

EAPC Core Curriculum for Preventive Cardiology (compare to ESC Core Curriculum for the Cardiologist)

Matthias Wilhelm  ^{1*}, Ana Abreu², Paolo Emilio Adami³, Marco Ambrosetti  ⁴, Maria Antonopoulou⁵, Alessandro Biffi⁷, Elena Cavarretta^{8,9}, Flavio D'Ascenzi⁶, Irene Gibson¹⁰, Diederick E. Grobbee¹¹, Marie-Christine Iliou¹², Konstantinos Koskinas¹, Pedro Marques-Vidal  ¹³, Uwe Nixdorff¹⁴, Michael Papadakis¹⁵, Massimo F. Piepoli¹⁶, Vass Vassiliou¹⁷, David Wood^{18,19}, Paul Dendale  ²⁰, and Martin Halle  ^{21*}

¹Department of Cardiology, Inselspital, Bern University Hospital, University of Bern, Freiburgstrasse 46, 3010 Bern, Switzerland; ²Servico de Cardiologia, Hospital Universitario de Santa Maria/Centro Hospitalar Universitario Lisboa Norte (CHULN), Centro Academico de Medicina de Lisboa (CAML), Centro Cardiovascular da Universidade de Lisboa (CCUL), Avenida Professor Egas Moniz, 1649-035 Lisbon, Portugal; ³Health and Science Department, World Athletics, Monaco Principality, 6-8 Quai Antoine 1er, 98007 Monaco, Monaco; ⁴Cardiac Rehabilitation Unit ASST, Via Medaglie D'Oro, 9, 26013 Crema, Italy; ⁵Spili Primary Care Centre, Regional Health System of Crete, 740 53 Spili, Greece; ⁶Department of Medical Biotechnologies, Division of Cardiology, University of Siena, Viale Mario Bracci 16, 53100 Siena, Italy; ⁷Med-Ex Medicine & Exercise, Medical Partner Scuderia Ferrari, Via Vittorio Veneto 108, 00187 Rome, Italy; ⁸Department of Medical-Surgical Sciences and Biotechnologies, Sapienza University of Rome, Corso della Repubblica 97, 04100 Latina, Italy; ⁹Mediterranea Cardiocentro, Via Orazio, 2, 80122 Naples, Italy; ¹⁰National Institute for Prevention and Cardiovascular Health, Moyola Lane, Newcastle, Galway H91 FF68, Ireland; ¹¹Julius Center for Health Sciences and Primary Care, and University Medical Center Utrecht, 3584 CX Utrecht, The Netherlands; ¹²Cardiac Rehabilitation and Secondary Prevention Department, Corentin Celton Hospital, Assistance Publique Hopitaux de Paris Centre Université de Paris, Parvis Corentin Celton 4, 92130 Issy-les-Moulineaux, Paris, France; ¹³Department of Medicine, Internal Medicine, Lausanne University Hospital (CHUV), Rue du Bugnon 46, 1011 Lausanne, Switzerland; ¹⁴European Prevention Center c/o Medical Center Düsseldorf, Luise-Rainer-Straße 6-10, 40235 Düsseldorf, Germany; ¹⁵Cardiovascular Clinical Academic Group, St George's, University of London, London SW17 0RE, UK; ¹⁶Cardiac Unit, Guglielmo da Saliceto Hospital, University of Parma, 29121 Piacenza, Italy; ¹⁷Department of Cardiovascular Medicine, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK; ¹⁸National Institute for Prevention and Cardiovascular Health, National University of Ireland Galway, University Road, Galway H91 TK33, Ireland; ¹⁹National Heart and Lung Institute, Imperial College London, London SW3 6LY, UK; ²⁰Heart Centre Hasselt and Hasselt University, 3500 Hasselt, Belgium; and ²¹Department of Prevention and Sports Medicine, University Hospital rechts der Isar, Technical University Munich, German Centre for Cardiovascular Research, Georg-Brauchle-Ring 56, 80992 Munich, Germany

Received 5 November 2020; revised 15 January 2021; accepted 19 January 2021

* Corresponding authors. Tel: +41 31 632 8986, Email: matthias.wilhelm@insel.ch (M.W.); Tel: +49 89 289 244 31, Email: martin.halle@mri.tum.de (M.H.)

EAPC Core Curriculum Task Force:

Chair: Matthias Wilhelm

Ana Abreu, Paolo Emilio Adami, Alessandro Biffi, Elena Cavarretta, Flavio D'Ascenzi, Paul Dendale, Irene Gibson, Diederick E. Grobbee, Martin Halle, Konstantinos Koskinas, Uwe Nixdorff, Michael Papadakis, Massimo Piepoli, Vass Vassiliou, David Wood

EAPC Core Curriculum Writing Group: Population Science and Public Health Section: Konstantinos Koskinas, Pedro Marques-Vidal, Vass Vassiliou

Primary Care and Risk Factor Management Section: Maria Antonopoulou, Alessandro Biffi, Irene Gibson

Secondary Prevention and Rehabilitation Section: Ana Abreu, Marco Ambrosetti, Marie-Christine Iliou

Sports Cardiology and Exercise Section: Paolo Emilio Adami, Elena Cavarretta, Michael Papadakis

Young Community: Flavio D'Ascenzi

EAPC Board Reviewers: Silvia Castelletti, Emeline Van Craenenbroeck, Constantin Davos, Nicolle Kraenkel, Trine Moholdt, Josef Niebauer

ESC Education Committee Reviewers: Nick Brooks, Agnès Pasquet, Felix Tanner

© The Author(s) 2021. Published by Oxford University Press on behalf of the European Society of Cardiology.

This is an Open Access article distributed under the terms of the Creative Commons Attribution Non-Commercial License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited. For commercial re-use, please contact journals.permissions@oup.com

Preventive cardiology encompasses the whole spectrum of cardiovascular disease (CVD) prevention, at individual and population level, through all stages of life. This includes promotion of cardiovascular (CV) health, management of individuals at risk of developing CVD, and management of patients with established CVD, through interdisciplinary care in different settings. Preventive cardiology addresses all aspects of CV health in the context of the social determinants of health, including physical activity, exercise, sports, nutrition, weight management, smoking cessation, psychosocial factors and behavioural change, environmental, genetic and biological risk factors, and CV protective medications.

This is the first European Core Curriculum for Preventive Cardiology, which will help to standardize, structure, deliver, and evaluate training in preventive cardiology across Europe. It will be the basis for dedicated fellowship programmes and a European Society of Preventive Cardiology (EAPC) subspecialty certification for cardiologists, with the intention to improve quality and outcome in CVD prevention.

Keywords Population science • Prevention of CVD • Cardiovascular rehabilitation • Sports cardiology • Exercise testing

Table of content

List of abbreviations	3
Definition of preventive cardiology.....	3
Preventive cardiology—towards a sub-specialty of cardiology	3
The concept of the core curriculum for preventive cardiology.....	4
1. CanMEDS roles	7
2. Clinical competencies.....	7
3. Entrustable professional activities.....	7
4. Level of independence	8
5. Assessment of clinical competences using EPAs	9
Sources of knowledge in preventive cardiology	9
Chapter 1: Population science and public health	9
1.1 Design, implement and evaluate preventive interventions at the population level.....	9
Chapter 2: Primary prevention and risk factor management	10
2.1 Manage individuals with multifactorial cardiovascular risk profiles	10
2.2 Manage a patient with non-traditional cardiovascular risk factors.....	11
Chapter 3: Secondary prevention and rehabilitation.....	12
3.1 Manage a prevention and rehabilitation programme for a cardiovascular patient.....	12
3.2 Manage a prevention and rehabilitation programme for a cardiovascular patient with significant comorbidities, frailty, and/or cardiac devices.....	14
3.3 Manage a cardiovascular prevention and rehabilitation programme for an oncology patient.....	16
Chapter 4: Sports cardiology and exercise.....	17
4.1 Manage pre-participation screening in a competitive athlete	17
4.2 Manage the work-up of an athlete with suspected or known cardiovascular disease.....	19
Chapter 5: Cardiopulmonary exercise testing.....	20
5.1 Use cardiopulmonary exercise testing for diagnosis, risk stratification and exercise prescription	20

List of abbreviations

6MWT	6-min walk test
AHA	American Heart Association
ACC	American College of Cardiology
CIED	Cardiac implantable electrical devices
CVD	Cardiovascular disease
CV	Cardiovascular

CPET	Cardiopulmonary exercise testing
DOPS	Direct observation of procedural skills
EAPC	European Association for Preventive Cardiology
EBSC	European Board for the Specialty of Cardiology
ECG	Electrocardiogram
EPA	Entrustable professional activity
ESC	European Society of Cardiology
LVAD	Left ventricular assist device
Mini-CEX	Mini clinical evaluation exercise
MCQ	Multiple choice question
PPE	Pre-participation evaluation

Definition of preventive cardiology

Preventive cardiology encompasses the whole spectrum of cardiovascular disease (CVD) prevention, at individual and population level, through all stages of life.

This includes promotion of cardiovascular (CV) health, management of individuals at risk of developing CVD, and management of patients with established CVD, through interdisciplinary care in different settings.

Preventive cardiology addresses all aspects of CV health in the context of the social determinants of health, including physical activity, exercise, sports, nutrition, weight management, smoking cessation, psychosocial factors and behavioural change, environmental, genetic and biological risk factors, and CV protective medications.

Preventive cardiology—towards a sub-specialty of cardiology

Scientific advances have led to a substantial decline of death from CVD over the last decades.¹ However, CVD morbidity remains high and CVD are still the most common cause of death across European Society of Cardiology (ESC) member countries.² While positive trends have been observed for medical management of arterial hypertension and dyslipidaemias, the prevalence of obesity has more than doubled and the prevalence of diabetes mellitus has tripled in Europe.² More recent declines in the age-standardized incidence of CVD across ESC member countries have been small or absent.² The incidence of CVD's major components, ischaemic heart disease, and stroke, have both shown a downward trend but changes in prevalence have been small.² In a European Heart Network study, CVD was estimated to

cost the European Union economy 210 billion Euro a year in 2015, of which 53% (111 billion Euro) was due to healthcare costs.²

The cardiology community has started a transition from predominantly treatment to prevention of CVD.³ A large body of scientific evidence has been generated and appropriate guidelines and position papers are available in the four domains of preventive cardiology: Population science and public health,^{4,5} primary prevention and risk factor management,^{3,6–8} secondary prevention and cardiovascular rehabilitation,^{3,9–14} and sports cardiology and exercise.^{15–21} The European Association for Preventive Cardiology (EAPC) has recently started centre accreditation in these domains to standardize and optimize care.²²

Historically, CV prevention has been classified into primordial prevention (population-based measures to prevent risk factor development), primary prevention (management of individuals without clinically manifest disease but at risk of developing CVD, with the aim of delaying or preventing the onset of disease), and secondary prevention (focusing on people with established CVD). While preventive measures indeed differ in various ways for these three categories, this Task Force also acknowledges that CV risk is a continuum and that several measures to enhance CV health are applicable across the spectrum of CV prevention. Moreover, the distinction between primary and secondary prevention, albeit well-established, may in certain occasions be artificial; while people with subclinical disease (e.g. evidence of advanced atherosclerosis by imaging, but not yet with clinically manifest CVD) would formally belong to 'primary prevention', they often qualify for interventions applicable to the 'secondary prevention' setting.

Both in high-, middle-, and low-income countries, nine potentially modifiable health behaviours and CV risk factors account for most of the population attributable risk of myocardial infarction and stroke in both sexes and at all ages.^{23,24} Smoking, physical inactivity, unhealthy nutrition patterns, obesity, psychosocial factors, diabetes mellitus, dyslipidaemias, and arterial hypertension are key targets for lifestyle interventions, and optimization of medical therapy. In addition, biomarkers and genetics risk scores²⁵ have the potential to further characterize individual CVD risk profiles. Beyond traditional risk factors, other drivers of residual CV risk have come to the forefront, including inflammatory, pro-thrombotic, and metabolic pathways that contribute to recurrent events and are often unrecognized and not addressed in clinical practice.²⁶

The increasing rates of obesity and diabetes, the suboptimal lifestyle management and implementation of guideline-directed medical therapy in secondary prevention of CVD,²⁷ and the gaps in evidence highlight the need for further investment in preventive cardiology. The level of profound knowledge, specialized skills, and committed attitudes goes beyond core cardiology training and justifies sub-specialty training. In addition to expertise in a single CVD risk factor (e.g. diagnosis and management of dyslipidaemias), competencies are required to evaluate and manage single risk factors in the individual's overall risk profile, take environmental, genetic, lifestyle and psychosocial aspects into account, integrate guideline-directed medical therapy, and propose a holistic management plan including attainable and realistic short-, mid-, and long-term goals. Motivational interviewing skills are required to gain the patient's willingness to adhere to lifestyle changes and guideline-directed medical therapies in order to reach these goals. Leadership and communication skills are required to cooperate with interdisciplinary healthcare teams and other

partners. Beside classical patient groups (individuals with CV risk factors, patients after acute coronary syndromes, or with chronic coronary syndromes, heart failure, implantable devices, peripheral artery disease), preventive cardiology can contribute to CV risk factor management in different patient populations, e.g. diabetes,⁶ atrial fibrillation,²⁸ and cancer.^{29,30} Moreover, specific aspects of sports cardiology will have to be covered (Figure 1).

As a sub-specialty, a broader perspective of CVD prevention is necessary. Pregnancy, infancy, adolescence, early adulthood, adult and elderly life are distinct periods with individual potential opportunities for prevention. Pre-conception and pregnancy are important phases for the next generation, while post-mortem autopsy may reveal relevant information for living relatives (Figure 2).³¹ Precision medicine and digital health start to play a role in CVD prevention and have the potential to improve phenotyping of patients for more personalized and tailored therapies, and better outcomes.^{32,33} Emerging concepts inform new collaborations in the future and an expansion of the field of preventive cardiology.

A common European core curriculum for preventive cardiology will help to standardize, structure, deliver, and evaluate training of cardiologists in preventive cardiology across Europe. This will be the basis for dedicated fellowship programmes and an EAPC sub-specialty certification, contributing to improvements of quality and outcome in CVD prevention. Similar initiatives have been launched in the USA.^{34–36} In the evolving field of preventive cardiology, the core curriculum will have to be updated at regular intervals to include emerging concepts and new scientific evidence.

The concept of the core curriculum for preventive cardiology

The changing nature of our profession and the changing environment of healthcare has led to specific requirements in the field of cardiology. In 2007, the European Board for the Specialty of Cardiology (EBSC) published recommendations for sub-specialty accreditation in cardiology.³⁷ A sub-specialty is defined as a specific field of cardiology, where knowledge and skills go beyond the basic requirements of general cardiology and additional training is necessary. Sub-specialty training should be based on a published core curriculum.³⁷ The core curriculum should include a formal education plan intended to bring expected learning outcomes. It should include the rationale, aims, and objectives, expected learning outcomes, education content, teaching and learning strategies, and assessment procedures.³⁷

Over the last decades, sub-specialty curricula have been developed and published by most ESC associations (Acute Cardiovascular Care, Arrhythmias & Cardiac Pacing, Heart Failure, Cardiovascular Imaging, Percutaneous Cardiovascular Interventions).³⁸ In the field of preventive cardiology, the American College of Cardiology (ACC)/American Heart Association (AHA) published a competence and training statement in 2009.³⁴ More recent proposals for sports cardiology qualification are available from the ACC and EAPC.^{16,39}

This document is the first common European core curriculum for preventive cardiology, covering all aspects of the field, including prevention, rehabilitation, and sports cardiology. It should serve as a framework for the sub-specialty qualification of cardiologists in

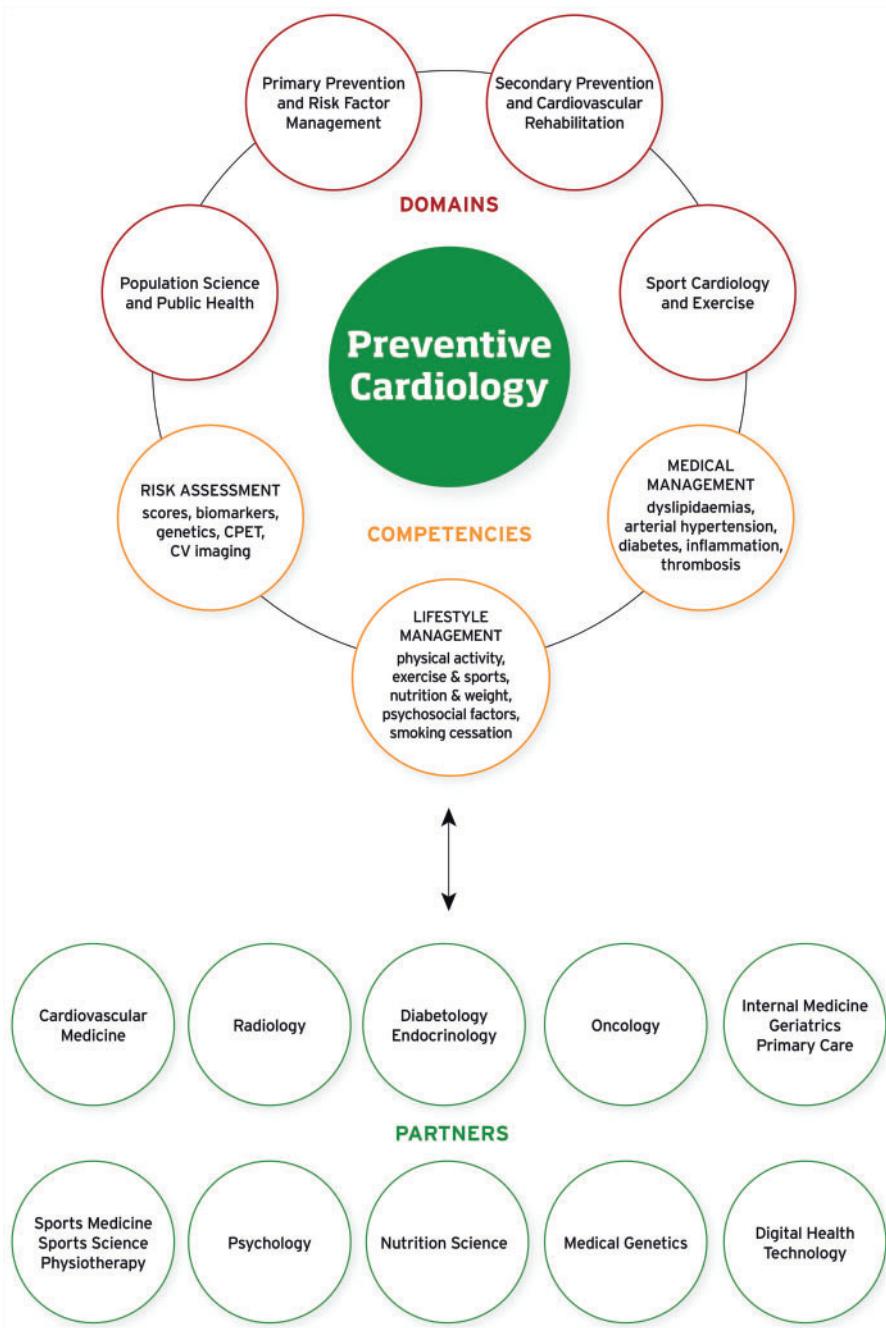


Figure 1 Preventive cardiology—domains, necessary competencies, and cooperation partners. CPET, cardiopulmonary exercise testing; CV, cardiovascular.



Figure 2 Lifelong cardiovascular disease prevention from the cradle to the grave and beyond.³¹

preventive cardiology. The description of practical educational programmes, requirements for training centres and trainers is out of the scope of this document, and will be addressed in future documents. Advanced competencies in sports cardiology may be required in dedicated referral centres, addressed by a specific additional curriculum.

A core curriculum task force was established in 2019, including members of the EAPC Education Committee, the EAPC Board, and the EAPC Young Community. A writing group, including representatives of the four EAPC sections contributed to the drafting of the entrustable professional activities (EPAs).⁴⁰ Their views and comments were captured in an iterative process employing teleconferences, in-person discussions, an online Delphi survey, and workshops at EAPC meetings.

The document was developed in cooperation with the task force of the ESC Core Curriculum for the Cardiologist.⁴¹ Key competencies from the field of preventive cardiology are important for core cardiology training and covered in Chapter 8 on prevention, rehabilitation, and sports.⁴¹ This chapter was used during the drafting process of this document, and served as a guideline to harmonize structure and content. The intention of this core curriculum is to describe the additional knowledge, skills, and attitudes necessary for sub-specialty qualification in preventive cardiology. The final document was approved by the EAPC Board in October 2020, and reviewed by the ESC Education Committee.

1. CanMEDS roles

The Royal College of Physicians and Surgeons of Canada have produced a widely accepted standard framework of physician roles, CanMEDS.⁴² This framework was built to identify and describe the abilities physicians require to effectively meet the healthcare needs of the people they serve (Table 1).⁴² The ESC has adopted the CanMEDS roles in the ESC Core Curriculum for the Cardiologist.⁴¹

CanMEDS roles can be assessed and taught individually, and they are all represented to a different extend in each of the EPAs of the Core Curriculum for Preventive Cardiology as outlined in Chapters 1–5. While EPAs are proposed as the preferred method of assessing specialty competencies, the CanMEDS roles can be viewed as generic competencies of physicians.

In the field of preventive cardiology, physicians work in interdisciplinary teams and the scope of cardiovascular prevention goes beyond patient care. Thus, the CanMEDS roles of communicator, collaborator, and health advocate are of particular importance.

2. Clinical competencies

The conceptualization, organization, and administration of preventive cardiology involves different groups of healthcare professionals. In the context of this curriculum, we focus on the competences of the cardiologist to administer of preventive cardiology in clinical practice.

In addition to the clinical competencies acquired during core cardiology training,⁴¹ the sub-specialty of preventive cardiology requires specific knowledge, skills and appropriate attitudes in primary prevention, risk factor assessment and management, population science, public health, secondary prevention, rehabilitation, sports cardiology, and exercise testing and training.

The number of clinical competencies calls for assessment throughout sub-specialty training. Within the process of continuous professional development, this may encourage continuous learning which will continue after sub-specialist certification. To enable these goals,

the core curriculum consists of EPAs (see below). To make knowledge accessible, each EPA contains a detailed map linking to contemporary guidelines and position papers and the ESC topic list, thereby enabling cross-linking with knowledge and training databases including textbooks, structured and case-based learning courses, congress programmes, and online materials.⁴¹

3. Entrustable professional activities

Trust is not only central for the relationship between trainers and trainees, but also in the shared decision-making process between physicians and their patients, and in the interaction with other healthcare professionals.⁴¹ An EPA is a key task of a discipline that an individual can be trusted to perform in a given healthcare context, once sufficient competence has been demonstrated.⁴⁰ The EPA concept allows trainers to make competency-based decisions about the level of supervision required by trainees.⁴⁰ Competency-based education targets standardized levels of proficiency to guarantee that all learners have a sufficient level of proficiency at the completion of training.⁴⁰ EPAs are not an alternative for competencies, but a means to translate competencies into clinical practice. While competencies are descriptors of physicians, EPAs are descriptors of work. EPAs usually require multiple competencies in an integrative holistic nature.⁴⁰ EPAs are observable and measurable and can be mapped to competencies and milestones across the entire landscape of physician activities. They can be monitored, documented, and certified.⁴¹

The American Board of Pediatrics was one of the first certifying agencies that introduced the concept of EPAs in their revised training guideline for the sub-specialty of paediatric cardiology in 2015.⁴³ The ESC has introduced EPAs in the 2020 update of the ESC Core Curriculum for the Cardiologist, containing one chapter on prevention, rehabilitation, and sports with seven EPAs.⁴¹

The nine EPAs of the EAPC Core Curriculum for Preventive Cardiology describe the additional competencies necessary for the sub-specialty of preventive cardiology and are grouped in chapters, according to specific domains of preventive cardiology (Table 2).

All EAPC sections were involved in the definition of the content. The EPA 2.2 *Manage a patient with non-traditional cardiovascular risk factors*, builds upon the competencies required for EPA 2.1 *Manage individuals with multifactorial cardiovascular risk profiles*, and the knowledge, skills, and attitude sections emphasize additional and particularly relevant aspects only. The same applies to EPA 3.2 *Manage a prevention and rehabilitation programme for a cardiovascular patient with significant comorbidities, frailty, and/or cardiac devices*, and EPA 3.1 *Manage a prevention and rehabilitation programme for a cardiovascular patient*. The EPA 5.1 *Use cardiopulmonary exercise testing for diagnosis, risk stratification and exercise prescription*, deals with a testing modality, specific for preventive cardiology, since independent execution and interpretation is not required during core cardiology training.⁴¹ This EPA is relevant in all domains of preventive cardiology.

All EPAs of this core curriculum share a common structure. The clinical competence is defined in the title, followed by a description of scope and timeframe, setting, including and excluding situations and procedures. Relevant roles of the CanMEDS Physician Competency Framework are mentioned.⁴² Knowledge, skills, and attitudes are formulated as learning outcomes, and assessment tools are recommended. The required level of independence is mentioned. Related

Table 1 CanMEDS Physician Competency Framework, modified and adopted from the Royal College of Physicians and Surgeons of Canada, with permission⁴²

Role	Description	Key competencies
Medical expert	As medical experts, physicians integrate all of the CanMEDS roles, applying medical knowledge, clinical skills, and professional values in their provision of high quality and safe patient-centred care. Medical expert is the central physician role in the CanMEDS framework and defines the physician's clinical scope of practice.	<ul style="list-style-type: none"> • Practise medicine within their defined scope of practice and expertise • Perform a patient-centred clinical assessment and establish a management plan • Plan and perform procedures and therapies for the purpose of assessment and/or management • Establish plans for ongoing care and, when appropriate, timely consultation • Actively contribute, as an individual and as a member of a team providing care, to the continuous improvement of healthcare quality and patient safety • Apply novel digital methods of diagnosis, treatment communication and process to achieve optimal clinical outcomes
Communicator	As communicators, physicians form relationships with patients and their families that facilitate the gathering and sharing of essential information for effective health care.	<ul style="list-style-type: none"> • Establish professional therapeutic relationships with patients and their families (in-person and virtual communication) • Elicit and synthesize accurate and relevant information, incorporating the perspectives of patients and their families • Share healthcare information and plans with patients and their families • Engage patients and their families in developing plans that reflect the patient's healthcare needs and goals • Document and share written and electronic information about the medical encounter to optimize clinical decision-making, patient safety, confidentiality, and privacy
Collaborator	As collaborators, physicians work effectively with other healthcare professionals to provide safe, high quality, patient-centred care.	<ul style="list-style-type: none"> • Work effectively with physicians and other colleagues in the healthcare professions • Work with physicians and other colleagues in the healthcare professions to promote understanding, manage differences, and resolve conflicts • Hand over the care of a patient to another healthcare professional to facilitate continuity of safe patient care
Leader	As leaders, physicians engage with others to contribute to a vision of a high-quality healthcare system and take responsibility for the delivery of excellent patient care through their activities as clinicians, administrators, scholars, or teachers	<ul style="list-style-type: none"> • Contribute to the improvement of healthcare delivery in teams, organizations, and systems • Engage in the stewardship of healthcare resources • Demonstrate leadership in professional practice • Manage career planning, finances, and health human resources in a practice
Health advocate	As health advocates, physicians contribute their expertise and influence as they work with communities or patient populations to improve health. They work with those they serve to determine and understand needs, speak on behalf of others when required, and support the mobilization of resources to effect change.	<ul style="list-style-type: none"> • Respond to an individual patient's health needs by advocating with the patient within and beyond the clinical environment • Respond to the needs of the communities or populations they serve by advocating with them for system-level change in a socially accountable manner
Scholar	As scholars, physicians demonstrate a lifelong commitment to excellence in practice through continuous learning and by teaching others, evaluating evidence, and contributing to scholarship.	<ul style="list-style-type: none"> • Engage in the continuous enhancement of their professional activities through ongoing learning • Teach students, residents, the public, and other health care professionals • Integrate best available evidence into practice

Table 1 *Continued*

Role	Description	Key competencies
Professional	As professionals, physicians are committed to the health and well-being of individual patients and society through ethical practice, high personal standards of behaviour, accountability to the profession and society, physician-led regulation, and maintenance of personal health.	<ul style="list-style-type: none"> Contribute to the creation and dissemination of knowledge and practices applicable to health Demonstrate a commitment to patients by applying best practices and adhering to high ethical standards Demonstrate a commitment to society by recognizing and responding to societal expectations in health care Demonstrate a commitment to the profession by adhering to standards and participating in physician-led regulation Demonstrate a commitment to physician health and well-being to foster optimal patient care

Table 2 Comparison of Entrustable Professional Activities between the 2020 ESC Core Curriculum for the Cardiologist and the 2021 EAPC Core Curriculum for Preventive Cardiology

Preventive cardiology domains	ESC Core Curriculum for the Cardiologist	EAPC Core Curriculum for Preventive Cardiology
Population science and public health		<ul style="list-style-type: none"> Design, implement, and evaluate preventive interventions at the population level
Primary prevention and risk factor management	<ul style="list-style-type: none"> Manage a patient with hypertension Manage a patient with dyslipidaemia Manage cardiovascular aspects in a diabetic patient Manage a cardiac patient in primary prevention 	<ul style="list-style-type: none"> Manage individuals with multifactorial cardiovascular risk profiles Manage a patient with non-traditional cardiovascular risk factors
Secondary prevention and cardiovascular rehabilitation	<ul style="list-style-type: none"> Manage a cardiac patient in secondary prevention Prescribe a prevention and rehabilitation programme for a cardiovascular patient 	<ul style="list-style-type: none"> Manage a prevention and rehabilitation programme for a cardiovascular patient Manage a prevention and rehabilitation programme for a cardiovascular patient with significant comorbidities, frailty, and/or cardiac devices Manage a cardiovascular prevention and rehabilitation programme for an oncology patient
Sports cardiology and exercise	<ul style="list-style-type: none"> Manage cardiovascular aspects in an athlete 	<ul style="list-style-type: none"> Manage pre-participation screening in a competitive athlete Manage the work-up of an athlete with suspected or known cardiovascular disease Use cardiopulmonary exercise testing for diagnosis, risk stratification and exercise prescription
All		

ESC Guidelines and EAPC Position Papers are included as primary sources of knowledge. Relevant topics from the ESC topic list for each EPA are summarized in a [Supplementary material online, File](#).

4. Level of independence

The level of entrustment or independence for executing an EPA will change during the training period ([Table 3](#)). At a certain time of the

training, trainees may have different levels of independence in different EPAs.⁴¹ Given the broad spectrum of CVD prevention, subspecialty training is not intended to achieve level of independence of five in all nine EPAs. For the following three EPAs, a lower level of independence is recommended.

1.1 Design, implement and evaluate preventive interventions at the population level (level 3)

Table 3 Level of independence for a profession activity, adopted from⁴¹

Level 1	Trainee is able to observe
Level 2	Trainee is able to <i>perform the activity under direct supervision</i> (proactive, supervisor in the room)
Level 3	Trainee is able to <i>perform the activity under indirect supervision</i> (reactive, on-demand supervision, supervisor readily available)
Level 4	Trainee is able to <i>perform the activity under distant supervision</i> (reactive, supervision available remotely or <i>post hoc</i>)
Level 5	Trainee is able to <i>perform the activity without supervision and to supervise others</i>

Table 4 Tools for the assessment of clinical competencies, adopted from the ESC Core Curriculum for the Cardiologist⁴¹

Knowledge	<ul style="list-style-type: none"> Self-assessment with multiple choice questions (MCQs), e.g. provided after a webinar
Skills	<ul style="list-style-type: none"> Case-based discussions Direct observation of procedural skills (DOPS) Workplace-based assessments Mini clinical evaluation exercise (mini-CEX)
Attitudes	<ul style="list-style-type: none"> Multiple consultant reports Multi-source feedback

2.2 Manage a patient with non-traditional cardiovascular risk factors (level 4)

4.2 Manage the work-up of an athlete with suspected or known cardiovascular disease (level 4)

5. Assessment of clinical competences using EPA's

One important aspect in the concept of EPAs is the assessment of clinical competencies. EPAs provide a framework for trainers to perform easy, formative and repeated assessments of trainees during their sub-specialty training, which help to adjust the trainee's level of independence.⁴¹ Optimally, these assessments should be integrated into routine clinical care. The competencies of the trainees will further increase after completing the training in line with their continuous professional development. Consulting more experienced colleagues or other experts in complex cases should not be judged as need for supervision, but as a clinical reality in times of rapid increasing medical knowledge. When a trainee is able to execute an EPA in routine cases in an independent manner and to assume the expected professional responsibilities, the highest level of independence is achieved.

Suitable tools for the assessment of EPAs depend on the nature of the activity and are proposed in the assessment section of each EPA (Table 4).⁴¹

Sources of knowledge in preventive cardiology

In addition to specific guidelines and position papers provided at the end of each EPA, the ESC has published four textbooks in the field of preventive cardiology as additional source of comprehensive knowledge.⁴⁴

- ESC Textbook of Preventive Cardiology 2015
- ESC Handbook of Preventive Cardiology 2016
- ESC Textbook of Sports Cardiology 2019
- ESC Handbook of Cardiovascular Rehabilitation 2020

Chapter 1: Population science and public health

1.1 Design, implement and evaluate preventive interventions at the population level

Description

Scope and timeframe:

All public health interventions in the field of CVD prevention

From identifying the need for interventions to evaluating the effect of the interventions in populations

Setting:

Community setting

Including:

Identification of potential needs of a population and preventive interventions

Review of past and ongoing community cohorts

Selection of the appropriate lifestyle and pharmacological interventions

Setting up budget, timeframe, milestones, and main outcomes for the interventions

Setting up the criteria for the evaluation of the interventions

Setting up occupational health programmes

Setting up population screening programmes (e.g. schools, workplaces)

Continued

Continued**CanMEDS roles**

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Identify target populations and preventive interventions, including groups currently underrepresented in clinical studies (women, older people, ethnic minorities, migrants)
- Appraise the evidence regarding population-based approaches to prevention (e.g. epidemiology, randomized controlled trials, and cost effectiveness studies)
- Be aware of potential stakeholders and collaborators
- Design studies to check safety and success of interventions
- Describe research methodology to collect data/run analysis/synthesize results of study outcomes/use audit tools

Skills

- Build a network of collaborators to identify and engage with key stakeholders, including policy makers, health services, healthcare professionals, academia, and members of the public
- Conduct a needs assessment to identify the population priorities based on good knowledge of the local population
- Integrate recommended interventions into existing preventive strategies on a population level
- Design the interventions
- Perform power calculations to determine sample sizes required to evaluate the interventions with confidence
- Create, validate, and implement data collection tools (questionnaires, instruments to collect clinical data)
- Evaluate statistical methods to analyse data taking into account possible biases/confounders.
- Calculate the cost-effectiveness of interventions
- Use early public involvement and engagement
- Engage communication channels to publicize the interventions
- Disseminate results to professionals, the public and politicians
- Evaluate effectiveness of implemented interventions, and recommend adjustments in preventive strategy if needed
- Manage projects appropriately

Attitudes

- Collaborate/negotiate with other stakeholders in planning of study
- Communicate to ensure that the intervention is understood by the target population, the stakeholders and politicians
- Consistently evaluate the intervention and adjust it according to the local results

Assessment tools

- Multiple choice questions (MCQs)
- Case-based discussions, entrustment-based discussions
- Multi-source feedback
- Simulation of population interventions
- Presentation and publication of results of the intervention

Level of independence

- Level 3 (perform the activity under indirect supervision. In this context, this means to contribute to design, implementation, and evaluation of preventive interventions, and cooperate with partners from population science and public health, but not necessarily to take the lead in these type of projects)

Related ESC guidelines and EAPC position papers

- Timmis A, Townsend N, Gale CP, et al. European Society of Cardiology: cardiovascular disease statistics 2019. *Eur Heart J* 2020;41:12–85.
- Arena R, Guazzi M, Lianov L, et al. Healthy lifestyle interventions to combat noncommunicable disease—a novel nonhierarchical connectivity model for key stakeholders: a policy statement from the American Heart Association, European Society of Cardiology, European Association for Cardiovascular Prevention and Rehabilitation, and American College of Preventive Medicine. *Eur Heart J* 2015;36:2097–2109.
- Jorgensen T, Capewell S, Prescott E, et al. Population-level changes to promote cardiovascular health. *Eur J Prev Cardiol* 2013;20:409–421.

Chapter 2: Primary prevention and risk factor management

2.1 Manage individuals with multifactorial cardiovascular risk profiles

Description

Scope and timeframe:

For every individual with known or suspected CV risk

From first evaluation to follow-up, as advised by the clinical condition

Setting:

Primary care setting (including nursing home care), in-patient setting, out-patient setting, emergency department, community setting, workplace

Including:

Baseline assessment, identification of single or multiple risk factors and multi-morbidity

Identification of individualized targets for CVD prevention using basic and advanced tools for investigation

Use of risk modifiers, and imaging in intermediate risk individuals

Guidance, lifestyle recommendations, guideline-directed medical therapy, referral, follow-up

Excluding:

Performing specialist investigations or interventional or surgical procedures

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Discuss the epidemiology of CVD and its associated lifestyle, medical, and psychosocial risk factors
- Understand specific aspects of groups currently underrepresented in clinical studies (women, older people, ethnic minorities, migrants)
- Demonstrate an understanding of strategies for the reduction of CV risk across the life course
- Understand the concept of risk and the role of risk estimation tools in CVD prevention
- Understand the concept of precision medicine and deep phenotyping based on panomics and their current relevance for clinical decision-making
- Identify what individual/patient groups are at high risk for CVD and how they should be targeted for preventive care
- Describe the key critical success factors for delivering effective CVD prevention programmes
- Demonstrate an understanding of how the social determinants of health influence CV health and health inequalities
- List the investigations used to diagnose multifactorial risk profiles
- Demonstrate an understanding of lifestyle risk factor management, which includes smoking cessation, diet, and physical activity
- Appraise the latest evidence-based guidelines for managing individuals with multifactorial CV risk profiles

Skills

- Obtain a personal and family history
- Explore patient expectations, values, and priorities
- Perform a thorough physical examination
- Perform a comprehensive CV risk assessment using appropriate risk calculators and including additional tests, if necessary [blood tests, resting and exercise electrocardiography (ECG), cardiopulmonary exercise testing (CPET), CV imaging]
- Assess CV and extracardiac comorbidities
- Interpret the results of examination and tests showing abnormal values
- Determine and compare the benefits of lifestyle interventions, pharmacology of drugs, or both for primary prevention
- Manage CV risk factors in line with level of individual risk and evidence-based guidelines and patient preference
- Assess nutritional habits and integrate into nutritional strategy
- Provide personalized lifestyle advice for smoking cessation, physical activity and exercise, nutrition and diet, stress management, and psychological health
- Participate as an interdisciplinary team member, working collaboratively with general practitioners, nurses, dietitians, physiotherapists, sports scientists, psychologists, occupational therapists, pharmacists, and other professionals involved in CVD prevention
- Apply effective communication and motivational skills to support the patient in making positive lifestyle and behaviour modifications
- Communicate with family and social environment to provide support and enhance changes

Continued

Continued**Attitudes**

- Adopt a non-judgemental attitude regarding individual lifestyle
- Adopt a shared decision approach by actively engaging the patient in management decisions based on individual values, preferences, and associated conditions and co-morbidities
- Adopt a culture of interdisciplinary teamwork
- Recognize the importance of primary prevention in individuals and patients with multifactorial CV risk

Assessment tools

- MCQs
- Direct observation, workplace-based assessments [e.g. direct observation of procedural skills (DOPS), mini clinical evaluation exercise (mini-CEX), fieldnotes]
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Knuuti J, Wijns W, Saraste A, et al. 2019 ESC Guidelines for the diagnosis and management of chronic coronary syndromes. *Eur Heart J* 2020;41:407–477.
- Mach F, Baigent C, Catapano AL, et al. 2019 ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. *Eur Heart J* 2020;41:111–188.
- Cosentino F, Grant PJ, Aboyans V, et al. 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. *Eur Heart J* 2020;41:255–323.
- Williams B, Mancia G, Spiering W, et al. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur Heart J* 2018;39:3021–3104.
- Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37:2315–2381. **Update 2021.**

2.2 Manage a patient with non-traditional cardiovascular risk factors

Description**Scope and timeframe:**

For every individual with non-traditional CV risk factors, suitable for CVD prevention

From first presentation to follow-up, as advised by clinical condition

Setting:

Primary care setting (including nursing home care), in-patient setting, out-patient setting, emergency department, community settings, workplace

Including:

Assessment of CV risk in patients with abnormal biomarkers, cancer therapy, chronic kidney disease, chronic obstructive pulmonary disease, inflammatory disease, congenital heart disease, migraine with aura, erectile dysfunction, preeclampsia, gestational diabetes, sleep disorders

Identification of residual CV risk and targets for CVD prevention using basic and advanced tools for investigation

Guidance, lifestyle recommendations, guideline-directed medical therapy, referral, follow-up

Excluding:

Performing specialist investigations or interventional or surgical procedures

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Continued

Knowledge

- List important non-traditional CV risk factors and diseases with elevated CV risk (e.g. abnormal biomarkers, cancer therapy, chronic kidney disease, chronic obstructive pulmonary disease, congenital heart disease, inflammatory disease, migraine with aura, erectile dysfunction, preeclampsia, gestational diabetes, sleep disorders)
- Describe the biopsychosocial spectrum of non-traditional CV risk factors and recognize their importance for CVD primary prevention
- Explain the use of investigations for and management of individuals with non-traditional CV risk factors
- Discuss the management of clinical complications of patients with non-traditional CV risk factors
- Outline proper laboratory testing or referral/collaboration with other specialists, in order to assess the CV risk and plan a personal health strategy

Skills

- Obtain a relevant history
- Explore patient expectations, values, and priorities
- Evaluate non-traditional CV risk factors
- Assess pharmacology of approved drugs, interactions, side effects in relation to cardiovascular and extracardiac complications
- Interpret biochemical and imaging assessments and appropriately refer for complete and thorough assessment
- Implement guidelines and protocols for diagnosis and management plans for non-traditional risk factors
- Select the appropriate investigations for refining non-traditional CV risk stratification
- Manage lifestyle changes, and pharmacological treatment
- Communicate with families, employers, other specialists, and general practitioners
- Motivate individuals to adopt healthier lifestyles, according to their special needs and preferences or health problems

Attitudes

- Adopt a non-judgemental attitude regarding the individual lifestyle
- Adopt a shared decision approach by actively engaging the patient in management decisions based on individual values, preferences, and associated conditions and co-morbidities
- Adopt a culture of interdisciplinary teamwork
- Advocate for an integrated approach to chronic disease management, to include those with both traditional and non-traditional CV risk factors
- Advocate for patient education on primary prevention as an essential component of cardiac care
- Recognize the importance of primary and secondary prevention in individuals and patients with non-traditional CV risk factors
- Advocate for greater public awareness around non-traditional CV risk factors

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of Independence

- Level 4 (perform the activity under distant supervision. In this context this means to collaborate with experts of the clinical conditions associated with elevated CV risk)

Related ESC guidelines and EAPC position papers

- Regitz-Zagrosek V, Roos-Hesselink JW, Bauersachs J, et al. 2018 ESC Guidelines for the management of cardiovascular diseases during pregnancy. *Eur Heart J* 2018;39:3165–3241.
- Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts)Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37:2315–2381. **Update 2021.**
- Zamorano JL, Lancellotti P, Rodriguez Munoz D, et al. 2016 ESC Position Paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines: The Task Force for cancer treatments and cardiovascular toxicity of the European Society of Cardiology (ESC). *Eur Heart J* 2016;37:2768–2801.

Chapter 3: Secondary prevention and rehabilitation

3.1 Manage a prevention and rehabilitation programme for a cardiovascular patient

Description

Scope and timeframe:

All standard patients (outlined below) with an indication for a comprehensive CV prevention and rehabilitation programme
From referral to follow-up after a structured programme

Setting:

In-patient, out-patient, home based, community, virtual (including online and tele rehabilitation)

Including:

Management of patients with acute coronary syndromes, chronic coronary syndromes, after coronary artery bypass graft, valve, and large vessel surgery, valve interventions, chronic heart failure, myocardial disease, congenital heart disease
Complete evaluation and risk stratification using appropriate tests
Lifestyle modification, through smoking cessation, nutritional, physical activity, and psycho-social counselling
Exercise prescription, exercise training structuring and supervision
Cardiorespiratory performance and interpretation
Guideline-directed medical therapy implementation
Behavioural change and self-management
Organization and optimization of a patient and family education programme
Organization of long-term follow-up

Excluding:

Patients with relevant comorbidities, cardiac implantable electrical devices (CIEDs), left ventricular assist devices (LVAD), heart transplantation (HTX) (see Chapter 3.2)

Performing specialist investigations or interventional or surgical procedures, acute or unstable condition, acute settings

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Outline indications for comprehensive CV prevention and rehabilitation
- Understand specific aspects of groups currently underrepresented in clinical studies (women, older people, ethnic minorities, migrants)
- Describe current evidence and expected benefits of comprehensive CV prevention and rehabilitation
- Consider appropriate referral and contraindication to comprehensive CV prevention and rehabilitation
- Outline the main core components of comprehensive CV prevention and rehabilitation programmes
- Discuss the global patient evaluation strategy
- Explain the different modalities of exercise
- Outline the principles of the FITT-VP (frequency, intensity, time, type, volume, progression) model for exercise prescription and of using scales of perceived exertion (e.g. Borg)
- Discuss indications and interpretation of exercise capacity tests [ECG exercise testing, CPET, 6-min walk test (6MWT), strength tests]
- Outline indication and mechanisms of guideline-directed medical therapies
- Identify the interaction of pharmacological therapies with exercise
- Identify the principles of counselling for secondary prevention
- Describe psychological profiles and their impact on CV health
- Describe the patient education management (empowerment, self-management, self-efficacy, adherence promotion)
- Discuss the new technologies and their use for remote monitoring, programme delivery, and education
- Outline the composition and relationships of the interdisciplinary CV prevention and rehabilitation staff
- Outline the role of the family and social support for CVD patients

Skills

- Perform evaluation including CV risk factors, clinical condition, non-invasive assessment of CV functioning/disease, disabilities, nutrition, psycho-social impact

- Explore patient expectations, values and priorities
- Perform and analyse exercise capacity tests [ECG exercise test, CPET, 6MWT, strength tests] for tailored exercise prescriptions
- Prescribe endurance continuous/interval training, resistance/strength training, balance training, and respiratory training
- Coordinate psychosocial, nutrition, and smoking cessation counselling and integrate results in clinical shared decision-making
- Optimize and up-titrate guideline-directed medical therapies, under consideration of effects on exercise tolerance
- Develop exercise training according to settings (residential, ambulatory, community-based, tele-monitoring), patient conditions (age, sex, psychology, comorbidities), and preferences
- Assess nutritional habits and integrate into nutritional strategy
- Conceptualize, organize and drive an educational programme
- Organize a tele monitoring/tele-rehabilitation programme
- Manage comorbidities
- Recognize and treat emergency cases
- Manage patients with residual ischaemia (e.g. incomplete optimal revascularization, diffuse atherosclerotic disease)
- Detect post-interventional or post-surgical complications (e.g. early stent thrombosis or restenosis, pericardial tamponade)
- Apply effective communication and behavioural change techniques (e.g. motivational interviewing for smoking cessation and patient education)
- Organize the follow-up, links with general practitioners and/or cardiologists, and other health professionals

Attitudes

- Adopt a non-judgemental attitude regarding individual lifestyle choices
- Be aware of the influence of CV risk factors and diseases in patient prognosis (differentiate mortality and morbidity) and quality of life
- Be aware of the importance of CV prevention and rehabilitation in the pathway and care delivery of the CV patient
- Work in interdisciplinary teams with health professionals involved in secondary prevention
- Deliver education, empathy and encouragement to the patient to reduce their CV risk factors with help of all the professional resources
- Educate patients on how his/her entourage can support prevention
- Support patients with genetic disorders (psychological counselling, explain consequences for disease management and for relatives)
- Motivate patient to sustain long term adherence with lifestyle, exercise training, and medical therapy
- Actively involve the patient in shared decision-making to promote optimal self-management and long-term adherence to behaviour change
- Advocate comprehensive CV prevention and rehabilitation programmes to include all high-risk patients

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320913379.
- Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary prevention through cardiovascular rehabilitation programmes in Europe: The avenue towards EAPC accreditation programme: a position statement of the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology (EAPC). *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320924912.
- Scherrenberg M, Wilhelm M, Hansen D, et al. The future is now: a call for action for cardiac telerehabilitation in the COVID-19 pandemic from the secondary prevention and rehabilitation section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320939671.
- Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts) Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37:2315–2381. **Update in 2021.**
- Mezzani A, Hamm LF, Jones AM, et al. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: a joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation and the Canadian Association of Cardiac Rehabilitation. *Eur J Prev Cardiol* 2013;20:442–467.
- Piepoli MF, Conraads V, Corra U, et al. Exercise training in heart failure: from theory to practice. A consensus document of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation. *Eur J Heart Fail* 2011;13:347–357.

3.2 Manage a prevention and rehabilitation programme for a cardiovascular patient with significant comorbidities, frailty, and/or cardiac devices

Description

Scope and timeframe:

All complex patients (outlined below) with an indication for a comprehensive CV prevention and rehabilitation programme

From referral to follow-up after a structured programme

Setting:

In-patient, out-patient, home based, community, virtual (including online and tele rehabilitation)

Including:

Management of patients with stroke, peripheral artery occlusive disease (PAOD, including amputation), diabetes, chronic kidney disease, chronic obstructive pulmonary disease, rheumatologic disease, orthopaedic disease, and frailty

Management of CIED, LVAD, and HTX patients

Patient global evaluation and risk stratification using appropriate tests

Lifestyle modification, through nutritional, physical activity and psycho-social counselling

Adapted exercise prescription, adapted exercise training structuring and supervision

Cardiorespiratory performance and interpretation (identifying those patients who cannot do it)

Guideline-directed medical therapy implementation

Behavioural change and self-management

Organization and optimization of a patient education programme, including specific information related to the comorbidity

Organization of long-term follow-up

Excluding:

Performing specialist investigations or interventional or surgical procedures, acute or unstable conditions, acute settings

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Discuss the management of individual comorbidities: stroke, PAOD, diabetes, chronic kidney disease, chronic obstructive pulmonary disease, rheumatologic disease, orthopaedic disease, and frailty
- Discuss the management of CIED, LVAD, and HTX patients
- Describe the current evidence and expected benefits of comprehensive CV prevention and rehabilitation
- Consider appropriate referral and contraindication to comprehensive CV prevention and rehabilitation programmes
- Outline the main core components of comprehensive CV prevention and rehabilitation programmes
- Discuss the global patient evaluation strategy
- Identify the interaction between pharmacological and CIED therapies with exercise
- Explain the different modalities of exercise and how to adapt to specific comorbidities, and frailty
- Outline the principles of the FITT-VP (frequency, intensity, time, type, volume, progression) model for exercise prescription and of using scales of perceived exertion (e.g. Borg)
- Discuss indications and interpretation of exercise capacity tests (ECG exercise testing, CPET, 6MWT, strength tests)
- Know key frailty tests (i.e. timed up and go, walking speed test) and tests for cognitive deficits (mini-mental status test)
- Identify the principles of counselling for secondary prevention, specifically including management linked to comorbidities
- Describe psychological profiles and their impact on CV health
- Describe the patient education management (empowerment, self-management, self-efficacy, adherence promotion)
- Discuss the new technologies and their use for remote monitoring, programme delivery, and education
- Outline the composition of and relationships between the interdisciplinary CV prevention and rehabilitation staff
- Discuss how comorbidities influence CV prevention and rehabilitation delivery and need for adaptation
- Discuss the influence of CV risk factors and diseases in patient prognosis (differentiate mortality and morbidity) and quality of life
- Outline the importance of comprehensive CV prevention and rehabilitation in the pathway and care delivery of the CV patient without and with comorbidities

Continued

Continued**Skills**

- Manage specific aspects of individual comorbidities: stroke, PAOD, diabetes, chronic kidney disease, chronic obstructive pulmonary disease, rheumatologic disease, orthopaedic disease, and frailty
- Manage specific aspects of CIED, LVAD and heart transplant patients
- Perform evaluation including CV risk factors, clinical condition, non-invasive assessment of CV functioning/disease, disabilities, nutrition, psycho-social impact
- Explore patient expectations, values and priorities
- Perform and interpret exercise capacity tests (ECG exercise testing, CPET, 6MWT, strength tests) for tailored exercise prescriptions
- Prescribe endurance continuous/interval training, resistance/strength training, and respiratory training
- Develop exercise training according to settings (residential, ambulatory, community-based, tele-monitoring), patient conditions (age, sex, comorbidities, psychologic status), and preferences
- Conceptualize, organize and drive an educational programme with specificities to the different comorbidities
- Organize a tele-monitoring/tele-rehabilitation programme
- Optimize and up-titrate guideline-directed medical therapies, adapted to the exercise tolerance and comorbidities
- Identify and analyse CIED functioning at rest and during effort
- Manage comorbidities under consideration of possible drug interactions and contraindications
- Recognize and treat emergency cases related to comorbidities or devices
- Manage patients with residual ischaemia (e.g. incomplete optimal revascularization, diffuse atherosclerotic disease)
- Detect post-interventional or post-surgical complications (e.g. early stent thrombosis or restenosis, pericardial tamponade)
- Apply effective communication and behavioural change techniques (e.g. motivational interviewing for smoking cessation and patient education)
- Make end of life discussions possible for terminal patients
- Organize the follow-up, links with general practitioners and/or cardiologists, and other health professionals

Attitudes

- Work with interdisciplinary teams of health professionals involved in secondary prevention and rehabilitation
- Educate and encourage patients to reduce their CV risk factors with help of all the professional resources
- Educate patients on how his/her entourage can support prevention
- Support patients with genetic disorders (psychological counselling, explain consequences for disease management and for relatives)
- Motivate patients to sustain long-term adherence with lifestyle, exercise training, and medical therapy, despite their comorbidities
- Actively involve patients in shared decision-making to promote optimal self-management and long term adherence to behaviour change
- Advocate for comprehensive CV prevention and rehabilitation programmes to improve referral and uptake

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Pedretti RF, Iliou MC, Israel CW et al. Comprehensive multicomponent cardiac rehabilitation in cardiac implantable electronic devices recipients. A consensus document from the European Association of Preventive Cardiology (EAPC; Section on Secondary Prevention and Rehabilitation) and European Heart Rhythm Association (EHRA). *Eur J Prev Cardiol* 2020;doi:10.1093/eurjpc/zwaa121.
- Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320913379.
- Abreu A, Frederix I, Dendale P, et al. Standardization and quality improvement of secondary prevention through cardiovascular rehabilitation programmes in Europe: the avenue towards EAPC accreditation programme: A position statement of the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology (EAPC). *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320924912.
- Scherrenberg M, Wilhelm M, Hansen D, et al. The future is now: a call for action for cardiac telerehabilitation in the COVID-19 pandemic from the secondary prevention and rehabilitation section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320939671.
- Hansen D, Kraenkel N, Kemps H, et al. Management of patients with type 2 diabetes in cardiovascular rehabilitation. *Eur J Prev Cardiol* 2019;26:133–144.
- Kemps H, Kraenkel N, Dorr M, et al. Exercise training for patients with type 2 diabetes and cardiovascular disease: What to pursue and how to do it. A Position Paper of the European Association of Preventive Cardiology (EAPC). *Eur J Prev Cardiol* 2019;26:709–727.

Continued

Continued

- Vigorito C, Abreu A, Ambrosetti M, Belardinelli R, Corra U, Cupples M, Davos CH, Hoefer S, Iliou MC, Schmid JP, Voeller H, Doherty P. Frailty and cardiac rehabilitation: A call to action from the EAPC Cardiac Rehabilitation Section. *Eur J Prev Cardiol* 2017;24:577–590.
- Piepoli MF, Hoes AW, Agewall S, et al. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: the Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts)Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;37:2315–2381. **Update in 2021.**
- Mezzani A, Hamm LF, Jones AM, et al. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: a joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation and the Canadian Association of Cardiac Rehabilitation. *Eur J Prev Cardiol* 2013;20:442–467.
- Piepoli MF, Conraads V, Corra U, et al. Exercise training in heart failure: from theory to practice. A consensus document of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation. *Eur J Heart Fail* 2011;13:347–357.

3.3 Manage a cardiovascular prevention and rehabilitation programme for an oncology patient

Description**Scope and timeframe:**

Cancer patients, in particular after cardiotoxic cancer therapy, from cancer diagnosis to follow-up surveillance

Setting:

In-patient, out-patient, home based, community, virtual (including online and tele rehabilitation)

Including:

Assessment of the clinical status, identification of risk factors for CVD and cancer, using basic and advanced tools for investigation; pharmacological and non-pharmacological treatment

Excluding:

Performing specialist investigations or interventional or surgical procedures, acute or unstable condition, acute settings

CanMEDS-Roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Identify clinical interactions between cancer and CVDs
- Identify risk factors common to cancer and CVD (e.g. ageing, smoking, alcohol abuse, unbalanced diet and physical inactivity)
- Describe CV toxicity of specific chemo- and radiotherapies in cancer patients undergoing treatment as well as cancer survivors and its influence on exercise capacity and quality of life
- Describe the prognosis of different cancers
- Discuss the specific rehabilitation needs of cancer patients with or at risk of CVD (exercise, psychological, prevention, social, education)
- Describe the role of exercise in cardio-oncology rehabilitation to minimize the negative effects of cancer therapies (e.g. cardio-toxicity, fatigue, bone loss, lymphoedema, autonomic dysfunction, depression, anxiety)
- Discuss indications and interpretation of exercise capacity tests (ECG exercise testing, CPET, 6MWT, strength tests)
- Describe the role of exercise and cardio-oncology rehabilitation to limit cancer progression and relapses
- Discuss the strategies to limit disabilities, impaired quality of life and psychosocial distress induced by cancer and CVD

Skills

- Differentiate cardio-oncology rehabilitation in cancer patients from conventional oncology rehabilitation
- Identify cancer patients with expected greater benefits from cardio-oncology rehabilitation
- Adapt comprehensive cardio-oncology rehabilitation to the cancer situation (active cancer or cancer survivors)
- Perform and interpret exercise capacity tests (ECG exercise testing, CPET, 6MWT, strength tests) for tailored exercise prescriptions
- Interpret imaging investigations performed in oncology patients and derive prognostic information

Continued

- Identify the appropriate cardio-oncology rehabilitation setting (residential, out-patients, centre-based, community-based, home-based) according to patient's preferences and possibilities
- Review cancer history, cancer therapies and related side effects, drug interactions
- Evaluate the risk of CVD in active cancer and cancer survivors
- Establish goals for risk factors control modulated by the presence or history of cancer
- Select the appropriate method of functional testing in cancer patients
- Evaluate and treat cancer-related cachexia, sarcopenia and anaemia
- Adapt type and intensity of training to cancer localization, cancer stages and specific sequelae (e.g. appropriate intensity in case of cachexia or frailty, role of upper body strength training in breast cancer, role of inspiratory muscle training in thoracic cancer)
- Interdisciplinary work with the oncology team, and other healthcare professionals
- Make end of life discussions possible for terminal patients
- Provide view/opinion about return to work

Attitudes

- Aim to decrease the risk of CVD in cancer patients
- Consider cardio-oncology rehabilitation as a standard of care for cancer patients and survivors at high risk for CVD
- Deal optimistically with cancer
- Collaborate with oncologists and other care providers in the field of oncology
- Reassure and motivate cancer patients

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of Independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Zamorano JL, Lancellotti P, Rodriguez Munoz D, et al. 2016 ESC Position Paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines: the Task Force for cancer treatments and cardiovascular toxicity of the European Society of Cardiology (ESC). *Eur Heart J* 2016;37:2768–2801.

Related AHA Scientific Statement

- Gilchrist SC, Barac A, Ades PA, et al. Cardio-oncology rehabilitation to manage cardiovascular outcomes in cancer patients and survivors: a scientific statement from the American Heart Association. *Circulation* 2019;139:e997–e1012.

Chapter 4: Sports cardiology and exercise

4.1 Manage pre-participation evaluation in a competitive athlete

Description

Scope and timeframe:

Competitive athletes, from evaluation to eligibility for competition

Setting:

Out-patient setting

Including:

Evaluation of personal and family history (including habitual physical activity level, sport type, fitness), physical examination, blood pressure measurement, 12-lead ECG, further testing (ambulatory ECG monitoring, echocardiography, advanced imaging, exercise testing, CPET), if appropriate

Identification of potential high-risk athletes for sudden cardiac death and for other CV conditions that may worsen because of intensive athletic training

Excluding:

Performing specialist investigations or interventional or surgical procedures

CanMEDS roles

- Medical expert
- Communicator
- Collaborator

Continued

- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Describe physiological adaptations to acute and chronic exercise
- Describe physiological adaptations in different situations such as deep sea, high altitude, low or high temperatures
- Assess the type of practiced sport (skill, power, mixed, endurance), the specific metabolic features and induced CV remodelling
- Describe the physiological CV adaptation induced by regular exercise and the normal vs. borderline ECG findings in athletes
- Describe the incidence of sudden cardiac death in athletes and the most frequent and emergent CV conditions involved
- Describe CV conditions that may worsen because of intensive athletic training and those that will benefit from primary prevention
- Describe how to establish a diagnostic flowchart for sudden death prevention in the presence of abnormal findings (including ECG and physical examination findings) during pre-participation evaluation (PPE) in athletes
- Describe indications for cardiac multi-modality imaging and genetic testing in PPE
- Discuss the CV effects of the main doping substances

Skills

- Obtain a relevant history and perform an appropriate physical examination, including habitual physical activity level and sport type (skill, power, mixed, endurance)
- Evaluate the CV risk profile based on appropriate risk calculators and the fitness level of an athlete over 35 years of age and the burden of risk factors for CVD
- Understand the results of physical examination and 12-lead ECG showing physiological, borderline or pathological findings
- Identify the potential high-risk athletes and further evaluate the risk of sudden cardiac death or acceleration of an inherited predisposition or exacerbation of cardiac damage due to intercurrent illness resulting from intense and prolonged exercise.
- Evaluate potential doping issues and substance abuse
- Choose the appropriate screening modality in the presence of abnormal findings (e.g. ECG exercise test, CPET, echocardiography, ambulatory ECG monitoring, cardiac computed tomography angiography, cardiac magnetic resonance, genetic testing)
- Perform and interpret ECG exercise test, CPET, echocardiography, ambulatory ECG monitoring if indicated
- Integrate results from advanced CV imaging and genetic testing in clinical decision-making
- Advise regarding exercise and exercise training in athletes with cardiac disease according to history, clinical finding, diagnostics and CPET

Attitudes

- Adopt a non-judgemental attitude to an athlete regarding her/his lifestyle or referred symptoms, if any
- Communicate with the athlete, family, and the team physician to optimize the management of potentially abnormal findings during PPE and how this may affect sports eligibility
- Communicate concepts of exercise and exercise programme with the athlete
- Motivate the athlete to systematically undergo PPE and explain the cost-effectiveness consideration of this model

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Pelliccia A, Sharma S, Gati S, et al. 2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease. *Eur Heart J* 2020;doi:10.1093/eurheartj/ehaa605.
- Budts W, Pieles GE, Roos-Hesselink JW, et al. Recommendations for participation in competitive sport in adolescent and adult athletes with Congenital Heart Disease (CHD): position statement of the Sports Cardiology & Exercise Section of the European Association of Preventive Cardiology (EAPC), the European Society of Cardiology (ESC) Working Group on Adult Congenital Heart Disease and the Sports Cardiology, Physical Activity and Prevention Working Group of the Association for European Paediatric and Congenital Cardiology (AEPC). *Eur Heart J* 2020;doi:10.1093/eurheartj/ehaa501.
- Heidbuchel H, Adami PE, Antz M, et al. Recommendations for participation in leisure-time physical activity and competitive sports in patients with arrhythmias and potentially arrhythmogenic conditions: Part 1: Supraventricular arrhythmias. A position statement of the Section of Sports Cardiology and Exercise from the European Association of Preventive Cardiology (EAPC) and the European Heart Rhythm Association (EHRA), both associations of the European Society of Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320925635.

Continued

- Heidbuchel H, Arbelo E, D'Ascenzi F, et al. Recommendations for participation in leisure-time physical activity and competitive sports of patients with arrhythmias and potentially arrhythmogenic conditions. Part 2: ventricular arrhythmias, channelopathies, and implantable defibrillators. *Europace* 2020;doi:10.1093/europace/euaa106.
- Pelliccia A, Solberg EE, Papadakis M, et al. Recommendations for participation in competitive and leisure time sport in athletes with cardiomyopathies, myocarditis, and pericarditis: position statement of the Sport Cardiology Section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2019;40:19–33.
- Borjesson M, Dellborg M, Niebauer J, et al. Recommendations for participation in leisure time or competitive sports in athletes-patients with coronary artery disease: a position statement from the Sports Cardiology Section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2019;40:13–18.
- Niebauer J, Borjesson M, Carre F, et al. Recommendations for participation in competitive sports of athletes with arterial hypertension: a position statement from the sports cardiology section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2018;39:3664–3671.
- Mont L, Pelliccia A, Sharma S, et al. Pre-participation cardiovascular evaluation for athletic participants to prevent sudden death: Position paper from the EHRA and the EACPR, branches of the ESC. Endorsed by APHRS, HRS, and SOLAECE. *Europace* 2017;19:139–163.

4.2 Manage the work-up of an athlete with suspected or known cardiovascular disease

Description

Scope and timeframe:

Leisure-time and competitive athletes, from the time the athlete with suspected or known CVD self-refers or is referred for a consultation until regular follow-up

Setting:

Most commonly out-patient setting, but also in-patient setting and emergency department

Including:

Assessment with history, physical examination, basic and advanced tools for investigation, differentiation of physiological adaptation to exercise from phenotypes of CVD, identification of risk factors for sudden cardiac death and high-risk conditions, recommendation of lifestyle and pharmacological treatment, exercise prescription and counselling on leisure-time and competitive sports

Excluding:

Performing specialist investigations or interventional or surgical procedures, interpreting genetic test results

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Leader
- Health advocate
- Scholar
- Professional

Knowledge

- Describe phenotypes of physiological adaptation to exercise
- Recognize the challenges of differentiating athlete's heart from heart disease
- Identify risk factors for sudden cardiac death and high-risk conditions
- Outline non-pharmacological and pharmacological treatment of athletes with common CV conditions
- Outline exercise recommendations in athletes with CVD
- Recognize the ethical and legal considerations of disqualification from competitive sports participation

Skills

- Obtain a focused history and perform appropriate physical examination
- Propose and perform appropriate non-invasive, first-line clinical investigations (12-lead ECG, transthoracic echocardiogram, exercise testing/CPET, ECG monitor) to assess athletes with suspected or known cardiac disease
- Propose further appropriate advanced investigations, including genetic testing
- Integrate the results in an interdisciplinary setting
- Illustrate how risk stratification of athletes with CVD informs their management
- Prescribe tailored exercise recommendations based on CPET
- Implement recommendations for exercise prescription and eligibility for participation in competitive sport in athletes with cardiac disease
- Prescribe comprehensive CV prevention and rehabilitation for athletes with CVD, if indicated, and adopt programmes appropriately

Attitudes

- Integrate the results of investigations in an interdisciplinary setting
- Communicate effectively results and exercise recommendations to the athletes, team doctors, coaches, families
- Promote a shared-decision-making model, particularly in conditions with limited evidence relating to the risk of exercise
- Adopt a holistic approach to the impact of exercise restriction and disqualification from competitive sports on an athlete, in terms of psychological, physical, and financial wellbeing

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports
- Multi-source feedback

Level of independence

- Level 4 (perform the activity under distant supervision. In this context this means to work in a network with dedicated sports cardiology referral centres in complicated cases)

Related ESC guidelines and EAPC position papers

- Pelliccia A, Sharma S, Gati S, et al. 2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease. *Eur Heart J* 2020;doi:10.1093/eurheartj/ehaa605.
- Budts W, Pieles GE, Roos-Hesselink JW, et al. Recommendations for participation in competitive sport in adolescent and adult athletes with Congenital Heart Disease (CHD): position statement of the Sports Cardiology & Exercise Section of the European Association of Preventive Cardiology (EAPC), the European Society of Cardiology (ESC) Working Group on Adult Congenital Heart Disease and the Sports Cardiology, Physical Activity and Prevention Working Group of the Association for European Paediatric and Congenital Cardiology (AEPC). *Eur Heart J* 2020;doi:10.1093/eurheartj/ehaa501.
- Heidbuchel H, Adami PE, Antz M, et al. Recommendations for participation in leisure-time physical activity and competitive sports in patients with arrhythmias and potentially arrhythmogenic conditions: Part 1: Supraventricular arrhythmias. A position statement of the Section of Sports Cardiology and Exercise from the European Association of Preventive Cardiology (EAPC) and the European Heart Rhythm Association (EHRA), both associations of the European Society of Cardiology. *Eur J Prev Cardiol* 2020;doi:10.1177/2047487320925635.
- Heidbuchel H, Arbelo E, D'Ascenzi F, et al. Recommendations for participation in leisure-time physical activity and competitive sports of patients with arrhythmias and potentially arrhythmogenic conditions. Part 2: ventricular arrhythmias, channelopathies, and implantable defibrillators. *Europace* 2020;doi:10.1093/europace/euaa106.
- Pelliccia A, Solberg EE, Papadakis M, et al. Recommendations for participation in competitive and leisure time sport in athletes with cardiomyopathies, myocarditis, and pericarditis: position statement of the Sport Cardiology Section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2019;40:19–33.
- Borjesson M, Dellborg M, Niebauer J, et al. Recommendations for participation in leisure time or competitive sports in athletes-patients with coronary artery disease: a position statement from the Sports Cardiology Section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2019;40:13–18.
- Niebauer J, Borjesson M, Carre F, et al. Recommendations for participation in competitive sports of athletes with arterial hypertension: a position statement from the sports cardiology section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2018;39:3664–3671.

Chapter 5: Cardiopulmonary exercise testing

5.1 Use cardiopulmonary exercise testing for diagnosis, risk stratification and exercise prescription

Description

Scope and timeframe:

Healthy individuals, athletes, individuals with CVD risk factors, and CVD patients. From indication for using CPET until communicating the results

Setting:

In-patient, out-patient, exercise physiology laboratory, on field

Including:

Performing a comprehensive CPET on a bicycle or treadmill, or other types of ergometers, or using mobile devices under real-life conditions (i.e. patient's workplace, athlete on the field), with and without invasive measurements, interpreting and reporting the results

Excluding:

Complex cases with a predominant pulmonary problem which should be managed in cooperation with a pulmonary specialist

Continued

CanMEDS roles

- Medical expert
- Communicator
- Collaborator
- Scholar
- Professional

Knowledge

- Understand CV exercise physiology and cardiorespiratory fitness
- List the indications and contraindications for CPET in healthy individuals, patients with CVD, and athletes
- Know the risk of CPET in infective patients and preventive measures for the personal
- Know the potential complications of CPET
- Define the key variables of CPET
- Discuss the interpretation of the nine-panel plot
- Discuss the indications for and value of additional blood gas analysis
- Describe patterns of pulmonary, cardiac, and muscular conditions
- List and detect pitfalls and artefacts of CPET
- Describe the role of combining CPET with other (haemodynamic) evaluations (e.g. echocardiography, right heart catheterization)
- Describe the overlapping and discriminating concepts of CPET and lactate testing

Skills

- Apply appropriate indications and avoid contraindication to CPET
- Perform CPET calibration and quality control
- Prepare the patient or athlete
- Choose the appropriate exercise protocol and device
- Interpret the nine-panel plot
- Formulate a function-based diagnosis and prognostic stratification
- Formulate exercise training recommendations based on ventilatory thresholds
- Communicate the results appropriately

Attitudes

- Integrate CPET in the evaluation of healthy individuals, CV patients and athletes
- Recognize the strengths and weaknesses of CPET in a clinical situation and in relation to other diagnostic modalities
- Interact cooperatively with sports physicians, sports scientists, and paramedical staff involved in the execution of the test

Assessment tools

- MCQs
- Direct observation, workplace-based assessments (e.g. DOPS, mini-CEX, fieldnotes)
- Case-based discussions, entrustment-based discussions
- Multiple consultant reports

Level of independence

- Level 5 (perform the activity without supervision, teach and supervise others)

Related ESC guidelines and EAPC position papers

- Guazzi M, Adams V, Conraads V, et al. EACPR/AHA Joint Scientific Statement. Clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. *Eur Heart J* 2012;33:2917–2927.
- Guazzi M, Arena R, Halle M, et al. 2016 focused update: clinical recommendations for cardiopulmonary exercise testing data assessment in specific patient populations. *Eur Heart J* 2018;39:1144–1161.
- Mezzani A, Hamm LF, Jones AM, et al. Aerobic exercise intensity assessment and prescription in cardiac rehabilitation: a joint position statement of the European Association for Cardiovascular Prevention and Rehabilitation, the American Association of Cardiovascular and Pulmonary Rehabilitation and the Canadian Association of Cardiac Rehabilitation. *Eur J Prev Cardiol* 2013;20:442–467.

Supplementary material

Supplementary material is available at *European Journal of Preventive Cardiology* online.

Conflict of interest: MP received research grants from the charitable organisation Cardiac Risk in the Young which supports cardiac screening of young individuals. No other author declared a conflict of interest in the context of this core curriculum.

References

1. Nabel EG, Braunwald E. A tale of coronary artery disease and myocardial infarction. *N Engl J Med* 2012;366:54–63.
2. Timmis A, Townsend N, Gale CP, Torbica A, Lettino M, Petersen SE, Mossialos EA, Maggioni AP, Kazakiewicz D, May HT, De Smedt D, Flather M, Zuhlske L, Beltrame JF, Huculeci R, Tavazzi L, Hindricks G, Bax J, Casadei B, Achenbach S, Wright L, Vardas P; European Society of Cardiology. European Society of Cardiology: cardiovascular disease statistics 2019. *Eur Heart J* 2020;41:12–85.
3. Piepoli MF, Hoes AW, Agewall S, Albus C, Brotons C, Catapano AL, Cooney MT, Corrà U, Cosyns B, Deaton C, Graham I, Hall MS, Hobbs FDR, Løchen ML,

Löllgen H, Marques-Vidal P, Perk J, Prescott E, Redon J, Richter DJ, Sattar N, Smulders Y, Tiberi M, van der Worp HB, van Dis I, Verschuren WMM, Binno S; ESC Scientific Document Group. 2016 European Guidelines on cardiovascular disease prevention in clinical practice: The Sixth Joint Task Force of the European Society of Cardiology and Other Societies on Cardiovascular Disease Prevention in Clinical Practice (constituted by representatives of 10 societies and by invited experts)Developed with the special contribution of the European Association for Cardiovascular Prevention & Rehabilitation (EACPR). *Eur Heart J* 2016;**37**:2315–2381.

4. Arena R, Guazzi M, Lianov L, Whitsel L, Berra K, Lavie CJ, Kaminsky L, Williams M, Hirvet M-F, Cherie Franklin N, Myers J, Dengel D, Lloyd-Jones DM, Pinto FJ, Cosentino F, Halle M, Gielen S, Dendale P, Niebauer J, Pelliccia A, Giannuzzi P, Corra U, Piepoli MF, Guthrie G, Shurney D, Arena R, Berra K, Dengel D, Franklin NC, Hirvet M-F, Kaminsky L, Lavie CJ, Lloyd-Jones DM, Myers J, Whitsel L, Williams M, Corra U, Cosentino F, Dendale P, Giannuzzi P, Gielen S, Guazzi M, Halle M, Niebauer J, Pelliccia A, Piepoli MF, Pinto FJ; ACPM Writing Group, Guthrie G, Lianov L, Shurney D. Healthy lifestyle interventions to combat non-communicable disease-a novel nonhierarchical connectivity model for key stakeholders: a policy statement from the American Heart Association, European Society of Cardiology, European Association for Cardiovascular Prevention and Rehabilitation, and American College of Preventive Medicine. *Eur Heart J* 2015; **36**:2097–2109.

5. Jørgensen T, Capewell S, Prescott E, Allender S, Sans S, Zdrojewski T, De Bacquer D, de Sutter J, Franco OH, Løstrup S, Volpe M, Malyutina S, Marques-Vidal P, Reiner Ž, Tell GS, Verschuren WMM, Vanuzzo D. Population-level changes to promote cardiovascular health. *Eur J Prev Cardiol* 2013; **20**:409–421.

6. Cosentino F, Grant PJ, Aboyans V, Bailey CJ, Ceriello A, Delgado V, Federici M, Filippatos G, Grobbee DE, Hansen TB, Huikuri HV, Johansson I, Jüni P, Lettino M, Marx N, Mellbin LG, Östgren CJ, Rocca B, Roffi M, Sattar N, Seferović PM, Sousa-Uva M, Valensi P, Wheeler DC; ESC Scientific Document Group. 2019 ESC Guidelines on diabetes, pre-diabetes, and cardiovascular diseases developed in collaboration with the EASD. *Eur Heart J* 2020; **41**:255–323.

7. Mach F, Baigent C, Catapano AL, Koskinas KC, Casula M, Badimon L, Chapman MJ, De Backer GG, Delgado V, Ference BA, Graham IM, Halliday A, Landmesser U, Mihaylova B, Pedersen TR, Riccardi G, Richter DJ, Sabatine MS, Taskinen MR, Tokgozoglu L, Wiklund O; ESC Scientific Document Group. 2019 ESC/EAS Guidelines for the management of dyslipidaemias: lipid modification to reduce cardiovascular risk. *Eur Heart J* 2020; **41**:111–188.

8. Williams B, Mancia G, Spiering W, Agabiti Rosei E, Azizi M, Burnier M, Clement DL, Coca A, de Simone G, Dominicak A, Kahan T, Mahfoud F, Redon J, Ruilope L, Zanchetti A, Kerins M, Kjeldsen SE, Kreutz R, Laurent S, Lip GYH, McManus R, Narkiewicz K, Ruschitzka F, Schmieder RE, Shlyakhto E, Tsiofis C, Aboyans V, Desormais I; ESC Scientific Document Group. 2018 ESC/ESH Guidelines for the management of arterial hypertension. *Eur Heart J* 2018; **39**:3021–3104.

9. Ambrosetti M, Abreu A, Corra U, Davos CH, Hansen D, Frederix I, Iliou MC, Pedretti RF, Schmid JP, Vigorito C, Voller H, Wilhelm M, Piepoli MF, Bjarnason-Wehrens B, Berger T, Cohen-Solal A, Cornelissen V, Dendale P, Doehner W, Gaita D, Gevaert AB, Kemps H, Kraenkel N, Laukkonen J, Mendes M, Niebauer J, Simonenko M, Zwilser AO. Secondary prevention through comprehensive cardiovascular rehabilitation: From knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020; doi:10.1177/2047487320913379.

10. Scherrenberg M, Wilhelm M, Hansen D, Völler H, Cornelissen V, Frederix I, Kemps H, Dendale P. The future is now: a call for action for cardiac telerehabilitation in the COVID-19 pandemic from the secondary prevention and rehabilitation section of the European Association of Preventive Cardiology. *Eur J Prev Cardiol* 2020; doi:10.1177/2047487320939671.

11. Kemps H, Kränkel N, Dörr M, Moholdt T, Wilhelm M, Paneni F, Serratos L, Ekkern Solberg E, Hansen D, Halle M, Guazzi M. Exercise training for patients with type 2 diabetes and cardiovascular disease: What to pursue and how to do it. A Position Paper of the European Association of Preventive Cardiology (EAPC). *Eur J Prev Cardiol* 2019; **26**:709–727.

12. Hansen D, Kraenkel N, Kemps H, Wilhelm M, Abreu A, Pfeiffer AF, Jordão A, Cornelissen V, Völler H. Management of patients with type 2 diabetes in cardiovascular rehabilitation. *Eur J Prev Cardiol* 2019; **26**:133–144.

13. Vigorito C, Abreu A, Ambrosetti M, Belardinelli R, Corrà U, Cupples M, Davos CH, Hoefer S, Iliou M-C, Schmid J-P, Voeller H, Doherty P. Frailty and cardiac rehabilitation: a call to action from the EAPC Cardiac Rehabilitation Section. *Eur J Prev Cardiol* 2017; **24**:577–590.

14. Piepoli MF, Conraads V, Corrà U, Dickstein K, Francis DP, Jaarsma T, McMurray J, Pieske B, Piotrowicz E, Schmid J-P, Anker SD, Solal AC, Filippatos GS, Hoes AW, Gielen S, Giannuzzi P, Ponikowski PP. Exercise training in heart failure: from theory to practice. A consensus document of the Heart Failure Association and the European Association for Cardiovascular Prevention and Rehabilitation. *Eur J Heart Fail* 2011; **13**:347–357.

15. Pelliccia A, Sharma S, Gati S, Bäck M, Börjesson M, Caselli S, Collet JP, Corrado D, Drezner JA, Halle M, Hansen D, Heidbuchel H, Myers J, Niebauer J, Papadakis M, Piepoli MF, Prescott E, Roos-Hesselink JW, Graham Stuart A, Taylor RS, Thompson PD, Tiberi M, Vanhees L, Wilhelm M; ESC Scientific Document Group. 2020 ESC Guidelines on sports cardiology and exercise in patients with cardiovascular disease. *Eur Heart J* 2021; **42**:17–96.

16. Heidbuchel H, Papadakis M, Panhuyzen-Goedkoop N, Carré F, Dugmore D, Mellwig K-P, Rasmussen HK, Solberg EE, Borjesson M, Corrado D, Pelliccia A, Sharma S. Position paper: proposal for a core curriculum for a European Sports Cardiology qualification. *Eur J Prev Cardiol* 2013; **20**:889–903.

17. Niebauer J, Börjesson M, Carre F, Caselli S, Palatini P, Quattrini F, Serratos L, Adami PE, Biffi A, Pressler A, Schmied C, van Buuren F, Panhuyzen-Goedkoop N, Solberg E, Halle M, La Gerche A, Papadakis M, Sharma S, Pelliccia A. Recommendations for participation in competitive sports of athletes with arterial hypertension: a position statement from the sports cardiology section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2018; **39**:3664–3671.

18. Borjesson M, Dellborg M, Niebauer J, LaGerche A, Schmied C, Solberg EE, Halle M, Adami E, Biffi A, Carré F, Caselli S, Papadakis M, Pressler A, Rasmussen H, Serratos L, Sharma S, van Buuren F, Pelliccia A. Recommendations for participation in leisure time or competitive sports in athletes-patients with coronary artery disease: a position statement from the Sports Cardiology Section of the European Association of Preventive Cardiology (EAPC). *Eur Heart J* 2019; **40**:13–18.

19. Budts W, Pieles GE, Roos-Hesselink JW, Sanz de la Garza M, D'Ascanzi F, Giannakoulas G, Müller J, Oberhoffer R, Ehringer-Schetitska D, Herceg-Cavruk V, Gabriel H, Corrado D, van Buuren F, Niebauer J, Börjesson M, Caselli S, Fritsch P, Pelliccia A, Heidbuchel H, Sharma S, Stuart AG, Papadakis M. Recommendations for participation in competitive sport in adolescent and adult athletes with Congenital Heart Disease (CHD): position statement of the Sports Cardiology & Exercise Section of the European Association of Preventive Cardiology (EAPC), the European Society of Cardiology (ESC) Working Group on Adult Congenital Heart Disease and the Sports Cardiology, Physical Activity and Prevention Working Group of the Association for European Paediatric and Congenital Cardiology (AEPC). *Eur Heart J* 2020; **41**:4191–4199.

20. Heidbuchel H, Adami PE, Antz M, Braunschweig F, Delise P, Scherr D, Solberg EE, Wilhelm M, Pelliccia A. Recommendations for participation in leisure-time physical activity and competitive sports in patients with arrhythmias and potentially arrhythmogenic conditions: Part 1: Supraventricular arrhythmias. A position statement of the Section of Sports Cardiology and Exercise from the European Association of Preventive Cardiology (EAPC) and the European Heart Rhythm Association (EHRA), both associations of the European Society of Cardiology. *Eur J Prev Cardiol* 2020; doi:10.1177/2047487320925635.

21. Heidbuchel H, Arbelo E, D'Ascanzi F, Borjesson M, Boveda S, Castelletti S, Miljöen H, Mont L, Niebauer J, Papadakis M, Pelliccia A, Saenen J, Sanz de la Garza M, Schwartz PJ, Sharma S, Zeppenfeld K, Corrado D. Recommendations for participation in leisure-time physical activity and competitive sports of patients with arrhythmias and potentially arrhythmogenic conditions. Part 2: ventricular arrhythmias, channelopathies, and implantable defibrillators. *Europace* 2020; **23**:147–148.

22. Abreu A, Frederix I, Dendale P, Janssen A, Doherty P, Piepoli MF, Völler H; Secondary Prevention and Rehabilitation Section of EAPC Reviewers: Marco Ambrosetti, Davos CH. Standardization and quality improvement of secondary prevention through cardiovascular rehabilitation programmes in Europe: The avenue towards EAPC accreditation programme: a position statement of the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology (EAPC). *Eur J Prev Cardiol* 2020; doi:10.1177/2047487320924912.

23. Yusuf S, Hawken S, Önnpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): case-control study. *Lancet* 2004; **364**:937–952.

24. O'Donnell MJ, Xavier D, Liu L, Zhang H, Chin SL, Rao-Melacini P, Rangarajan S, Islam S, Pais P, McQueen MJ, Mondo C, Damasceno A, Lopez-Jaramillo P, Hankey GJ, Dans AL, Yusoff K, Truelsen T, Diener H-C, Sacco RL, Ryglewicz D, Czonkowska A, Weimar C, Wang X, Yusuf S. Risk factors for ischaemic and intracerebral haemorrhagic stroke in 22 countries (the INTERSTROKE study): a case-control study. *Lancet* 2010; **376**:112–123.

25. Knowles JW, Ashley EA. Cardiovascular disease: The rise of the genetic risk score. *PLoS Med* 2018; **15**:e1002546.

26. Dhindsa DS, Sandesara PB, Shapiro MD, Wong ND. The evolving understanding and approach to residual cardiovascular risk management. *Front Cardiovasc Med* 2020; **7**:88.

27. Kotseva K, De Backer G, De Bacquer D, Rydén L, Hoes A, Grobbee D, Maggioni A, Marques-Vidal P, Jennings C, Abreu A, Aguiar C, Badaraine J, Bruthans J, Castro Conde A, Cifkova R, Crowley J, Davleton K, Deckers J, De Smedt D, De

Sutter J, Dilic M, Dolzhenko M, Dzerve V, Erglis A, Fras Z, Gaita D, Gotcheva N, Heuschmann P, Hasan-Ali H, Jankowski P, Lalic N, Lehto S, Lovic D, Mancas S, Mellbin L, Milicic D, Mirrakhimov E, Oganov R, Pogosova N, Reiner Z, Stöerk S, Tokgözoglu L, Tsiofis C, Vulic D, Wood D; on behalf of the EUROASPIRE Investigators. Lifestyle and impact on cardiovascular risk factor control in coronary patients across 27 countries: results from the European Society of Cardiology ESC-EORP EUROASPIRE V registry. *Eur J Prev Cardiol* 2019;26: 824–835.

28. Hindricks G, Potpara T, Dagres N, Arbelo E, Bax JJ, Blomström-Lundqvist C, Boriani G, Castella M, Dan GA, Dilaveris PE, Fauchier L, Filippatos G, Kalman JM, La Meir M, Lane DA, Lebeau JP, Lettino M, Lip GYH, Pinto FJ, Thomas GN, Valgimigli M, Van Gelder IC, Van Putte BP, Watkins CL; ESC Scientific Document Group. 2020 ESC Guidelines for the diagnosis and management of atrial fibrillation developed in collaboration with the European Association of Cardio-Thoracic Surgery (EACTS). *Eur Heart J* 2021;42:373–498.

29. Gilchrist SC, Barac A, Ades PA, Alfano CM, Franklin BA, Jones LW, La Gerche A, Ligibel JA, Lopez G, Madan K, Oeffinger KC, Salamone J, Scott JM, Squires RW, Thomas RJ, Treat-Jacobson DJ, Wright JS; On behalf of the American Heart Association Exercise, Cardiac Rehabilitation, and Secondary Prevention Committee of the Council on Clinical Cardiology; Council on Cardiovascular and Stroke Nursing; and Council on Peripheral Vascular Disease. Cardio-oncology rehabilitation to manage cardiovascular outcomes in cancer patients and survivors: a scientific statement from the American Heart Association. *Circulation* 2019;139:e997–e1012.

30. Zamorano JL, Lancellotti P, Rodriguez Muñoz D, Aboyans V, Asteggiano R, Galderisi M, Habib G, Lenihan DJ, Lip GYH, Lyon AR, Lopez Fernandez T, Mohty D, Piepoli MF, Tamargo J, Torbicki A, Suter TM. 2016 ESC Position Paper on cancer treatments and cardiovascular toxicity developed under the auspices of the ESC Committee for Practice Guidelines: The Task Force for cancer treatments and cardiovascular toxicity of the European Society of Cardiology (ESC). *Eur Heart J* 2016;37:2768–2801.

31. Dendale P, Scherrenberg M, Sivakova O, Frederix I. Prevention: from the cradle to the grave and beyond. *Eur J Prev Cardiol* 2019;26:507–511.

32. Leopold JA, Loscalzo J. Emerging role of precision medicine in cardiovascular disease. *Circ Res* 2018;122:1302–1315.

33. Sharma A, Harrington RA, McClellan MB, Turakhia MP, Eapen ZJ, Steinhubl S, Mault JR, Majmudar MD, Roessig L, Chandross KJ, Green EM, Patel B, Hamer A, Olglin J, Rumsfeld JS, Roe MT, Peterson ED. Using digital health technology to better generate evidence and deliver evidence-based care. *J Am Coll Cardiol* 2018;71:2680–2690.

34. Bairey Merz CN, Alberts MJ, Balady GJ, Ballantyne CM, Berra K, Black HR, Blumenthal RS, Davidson MH, Fazio SB, Ferdinand KC, Fine LJ, Fonseca V, Franklin BA, McBride PE, Mensah GA, Merli GJ, O’Gara PT, Thompson PD, Underberg JA; American Academy of Neurology; American Association of Cardiovascular and Pulmonary Rehabilitation; American College of Preventive Medicine; American College of Sports Medicine; American Diabetes Association; American Society of Hypertension; Association of Black Cardiologists; Centers for Disease Control and Prevention; National Heart, Lung, and Blood Institute; National Lipid Association; Preventive Cardiovascular Nurses Association. ACCF/AHA/ACP 2009 competence and training statement: a curriculum on prevention of cardiovascular disease: a report of the American College of Cardiology Foundation/American Heart Association/American College of Physicians Task Force on Competence and Training (Writing Committee to Develop a Competence and Training Statement on Prevention of Cardiovascular Disease); developed in collaboration with the American Academy of Neurology; American Association of Cardiovascular and Pulmonary Rehabilitation; American College of Preventive Medicine; American College of Sports Medicine; American Diabetes Association; American Society of Hypertension; Association of Black Cardiologists; Centers for Disease Control and Prevention; National Heart, Lung, and Blood Institute; National Lipid Association; and Preventive Cardiovascular Nurses Association. *Circulation* 2009;120:e100–e126.

35. Shapiro MD, Maron DJ, Morris PB, Kosiborod M, Sandesara PB, Virani SS, Khera A, Ballantyne CM, Baum SJ, Sperling LS, Bhatt DL, Fazio S. Preventive cardiology as a subspecialty of cardiovascular medicine: JACC council perspectives. *J Am Coll Cardiol* 2019;74:1926–1942.

36. Shapiro MD, Fazio S. Preventive cardiology as a dedicated clinical service: the past, the present, and the (Magnificent) future. *Am J Prev Cardiol* 2020;1:100011.

37. Lopez-Sendon J, Mills P, Weber H, Michels R, Mario CD, Filippatos GS, Heras M, Fox K, Merino J, Pennell DJ, Sochor H, Ortoli J, Mills P, Weber H, Lopez-Sendon J, Szatmari A, Pinto F, Amlie JP, Oto A, Lainscak M, Fox K, Kearney P, Goncalves L, Huikuri H, Carrera C; Authors/Task Force Members. Recommendations on sub-specialty accreditation in cardiology: the Coordination Task Force on Sub-specialty Accreditation of the European Board for the Specialty of Cardiology. *Eur Heart J* 2007;28:2163–2171.

38. ESC Subspecialty Curricula. <https://www.escardio.org/Education/esc-and-subspecialty-core-curricula> (last accessed November 4th 2020).

39. Baggish AL, Battle RW, Beckerman JG, Bove AA, Lampert RJ, Levine BD, Link MS, Martinez MW, Molossi SM, Salerno J, Wasfy MM, Weiner RB, Emery MS. Sports cardiology: core curriculum for providing cardiovascular care to competitive athletes and highly active people. *J Am Coll Cardiol* 2017;70:1902–1918.

40. Ten Cate O. Nuts and bolts of entrustable professional activities. *J Grad Med Educ* 2013;5:157–158.

41. Tanner FC, Brooks N, Fox KF, Gonçalves L, Kearney P, Michalis L, Pasquet A, Price S, Bonnefoy E, Westwood M, Plummer C, Kirchhof P; ESC Scientific Document Group. ESC core curriculum for the cardiologist. *Eur Heart J* 2020;41: 3605–3692.

42. Frank JR, Snell L, Sherbino J. CanMEDS 2015 Physician Competency Framework. Royal College of Physicians and Surgeons of Canada 2015. <http://canmeds.royalcollege.ca/en/framework> (last accessed November 4th 2020).

43. Ross RD, Brook M, Feinstein JA, Koenig P, Lang P, Spicer R, Vincent JA, Lewis AB, Martin GR, Bartz PJ, Fischbach PS, Fulton DR, Matherne GP, Reinking B, Srivastava S, Printz B, Geva T, Shirali GS, Weinberg P, Wong PC, Armsby LB, Vincent RN, Foerster SR, Holzer RJ, Moore JV, Marshall AC, Latson L, Dubin AM, Walsh EP, Franklin W, Kanter RJ, Saul JP, Shah MJ, Van Hare GF, Feltes TF, Roth SJ, Almodovar MC, Andropoulos DB, Bohn DJ, Costello JM, Gajarski RJ, Mott AR, Stout K, Valente AM, Cook S, Gurvitz M, Saidi A, Webber SA, Hsu DT, Ivy DD, Kulik TJ, Pahl E, Rosenthal DN, Morrow R, Mahle WT, Murphy AM, Li JS, Law YM, Newburger JW, Daniels SR, Bernstein D, Marino BS. 2015 SPCTPD/ACC/AAP/AHA training guidelines for pediatric cardiology fellowship programs. *J Am Coll Cardiol* 2015;doi:10.1016/j.jacc.2015.03.004.

44. ESC Preventive Cardiology Textbooks. <https://www.escardio.org/Education/Textbooks/prevention-and-rehabilitation> (last accessed November 4th 2020).