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ESC Report

Recommendations for the structure, organization, and operation of intensive cardiac care units

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Two major changes in patient characteristics and management occurred recently that demand distinctive alterations in the function of the intensive cardiac care unit (ICCU). These changes include the introduction of an early invasive strategy for the treatment of acute coronary syndromes, enabling early recuperation and shorter need for intensive care on the one hand, while the number of older and sicker patients requiring prolonged and more complex intensive care is steadily increasing. A task force of the European Society of Cardiology Working Group on Acute Cardiac Care was set to give a modern updated comprehensive recommendations concerning the structure, organization, and function of the modern ICCUs and intermediate cardiac units. These include the statement that specially trained cardiologists and cardiac nurses who can manage patients with acute cardiac conditions should staff the ICCUs. The optimum number of physicians, nurses, and other personal working in the unit is included. The document indicates the desired architecture and structure of the units and the intermediate cardiac unit and their relations to the other facilities in the hospital. Specific recommendations are also included for the minimal number of beds, monitoring system, respirators, pacemaker/defibrillators, and necessary additional equipment. The desired function is discussed, namely, the patients to be admitted, the length of stay, and the relocation policy. A uniformed electronic chart for ICCUs is advised, anticipating a common European database.

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Introduction

The following represents an expert consensus document written by the nucleus members of the European Society of Cardiology (ESC) Working Group for Acute Cardiac Care (ACC).

The first description of the intensive cardiac care units (ICCUs) was presented by Julian[1] to the British Thoracic Society in 1961 and was based on monitoring patients with acute myocardial infarction (AMI) for the early diagnosis and treatment of ventricular fibrillation. Nevertheless, significant benefit of the units was not obtained until some decisive policy changes were made, including treatment protocols and structural organizations.[2] The current objectives of the ICCUs are the monitoring and support of failing vital functions in acute and/or critically ill cardiac patients, in order to perform adequate diagnostic measures followed by medical and invasive therapies to improve outcome.

The current published literature regarding the structure, operation, and function of ICCUs is insufficient because of the following reasons: it focuses on non-cardiac care,[3] it is limited to part of the needs,[4] it describes only local standards,[5] it is published in non-English literature,[6] or it is very old.[7]

In a continental survey among hospitals from different parts of Europe, a great deal of divergence was found concerning the whole spectrum of organization and function of ICCUs (ESC WG on Acute Cardiac Care; unpublished results).

The ESC Working Group on ACC was established in 2001. One of its declared tasks is to improve and unify the function of ICCUs across Europe.

A task force composed of the nucleus members of the Working Group set out to write the following document in order to provide an updated guide indicating the minimal optimal requirements for the modern functioning ICCU. The manuscript is based on the current available literature; it reflects the existing working states in different European countries and the personal opinion of the task force members.

The manuscript has undergone extensive revision by the Guideline Committee of the ESC and by the editorial board of the European Heart Journal.

Local modifications should be implemented according to the local special needs derived from specific patient case-mix, available resources, and different laws and regulations.

Two changes occurred over the past two decades that demand distinctive alterations in the function of the ICCUs in the next decade. Changes will take place both in the patient population admitted to the ICCU and in the medical care supplied.

(i) Emergency reperfusion treatment policies (non-invasive or invasive) were adopted as an accepted standard of care in patients with AMI.[8] These policies dictate the necessity for special attention and immediate treatment of the patients early on, but after the success of the initial treatment, the patients show immediate drastic improvement in many cases. Follow-up and management are simpler and easier than in the past, recovery is faster, and the average length of stay is shorter.

(ii) The medical profession has reached a level of specialization in which the cardiologists and the intensive care physician are impelled to establish a long-term treatment policy for their patients rather than take care of only the patient's immediate and urgent problems.

Patient population

Acute coronary syndrome (ACS) will probably remain the most frequently primary admission diagnosis in ICCU in the next decade. Today these patients are treated effectively and quickly in different ways, thus the length of stay both in the unit and in the hospital is expected to decrease. On the other hand, the aging population in Europe, with increasing co-morbidities will probably change the ICCU population. Dramatic improvement in therapeutic measures will lead to a better outcome, with a prolonged survival for patients with coronary artery disease, with either a normal or a depressed left ventricular function. Therefore, the case-mix of our patients in the ICCU will change dramatically in the next decades.

As the population is aging, the unit will have to treat elderly patients who tend to suffer from multisystem diseases; the number of patients treated by multiple percutaneous or surgical revascularization procedures will increase; moreover, the ICCU is becoming the treatment centre for patients suffering from severe cardiac arrhythmias and decompensate heart failure or different combinations of diseased heart and other organs. As a result, it may likely be that the ICCU will be utilized for more complex patients who require a relatively longer length of stay in the Unit and will provide the treating staff with a special challenge. For these reasons, the requirements of the ICCU will increase, not decrease.

A special group of patients are those suffering from complications following invasive treatments in the catheterization lab. The still growing number of severe cases with multivessel disease, complex lesions, reduced left ventricular function, and a multitude of co-morbidities treated in the catheterization lab may increase the number of complications during and after coronary intervention procedures. These patients represent a special group of patients admitted to the Unit and need specific cardiological nursing and medical expertise.

Treatment policies

Reperfusion in acute ST-elevation myocardial infarction patients is undoubtedly an emergency.[9] Direct mechanical revascularization is becoming more and more popular, even though its availability is still restricted owing to lack of trained staff and budget constraints. In the near future, the catheterization laboratory and the ICCU will become more and more inseparable.

In the coming decade, the cardiologists will continue to observe constant efforts of the pharmaceutical industry to improve reperfusion at the patient's bedside, with

new, more efficient thrombolytics, anticoagulants, and antiplatelets agents, and more effective interventional therapy, which, in combination with newly developed drugs aimed at the salvage of the microvasculature and of the myocardium from ischaemia/reperfusion injury, will hopefully improve outcome in these patients.

This pre-vision has clear implications for the necessity of constantly updating the Units about novel resources for diagnosis and treatment, as well as preparing them to participate in multicentre research in order to determine the efficacy of the new therapeutic developments.

Professionalization of medicine is becoming more intense, with the need for cardiac patients be treated preferentially by properly trained cardiologists. In those hospitals in which the patients are transferred directly to the internal medicine ward, the physician in the Unit is compelled to determine a long-term treatment policy, in addition to being obliged to provide acute treatment. Thus, the different Units will develop methods for prognostic stratification (index-risk stratification), which will most probably include a combination of clinical data (age, sex, heart rate, blood pressure); ECG (ST-segment depression or elevation, T-wave inversion); cardiac markers of elevation, especially troponin; evaluation of the left ventricular function; residual ischaemia; and electrical instability.

Staff

The change in patient population and treating policies necessitate appropriate staff training. An increase in the number of complex and/or elderly patients (who may need respiratory treatment, intra-aortic balloon counter pulsation, haemodynamic complex monitoring, or dialysis) and participation in multicentre research projects require suitable training of the physicians and the nursing staff. It is reasonable that for specific specialization, there will be suitable training and accreditation both for physicians and for nurses, especially for the research nurses who will be an integral part of the ICCUs nursing staff.

Equipment

The standard monitoring equipment, including invasive and non-invasive electrocardiographic, haemodynamic, and respiratory assessment, will continue to be the basis of the ICCU.[10] Monitoring for the evaluation of autonomous function and electrical instability (heart rate variability, baroreceptor sensitivity, signal average electrocardiogram, and built-in continuous ECG Holter monitoring[11]) is likely to be added to standard equipment. Non-invasive assessment of cardiac function such as cardiac output[12,13] as well as continuous CO_2 and O_2 saturation monitoring, is becoming available and is routinely used in the modern ICCU.

Computers are a part of the everyday monitoring of the patients; it is used for collecting and analysing patient's data. A uniform electronic database management system of all the European ICCUs is an important task for the Working Group on ACC, including at least basic demographic and clinical data, modes of interventions, and in-hospital outcome. This will make communication among the different ICCUs simpler and could serve as database with an enormous source of information both for research and for quality control purposes.

Functional recommendations

ICCU patients

The decision to admit a patient will be made by the ICCU physician on duty; in case of physician disagreement, the decision will be made at the senior physician level. It is advisable for the following patients to be routinely admitted to the ICCU.[14,15]

(i) any patient with suspected acute ST-elevation myocardial infarction, up to 24 h from the onset of symptoms, especially if suitable for thrombolytic or primary angioplasty treatment;
(ii) patients with AMI, presenting $>$24 h after onset of symptoms with complications, or unstable high-risk patients (heart failure that requires intravenous therapy or haemodynamic monitoring or support of an intra-aortic balloon, serious cardiac dysrrhythmias, conduction disturbances, temporary pacemakers);
(iii) patients in cardiogenic shock;
(iv) patients with high-risk unstable coronary syndromes (e.g. ongoing or repeated anginal pain, heart failure, significant diffuse ST-depression, dynamic ST-shift, elevated troponins);
(v) unstable patients after a complicated percutaneous coronary intervention (PCI), who need special attention (at the discretion of the PCI operator);
(vi) patients with life-threatening cardiac arrhythmias, as a result of ischaemic heart disease, cardiomyopathy, rheumatic heart disease, electrolyte disturbances, drug effects, or poisoning;
(vii) patients with acute pulmonary oedema unresolved by initial therapy and depending on the underlying conditions;
(viii) patients in need of haemodynamic monitoring for evaluation of therapy;
(ix) patients after a heart transplant with acute problem, i.e. infection, haemodynamic deterioration, electrolyte imbalance, suspected acute rejection, and so on;
(x) massive pulmonary embolism.

This list is conclusive and should be adapted according to each individual case.

Length of stay in the ICCU

- The length of stay in the ICCU should be primarily planned to be at least 2–4 days, dictated by the individual clinical presentation.
- Patients with ST-elevation myocardial infarction without complications should continue the treatment in the ICCU for 48 h.

- Patients with unstable coronary syndromes with dynamic ST-shift and elevated cardiac troponins should stay in the ICCU until 24 h after the latest episode of ischaemia (non-invasive or planned invasive treatment, as dictated by ESC guidelines).
- High-risk ACS patients after acute PCI (with GP IIb/IIIa antagonists) should stay in the ICCU until the stable phase.

Relocation policy

- Once stabilized, patients are transferred from the ICCU to a cardiac intermediate care unit (with a simple electrocardiographic monitoring and run by cardiology oriented staff) or to the general ward, according to the local policy. After a short stay, an out-of-hospital specialized recreation facility is recommended prior to going back home. An alternative route is outpatient rehabilitation clinic.
- It is advisable to discuss the following with the patient in the presence of one of their dominant family members: medications, return to activities, risk factors and life-style modifications, a healthy diet, and recommendations for future tests (invasive and non-invasive) including an appointment for the outpatient follow-up clinic; this should be done shortly before their discharge from the ICCU.

Intermediate cardiac care unit patients

Decision to admit a patient to the intermediate ward is at the discretion of the treating physician, and according to the local policy at the particular institution.[16] It is recommended to consider the following conditions:

(i) intermediate risk unstable coronary syndrome patients;
(ii) patients in first stages of recovery from myocardial infarction;
(iii) patients with uncontrollable cardiac insufficiency not responsive to regular oral therapy, especially those with co-morbidities;
(iv) patients with heart disease in need of medical therapy adjustment, special cardiac investigations (e.g. electrophysiological study, cardiac catheterization, etc.), or some of the patients after special cardiac procedure (e.g. implantation of permanent pacemaker or internal cardiac defibrillators).

Number of beds in the ICCU

The number of beds in the ICCU must suit the size of the reference population and the relative specific workload of the hospital. The hospital's specific workload can be evaluated in a number of ways: the simplest measure of the relative workload is the number of visits to the hospital's internal emergency room.

Recommended formula for calculation:

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

The number of beds will be determined according to the highest of the two.

Number of beds in the intermediate cardiac care unit

The desired ratio of beds between ICCU and the intermediate CCU is 1:3.

ICCU equipment

(i) Patient monitoring unit: the basic patient monitoring unit must include at least two ECG channels, invasive pressure channel, non-invasive blood pressure monitor, and an SaO_2 metre. It is desirable that 50% of the beds include the following additional basic parameters: five ECG channels, two additional haemodynamic channels, end tidal CO_2, non-invasive cardiac output, and thermometer.
(ii) Nurse station: to be used for central monitoring and analysing. At least one ECG lead from each patient as well as relevant haemodynamic and respiratory data should continuously be present on a central screen. Slave monitors should be installed to enable monitoring of patients from different sites of the unit, as well as working stations for retrospective analysis of index events, i.e. changes in heart rate, rhythm disturbances, ST-events (ST-segment changes algorithm), heart rate variability, blood pressure, O_2 saturation, and so on.

Patients beds for the ICCU

Beds in the ICCU have to allow vertical movement, with the possibility of up and down head and leg positioning. Every bed must be equipped with oxygen, vacuum, and compressed-air intakes. It is desirable that one of the beds be suitable for patients with active contagious infectious diseases (e.g. methicillin resistant *Staphylococcus aureus*, HIV, tuberculosis, etc.) and filtered accordingly.

It is important to make sure that the patient can be X-rayed on the bed.

Additional equipment[17]

- Volumetric pump/automatic syringe: four to six per bed;
- mechanical respirators (including CPAP delivery system to use with face mask): one machine per two beds;
- intra-aortic balloon pump: one consol every three beds, up to the first six patients;
- haemodyalisis/haemofiltration machine: should be available (probably more cost effective if supplied by the nephrology department);
- pacemaker defibrillator (possibly biphasic): one apparatus every three beds;
- external pacemaker: one to two every six to eight beds;
- temporary pacemakers: three to four VVI and one DDD every six to eight beds;

- mobile echocardiography machine: one (consider a portable one, according to future technology development), including a TEE probe;
- blood clot metre (ACT): one;
- biochemical markers kits, for myocardial infarction, optional (to be omitted provided that the biochemistry tests are in the central laboratory in <30 min;
- glucose level measurement kit: one;
- blood gasses and electrolyte analyser: optional (to be omitted provided that the results of the blood gas and electrolyte tests come back from the central lab within 10 min);
- X-ray system for fluoroscopy: digital cardiac mobile C-arm enabling coronary angiography is recommended;
  - Ideally, a fully equipped catheterization and PCI laboratory should be in close association with the Unit and ready to perform invasive procedure on a 24 h basis.
  - An alternative route would be an available mobile unit to transfer a patient in need to a near by catheterization laboratory.
- mechanical compression devices used for groin and radial homeostasis: optional.

ICCU and intermediate CCU staff

- (physicians: cardiologists/residents in cardiology/ cardiology fellows)
- Physicians (day time shift):
- Department head: a certified cardiologist.
- First six beds: one physician every three beds.
- If more than six beds: one physician every four beds.

The ICCU should be staffed by at least one physician for every three to four patients, including the Unit director. The director of the Unit should be a board certified cardiologist, specially trained and accreditated as an acute cardiac care specialist, as cardiologists are the physicians better trained to assist patients with ACS and life-threatening cardiac diseases.

The cardiologist in charge of the ICCU should be skilled in treating urgent cardiac situations, including rhythm and haemodynamic disturbances and acute ischaemia. The cardiologist must be skilled at inserting an endotracheal tube, a temporary pacemaker, a catheter in the pulmonary artery, and a balloon in aorta for counter-pulsation. The cardiologist should be able to perform a transthoracic echo study on a basic level (i.e. evaluate the left ventricle systolic function, identify severe valvular disease, and find pericardial fluid) and should have further training in the general intensive care unit.

On-duty and on-call physicians

A skilled physician on duty should be present in the Unit at all times. This physician should be able to handle acute cardiac emergencies after short local training and approval for night duties by the director of the unit. An attending cardiologist on call should always be available for consultation and assistance.

Nurses

Nurses are as important as physicians. Proper nursing staff is the strength of the ICCU. A head nurse for the ICCU is appointed with authority and responsibility for the appropriateness of nursing care; they must have extensive experience in intensive care nursing and proper medical managerial skills, must be able to conduct routine nursing activity of the unit, must be involved in the on-going training of the unit staff, and must take an active part in research activities. The ICCU will employ only registered nurses. At least 75% of them should have completed formal intensive care training (which includes formal cardiology training).[18]

A unified recommendation for the size of the nursing staff is an intricate issue hampered by the divergence of nursing working habits and skills, case-mix of patients, and different Therapeutic Interventions Scoring System levels.[19]

The following recommendation is based on the estimated workload of an average ICCU, the calculated Whole Time Equivalents,[20] and the personal experience of the authors. Furthermore, allocating nursing manpower should take into account the need for the number of shifts per day, the number of beds in the units, the desired occupancy rate, extra manpower for holidays, and the ability to transfer the nurses from one facility to the other (intensive to intermediate to cardiology and vice versa).

The nursing staff should be constructed of at least 2.8 nurses per bed, to cover three shifts per day, so that the minimal number of nurses in a given time will be at least one nurse per two beds during day time and one per three beds during night shift.[21,22]

The intensive care nurse should have further training once in at least 5 years in the general intensive care unit. It is also advisable that further training courses be reciprocal so that the nurses working in the general intensive care unit could work in the cardiac intensive care unit as well.

Intermediate cardiac care unit staff

- Department head: a certified cardiologist.
- First 12 beds: one physician every six beds.
- If more than 12 beds: one physician every eight beds.
- Nurses: 1.8 nurses per bed.

Additional staff

- Secretary and nurse assistant full time.
- Dietician, computer expert (hardware and software), ventilation technician, social worker, physiotherapist, porters, and cleaners—part time.

ICCU and intermediate CCU: construction[23–25]

(i) The cardiac intensive care unit/intermediate unit/ cardiac ward should be constructed as an independent ward in the hospital.[26]
(ii) The desired intensive care unit standard is a separate room for each patient and up to two to three patients per one room in the intermediate unit.

(iii) There should be at least one single bedroom with the possibility to isolate patients with contagious infection.
(iv) The architecture of the unit should be designed to make it possible to observe the patients from the nurses' monitoring station and to have easy and fast access.
(v) The station should be in a central position and well equipped, and the surrounding area will be spacious so as to afford optimal working conditions.
(vi) The separate intensive care procedure room should be spacious enough so that it can contain all the physicians (cardiologists, anaesthesiologists, nurses, technicians) and multitude of bulky equipment (X-ray machine, heavy monitoring, intra-aortic balloon pump) necessary to initiate treatment for a complicated acute case. The minimal area should be 25 m^2. The room must have washable walls for 2 m in height. Construction should fit requirement for the use of X-ray fluoroscopy.
(vii) The electrical equipment should have an emergency feeding and a continuity apparatus.
(viii) Windows in the intensive care ward are desirable, but not a pre-requisite.

Summary table

	Intensive CCU	Intermediate CCU
Patients	STEMI—any patient. Within 24 h. High-risk patients, cardiogenic shock	ACS patients with intermediate risk
	High risk unstable coronary syndromes	First stages of recovery from MI
	Arrhythmias—life-threatening cardiac arrhythmias	Uncontrollable cardiac insufficiency
	Post-PCI—unstable/high-risk patients	
	Haemodynamic monitoring—for evaluation of therapy s/p heart transplant with acute problem massive PE	
Length of stay	Primarily planned to be at least 2–4 days	
	STEMI without complications—48 h	
	Unstable ACS—until 24 h after the latest ischaemic episode	
	High-risk ACS—until stabilized (medication, revascularization)	
Beds	The highest of the following: for each 100 000 inhabitants, four to five ICCU beds or for every 100 000 visits per year in the internal emergency room, 10 ICCU beds	Ratio of ICCU/intermediate beds is 1:3
Monitoring unit	Bedside: two ECG channels, invasive pressure, non-invasive pressure, SaO_2 metre	Bedside: two ECG channels, non-invasive pressure, SaO_2 metre
	Fifty per cent of the beds will include the following additional basic parameters: five ECG channels, two additional haemodynamic channels, end tidal CO_2, non-invasive cardiac output, and thermometer	
Central station	One ECG lead from each patient, relevant haemodynamic and respiratory data	One ECG lead from each patient
	Slave monitors	Working station for retrospective analysis
	Working station for retrospective analysis	
Equipment	Volumetric pump/automatic syringe, mechanical respirators, intra-aortic balloon pump, external pacemaker/defibrillator, temporary pacemakers, blood clot metre (ACT), glucose level measurement kit	Volumetric pump/automatic syringe external pacemaker/defibrillator glucose level measurement kit
	Echocardiography, X-ray fluoroscopy	
Optional	Biochemical markers kits for myocardial infarction, haemodyalisis/haemofiltration machine, blood gasses and electrolyte analyser	
Department head	Certified cardiologist	Certified cardiologist
Physicians	First six beds: one physician for every three bed	
	More than 6 beds: one physician for every four beds	
Nurses	Day time: one nurse per two beds	Day time: one nurse per four beds
	Night shift: one nurse per three beds	Night shift: one nurse per six beds
Additional staff	Secretary and nurse assistant full time	
	Dietician, computer expert (hardware and software), ventilation technician, social worker, physiotherapist, porters, and cleaners—part time	
Construction	Separate room for each patient	Two to three patient per one room central nurse station
	Central nurse station	
	One room with isolation possibility	
	Procedure room (X-ray, heavy monitoring, IABP)	
	Dialysis facility	
Other areas	Staff room, meeting room, family waiting room, office, store room	

(ix) The lighting should be good, but not dazzling; lightning should be indirect.
(x) A dialysis facility (source of water and sewage) should be established in a few rooms as necessary.
(xi) In larger intensive care units, one should consider dividing the nurses station into two or three according to the number of beds. It is advised that one nurses station should serve not more than six to eight beds.
(xii) The cardiac intensive care unit should be situated as close as possible to the emergency room, the catheterization lab, general intensive care unit, and operating theatres (if available in the institution).
(xiii) It is also desirable that the intensive care ambulance may have a direct access to the unit, so that in appropriate cases, a patient may be directly admitted, bypassing the emergency department.

Other areas to be included

(i) staff rooms (meeting the demands of the secretary, medical staff, nursing staff, patient relatives' interview, physician on-call dormitory, head nurse, and director of the unit);
(ii) meeting room;
(iii) family waiting room;
(iv) office;
(v) store room (a lot of electronic equipment that requires constant electricity recharge);
(vi) computer communications—inter-departmental. Departments and laboratories—an external system.

Database

The computer system is regarded as a positive means of collecting information, at local, national, and international levels. It facilitates everyday activities in patient management and data archiving. It can be used as database and enables analysis of information and quality control. Nevertheless, there are objective difficulties and obstacles on the way to adopt a uniform programme to be used as a continental database.

(i) Currently, there is no accepted optimal software for cardiac intensive care patients.
(ii) Many of the cardiology departments in Europe have a computer system with or without connections to similar systems within or out of the hospital.
(iii) Development of computerized systems depends on strategic decisions made by different Health System Authorities, both at national and at hospitals levels. Therefore, it will be impossible to introduce a uniform programme across Europe.
(iv) The existing programmes, and those to be developed in the near future, are based on different software systems. Effort and resources should be invested for the connection of those systems into a common database.

It is recommended that the ICCU will use an electronic chart routinely. This could facilitate patient admission, discharge, and follow-up as well as research and quality control. As several hardware and software facilities are available, and obviously many Units in Europe have already implemented their own electronic chart, a common European electronic chart would be an impractical dream. Yet, some key items common to all electronic charts could be chosen, transmitted through the internet, and will be used as a common European database for patient admitted to the different ICCUs.

Recently, the European Society of Cardiology launched the Cardiology Audit and Registration Data Sets (CARDS) initiative, under the auspices of the European Union.[27] One of the three main issues in CARDS is ACS, and the related Expert Committee on ACS published a report on the data standards for a ICCUs DB on ACS. This data set can constitute the common basis for all the different databases in European ICCUs, allowing interoperability and data sharing.

Quality assurance should be an integral part of the organization and standards of a ICCU: processes currently considered effective for patients outcome, such as adequately timed reperfusion and evidence-based care at discharge, should be monitored and quality control performed reviewed at least on an annual basis, together with personnel and administrators.

Conclusion

The current recommendations have been written as a guide and a rule for the function of a modern ICCU. The exponential speed of changes in technology, procedures, and treatment policies will undoubtedly provide a repeated need for updating these guidelines. For instance, what will be the effect of chest pain units (which are emerging throughout Europe) on the ICCU?

In the near future, reference centres for primary or facilitated PCI for ST-elevation myocardial infarction, as well as for early intervention in patients with non-ST-elevation myocardial infarction, will play a key role in the treatment of patients with ACS. The concept of networking for the coordination among tertiary centres, community hospitals, emergency rooms, and transportation, might also result in a need for updating.

The lack of evidence-based recommendation on the structure and function of ICCUs call upon properly designed studies looking at unresolved issues such as numbers of ICCU beds required for a given populations size, specific equipment, required personnel, and alike.

References

1. Julian DG. The history of coronary care units. *Br Heart J* 1987; **57**:497–502.
2. Killip T, Kimball JT. Treatment of myocardial infarction in a coronary care unit: a two year experience with 250 patients. *Am J Cardiol* 1967;**20**:457–464.
3. Ferdinande P. Members of the Task Force of the European Society of Intensive Care Medicine. Recommendations on minimal requirements of Intensive Care Departments. *Intensive Care Med* 1997;**23**:226–232.

4. Merkouris A, Papathanassoglou ED, Pstolas D, Papagiannaki V, Floros J, Lemonidou C. Staffing and organizations of nursing care in cardiac intensive care units in Greece. *Eur J Cardiovasc Nurs* 2003;**2**:123–129.
5. Valle Tudela V, Alonso Garcia A, Aros Borau F, Gutierrez Morlote J, Sanz Romero G, Spanish Society of Cardiology. Guidelines of the Spanish Society of Cardiolgy on requirements and equipment of the coronary care unit. *Rev Esp Cardiol* 2001;**54**:617–623.
6. Ruda Mla. Intensive care units for patients with acute coronary insufficiency. *Kardiologiia* 1976;**16**:148–158.
7. Shachtman J, Fields J, Craig S. Basic design and equipment needed for a coronary care units. *Isr J Med Sci* 1967;**3**:287–294.
8. Fuster V. 50th anniversary historical article. Myocardial infarction and coronary care units. *J Am Coll Cardiol* 1999;**34**:1851–1853.
9. Keeley EC, Boura JA, Grines CL. Primary angioplasty versus intravenous thrombolytic therapy for acute myocardial infarction: a quantitative review of 23 randomized trials. *Lancet* 2003;**361**:13–20.
10. Mangan B. Structuring cardiology services for the 21st century. *Am J Crit Care* 1996;**5**:406–411.
11. Leeper B. Continuous ST-segment monitoring. *AACN Clin Issues* 2003;**14**:145–154.
12. Cotter G, Moshkovitz, Y. Kaluski E, Cohen AJ, Miller H, Goor D, Vered Z. Accurate, noninvasive continuous monitoring of cardiac output by whole-body electrical bioimpedance. *Chest* 2004;**125**:1431–1440.
13. Mielck F, Buhre W, Hanekop G, Tirilomis T, Hilgers R, Sonntag H. Comparison of continuous cardiac output measurements in patients after cardiac surgery. *J Cardiothorac Vasc Anesth* 2003;**17**:211–216.
14. Nasraway SA, Cohen IL, Dennis RC, Howenstein MA, Nikas DK, Warren J, Wedel SK. Guidelines on admission and discharge for adult intermediate care units. American College of Critical Care Medicine of the Society of Critical Care Medicine. *Crit Care Med* 1998;**26**:607–610.
15. Bone RC, McElwee NE, Eubanks DH, Gluck EH. Analysis of indications for intensive care unit admission. Clinical efficacy assessment project: American College of Physicians. *Chest* 1993;**104**: 1806–1811.
16. Task Force of the American Society of Critical Care Medicine. Guidelines on Admission and Discharge for Adult Intermediate Care Units. *Crit Care Med* 1998;**26**:607–610.
17. Quinio P, Baczynski S, Dy L, Ferrec G, Catineau J, de Tinteniac A. Evaluation of a medical equipment checklist before intensive care room opening. *Ann Fr Anesth Reanim* 2003;**22**:284–290.
18. Depasse B, Pauwels D, Somers Y, Vincent JL. A profile of European ICU nursing. *Intensive Care Med* 1998;**24**:939–945.
19. Miranda DR, Nap R, de Rijk A, Schanufeli W, Lapichino G, TISS Working Group. Therapeutic intervention scoring system. Nursing activities score. *Crit Care Med* 2003;**31**:374–382.
20. Galley J, O'riordan B, Royal College of Nursing. Guidance for nurse staffing in critical care. *Intensive Crit Care Nurs* 2003;**19**:257–266.
21. Williams G, Clarke T. A consensus driven method to measure the required number of intensive care nurses in Australia. *Aust Crit Care* 2001;**14**:106–115.
22. Pronovost PJ, Jenckes MW, Dorman T, Garrett E, Breslow MJ, Rosenfeld BA, Lipsett PA, Bass E. Organization characteristics of intensive care units related to outcomes of abdominal aortc sugery. *JAMA* 1999;**281**:1330–1331.
23. Wedel S, Warren J, Harvey M, Hitchens Biel M, Dennis R. Guidelines for Intensive Care Unit Design. *Crit Care Med* 1995; **23**:582–588.
24. Ferdinande P. Recommendations on minimal requirements for Intensive Care Departments. Members of the Task Force of the European Society of Intensive Care Medicine. *Intensive Care Med* 1997;**23**:226–232.
25. Valle Tudela V, Alonso Garcia A, Aros Borau F, Gutierrez Morlote J, Sanz Romero G; Spanish Society of Cardiology. Guidelines of the Spanish society of cardiology on requirements and equipment of the coronary care unit. *Rev Esp Cardiol* 2001; **54**:617–623.
26. Fracchia C, Ambrosino N. Location and architectural structure of ICCU. *Monaldi Arch Chest Dis* 1994;**49**:496–498.
27. Flynn MR, Barrett C, Cosio FG, Gitt AK, Wallentin L, Keamey P, Lonergan M, Shelley E, Simmons ML. The Cardiology Audit and Registration Data Standards (CARDS), European data standards for clinical cardiology practice. *Eur Heart J* 2005;**26**,208–313.