parameters monitoring</li> <li>24/7 Echocardiography and thoracic ultrasound; direct current cardioversion; non-invasive ventilation; transcutaneous temporary pacing</li> </ul>	<ul style="list-style-type: none"> <li>All invasive and non-invasive cardiovascular monitoring</li> <li>Idem level I ICCU plus: ultrasound-guided central venous line insertion; transvenous temporary pacing; transoesophageal echocardiography; pulmonary artery catheter/right heart catheterisation; percutaneous circulatory support; X-ray system for fluoroscopy</li> </ul>	<ul style="list-style-type: none"> <li>All advanced invasive and non-invasive cardiovascular monitoring</li> <li>Idem level II ICCU plus: extracorporeal life support; mechanical circulatory support; renal replacement therapy; mechanical ventilation</li> </ul>
Hospital	<ul style="list-style-type: none"> <li>Emergency department; computed tomography scanner; transoesophageal echo; X-ray system for fluoroscopy</li> </ul>	<ul style="list-style-type: none"> <li>24/7 coronary interventional cath-lab; hub centre of a STEMI network</li> <li>Idem for level I ICCU plus pacing, cardiovascular resynchronisation therapy; implantable cardioverter-defibrillator programme; ablation therapy; renal support therapy; scanner and CMR</li> </ul>	<ul style="list-style-type: none"> <li>Tertiary or university hospital</li> <li>Idem for level II ICCU plus percutaneous structural heart intervention; endomyocardial biopsy; donor organ and transplantation programme; interventional vascular radiology; comprehensive cardiovascular surgery</li> </ul>
Level of competence	<ul style="list-style-type: none"> <li>Head: cardiologist</li> <li>Team: cardiologists</li> <li>On site: intensivist consultation 24/7</li> </ul>	<ul style="list-style-type: none"> <li>Head: cardiovascular intensivist</li> <li>Team: cardiovascular intensivists</li> <li>On site: intensivist consultation 24/7</li> </ul>	<ul style="list-style-type: none"> <li>Head: cardiovascular intensivist or co-directorship with a general critical care specialist</li> <li>Team: cardiovascular intensivists with additional education in critical care; may include general intensivists with additional education in cardiology</li> </ul>
Education programmes	<ul style="list-style-type: none"> <li>Recommended: written exam of the ESC-ACC certification for individuals; should master all the techniques required in level I ICCU</li> <li>Resident or fellow in cardiology</li> </ul>	<ul style="list-style-type: none"> <li>Required: specific national curriculum for acute cardiovascular care or ACCA curriculum for cardiovascular intensivist</li> <li>Residents or fellow in cardiovascular intensive care</li> </ul>	<ul style="list-style-type: none"> <li>Idem level II ICCU plus specific curriculum for general critical care training</li> <li>Resident and fellow in cardiovascular intensive care; critical care</li> </ul>
On-duty physicians	<ul style="list-style-type: none"> <li>Cardiologists with level I ICCU expertise; if approved by the unit's director, trained residents or other physicians provided availability of an on-call member of the ICCU team</li> </ul>	<ul style="list-style-type: none"> <li>Cardiovascular intensivists; trained cardiologists; physicians advanced in their cardiovascular intensivist training provided availability of a cardiovascular intensivist or an interventional cardiologist</li> </ul>	<ul style="list-style-type: none"> <li>Should have all the requirements and expertise for working in a level III ICCUs</li> </ul>
Nursing/ other personnel	<ul style="list-style-type: none"> <li>Nursing director (could be shared with regular ward)</li> <li>Dedicated nurses - nurse-to-patient ratio 1:4 for level-1 patients</li> </ul>	<ul style="list-style-type: none"> <li>Nursing director</li> <li>Dedicated nurses - nurse-to-patient ratio 1:2 or 1:3 for level-2 patients</li> </ul>	<ul style="list-style-type: none"> <li>Nursing director</li> <li>Dedicated nurses - nurse-to-patient ratio 1:2 or 1:1 for level-3 patients</li> </ul>
Research	<ul style="list-style-type: none"> <li>Encouraged to be part of outcome research</li> </ul>	<ul style="list-style-type: none"> <li>Encouraged to conduct clinical research</li> </ul>	<ul style="list-style-type: none"> <li>Strong commitment to perform clinical research</li> </ul>

ACCA: Acute Cardiovascular Care Association; ECLS: extracorporeal life support; ESC: European Society of Cardiology; STEMI: ST-elevation myocardial infarction.

regional basis with the participation of the ICCU directors in close collaboration with the national cardiovascular society and the regulatory authorities. It should define the clinical conditions that meet the criteria for transfer, transfer modalities, treatment protocols before and during transfer and also ensure communication between participating parties and on-time information on bed availability.<sup>27</sup> It should also deal with any potential legal or financial problems (e.g. reimbursement of transfer).

## 8.2 Exchange of expertise through telemedicine

It should be an objective of all hospitals in a regional network to organise access to multidisciplinary expertise for all of its constituent ICCUs. Video-conferences can be largely used for this purpose. ICCUs in hospitals without all the expertise required in acute cardiac care will thus benefit from participating in the heart team of larger hospitals.

Level II and III ICCUs should behave as a hub for emergency consultations and should be organised to provide expert opinions on acute cardiovascular conditions in hospital without cardiology or without PCI facilities. This can be achieved through video-conferencing with the visualisation of cardiovascular examinations such as coronary angiography or echocardiography.<sup>61</sup> Such programmes will streamline the transfer of patients for higher intensity of care and at reducing costs.

Telemedicine should be seen as a delivery tool or system, not a separate medical specialty.<sup>62</sup> It includes a growing variety of applications and services using video, smartphones, wireless tools and other forms of telecommunications technology. Videoconferencing, transmission of images and other data, and continuing medical education should all be part of an ICCUs' way of working and interacting with colleagues elsewhere.

Video-conferencing equipment should be available for the ICCU team and should be near the unit.<sup>63</sup> Organisations should establish a budget that encompasses the cost of implementation, which may include items such as staff education programmes, hardware, software and their upgrades and replacements.

## Summary

A summary of the requirements for different levels of ICCU is provided in Table 5.

## Conflict of interest

The authors declare that there is no conflict of interest.

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