

The ESC Textbook of  
**Cardiovascular  
Medicine**

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# The ESC Textbook of Cardiovascular Medicine

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SECOND EDITION

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# Foreword

The mission statement of the ESC is to improve the quality and quantity of lives of the European population by reducing the burden of cardiovascular disease. To fulfil its mission the ESC has taken on the responsibility of training cardiologists and disseminating knowledge through congresses, guidelines, reports, and through the publication of *The ESC Textbook of Cardiovascular Medicine*, which is now at its second edition.

We would like to take this opportunity to thank all of those who have contributed with their experience, time, and enthusiasm in order to produce this new edition, particularly the authors and editors. Their experience will be invaluable to bring the most pertinent information to our colleagues throughout Europe and around the world.

When confronted with a new project, such as the new edition of *The ESC Textbook of Cardiovascular Medicine*, a legitimate question arises: is it needed? The answer is clear: yes, it is needed.

Cardiology has in the last 50 years made incredible progress and has contributed to more than 6 out of 10 years of the lifespan increase. This is an enormous achievement, bigger than all of the other specialties combined. Despite this, cardiovascular disease is still the foremost cause of death and permanent disability in Western countries and is set to become the foremost cause of death by the year 2020. Thus, cardiology has not yet succeeded in avoiding cardiovascular mortality from occurring, it has just contributed to delaying it. Even this achievement is, of course, of paramount importance, but clearly there is still much to learn about

cardiovascular disease, particularly in understanding the basic mechanism of disease, the pathophysiology, and the evolution of diagnostic methods. The explosion of diagnostic techniques combined with new biological assays, particularly those based on genomes and proteomics, do help in making more accurate and precise diagnosis, but require a unusual degree of updated knowledge, the provision of which is one of the many goals of the new edition of *The ESC Textbook of Cardiovascular Medicine*. Equally, the management of cardiology patients, from collecting their histories, to dealing with the psychological impact of ageing, to the regulatory aspects of their disease, is rapidly changing and this is discussed in depth. Sport is becoming more and more popular also as a consequence of several campaigns of prevention. Together with the problem of non-cardiac surgery in cardiac patients, these are other specific goals of the new edition. Of course, the new topics are offered in addition to an extended and comprehensive revision of all topics of the first edition according to the updated guidelines and ESC core syllabus. We are confident and proud that the second edition will become the new benchmark for cardiology in Europe and beyond.

Roberto Ferrari  
President of the European Society of Cardiology  
2008–2010

Michel Komajda  
President Elect of the European Society of Cardiology  
2008–2010



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# Preface

The European Society of Cardiology (ESC) has been at the forefront of establishing best practice in cardiology, and was the first cardiac professional society to publish a textbook in its field. Since its inception in 2004, *The ESC Textbook of Cardiovascular Medicine* has sold many thousands of copies, and has been translated into a number of different languages, including Polish, Turkish, and Spanish. As the science of medicine moves at a fast pace, especially in cardiovascular medicine, this second edition is a timely reminder for all physicians to remain up-to-date with the latest practice.

*The ESC Textbook of Cardiovascular Medicine, Second Edition* follows the cardiology training curriculum of the ESC, and is designed to be used as a text for teaching and a guide for learning. Combining the ESC guidelines, Task Force reports, and Scientific statements, the textbook is sufficiently comprehensive to inform the large majority of clinical practice in cardiovascular medicine, and to serve as the essential training tool for accreditation and re-accreditation in cardiovascular medicine within the European Union and further afield.

This new edition contains seven new chapters: physical examination and history, choice of imaging techniques, the heart and other organs, sports medicine and certification, non-cardiac surgery in cardiac patients, psychological impact of heart disease, and occupational and regulatory aspects of heart disease. We have also combined topics such as atrial fibrillation, ventricular tachycardia, acute coronary syndromes, chronic ischaemic heart disease, and heart failure that were previously covered in two chapters into one chapter. The new edition is larger than the last edition of the book, to incorporate these changes.

As in the previous edition, each chapter begins with a brief summary, and concludes with a 'Personal perspective'

from the authors which outlines their view as to the 'state of the art' and the future of their subject. The contents are listed on the first page of the chapter. Each chapter is designed to provide high level information, the evidence-base from which guidelines have been derived, and, where appropriate, the major guideline recommendations.

The textbook is available both in print and online (<http://esc textbook.oxfordonline.com>). Purchasers of the print and online bundle can access the online material via the access codes printed at the front of this book. The online version contains all the material from the printed book, as well as extensive reference linking including via PubMed. In appropriate chapters video clips and additional images are also available online.

Purchasers with online access can also take advantage of multiple choice questions which can be used for CME/CPD accreditation, which is provided by the European Board for Accreditation in Cardiology (<http://www.ebac-cme.org>). Each chapter carries appropriate points of credit.

We could not have developed this textbook without the close cooperation of the Education Committee of the European Society of Cardiology. We would like to express our gratitude to those who only contributed to the first edition for their understanding. We also thank the many authors of this edition who made their contributions within the tight deadlines that were needed. Similarly we are grateful to the staff at Oxford University Press, particularly Tracey Mills, Helen Liepman, Julia Jeans, Mandy Hill, Kelly Hewinson, and Kate Wanwimolruk who worked enthusiastically and uncomplainingly to produce this new edition.

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Thomas F. Lüscher  
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Although first edition figure attributions have been carried over to the second edition it was not possible to make specific attributions to figures contributed by first edition authors.

# Symbols and abbreviations

	cross reference	AR	aortic regurgitation
	additional online material	ARB	angiotensin receptor blocker
	website	ARR	absolute risk reduction
(e)NOS	(endothelial) nitric oxide synthase	ART	assisted reproductive technology
2D	two-dimensional	ARVC	arrhythmogenic right ventricular cardiomyopathy
3D	three-dimensional	AS	aortic stenosis
AACVPR	American Association of Cardiovascular Prevention and Rehabilitation	ASA	acetylsalicylic acid
ABCD	Appropriate Blood pressure Control in Diabetes	AST	aspartate aminotransferase
ACC	American College of Cardiology	ASD	atrial septal defect
ACCP	American College of Chest Physicians	ASF	anterosuperior fascicle
ACE	angiotensin-converting enzyme	AST	aspartate aminotransferase
ACEI	angiotensin-converting enzyme inhibitor	ATP	adenosine triphosphate
ACM	all-cause mortality <i>or</i> alcoholic cardiomyopathy	AV	atrioventricular
ACT	activated coagulation time	AVA	aortic valve area
ADA	American Diabetes Association	AVN	atrioventricular node
ADH	antidiuretic hormone	AVNRT	atrioventricular nodal re-entrant tachycardia
ADP	adenosine diphosphate	AVP	arginine vasopressin
AED	automated external defibrillator	AVSD	atrioventricular septal defect
AF	atrial fibrillation	BAV	bicuspid aortic valve
AGE	advanced glycation end-product	BB	bundle branch/es
AH	atrial–His	BIMA	bilateral internal mammary artery
AHA	American Heart Association	BMP	bone morphogenetic protein
ALAT	alanine amino transferase	BNP	brain natriuretic peptide
ALT	alanine aminotransferase	BOLD	blood oxygen level dependent
AMDG	airport metal detector gates	BP	blood pressure
AMI	acute myocardial infarction	BPEG	British Pacing and Electrophysiology Group
ANP	atrial natriuretic peptide	bpm	beats per minute
Ao	aorta	BRS	baroreflex sensitivity
AoA	aortic orifice area	BrS	Brugada syndrome
apoB	apolipoprotein B	BSA	body surface area
apoE	apolipoprotein E	BUN	blood urea nitrogen
aPTT	activated partial thromboplastin time	CABG	coronary artery bypass graft
		CACS	coronary artery calcium scoring

CAD	coronary artery disease	EBCT	electron-beam computed tomography
CAM	cell adhesion molecule	EBM	evidence-based medicine
CAPD	continuous ambulatory peritoneal dialysis	ECG	electrocardiogram
CAT	common arterial trunk	ED	end-diastolic <i>or</i> Emergency Department
CBT	cognitive behavioural therapy	EDMD	Emery–Dreyfuss muscular dystrophy
CCR	comprehensive cardiac rehabilitation	EDV	end-diastolic volume
CCUS	complete <i>or</i> comprehensive compression ultrasound	EEG	electroencephalogram
CEA	carcinoembryonic antigen <i>or</i> carotid endarterectomy	EEL	external elastic lamina
CETP	cholesteryl ester transfer protein	EEM	external elastic membrane
CFR	coronary flow reserve	EF	ejection fraction
CHD	coronary heart disease	EHRA	European Heart Rhythm Association
CHF	chronic heart failure	ELISA	enzyme-linked immunosorbent assay
CI	cardiac index <i>or</i> confidence interval	EMI	electromagnetic interference
CK	creatinine kinase	eNOS	endothelial nitric oxide synthase
CKD	chronic kidney disease	EPI	echo-planar imaging
CMR	cardiac magnetic resonance	EPO	erythropoietin
CO	cardiac output	ER	European Region
COX	cyclo-oxygenase	ERO	effective regurgitant orifice
CPET	cardiopulmonary exercise testing	ES	end-systole <i>or</i> effect size
CPK	creatinine phosphokinase	ESC	European Society of Cardiology
CPR	cardiopulmonary resuscitation	ESH	European Society of Hypertension
CPVT	catecholaminergic polymorphic ventricular tachycardia	ET	endothelin
CR	cardiac rehabilitation	EU	Eustachian valve <i>or</i> European Union
CRF	conventional risk factor	FDCM	familial dilated cardiomyopathy
CRT	cardiac resynchronization therapy	FEV <sub>1</sub>	forced expiratory volume at 1 second
cSNRT	corrected sinus node recovery time	FFR	fractional flow reserve
CTPA	computed tomography pulmonary angiography	FH	familial hypercholesterolaemia
CTPH	chronic thromboembolic pulmonary hypertension	FLAIR	fluid attenuated inversion recovery
CUS	compression ultrasound	FLASH	fast low angle shot
CV	cardiovascular	FPG	fasting plasma glucose
CVD	cardiovascular disease	FXaI	factor Xa inhibitor
CVM	cardiovascular mortality	GFR	glomerular filtration rate
CW	continuous-wave	GIK	glucose–insulin–potassium
CYP	cytochrome P450	GORD	gastro-oesophageal reflux disease
DAG	dystrophin-associated glycoprotein	GUCH	grown-up congenital heart
DCM	dilated cardiomyopathy	GWAS	genome-wide association study
DES	drug-eluting stent	HB	His bundle
D <sub>L</sub> CO	diffusion capacity for carbon monoxide	Hb	haemoglobin
DSA	digital subtraction angiography	HBE	His bundle electrogram
DSE	dobutamine stress echocardiography	HCM	hypertrophic cardiomyopathy
DTI	direct thrombin inhibitor	HCTZ	hydrochlorothiazide
DVT	deep vein thrombosis	HDL	high-density lipoprotein
EASD	European Association for the Study of Diabetes <i>or</i> electronic article surveillance	HELLP	haemolysis elevated liver enzymes low platelets
		HES	hypereosinophilic syndrome
		HF-PEF	heart failure with preserved left ventricular ejection fraction
		HHT	hereditary haemorrhagic telangiectasia
		HIPAA	heparin-induced platelet activation

HIT	heparin-induced thrombocytopenia	LVEF	left ventricular ejection fraction
HIV	human immunodeficiency virus	LVH	left ventricular hypertrophy
HLHS	hypoplastic left heart syndrome	LVM	left ventricular mass
HMG-CoA	5-hydroxy-3-methylglutaryl-coenzyme A	LVNC	left ventricular non-compaction
HPA	hypothalamus–pituitary–adrenal	LVOT	left ventricular outflow tract
HR	hazard ratio	MA	mitral annulus
HRQL	health-related quality of life	MAPCA	major aortic pulmonary collateral artery
HRV	heart rate variability	MAPK	mitogen-activated protein kinase
HV	His–ventricular	MAS	multiple system atrophy
ICA	internal carotid artery	MBM	mechanism-based medicine
ICD	implantable cardioverter defibrillator	mcg	microgram
IEL	internal elastic lamina	MDRD	Modification of Diet in Renal Disease
IFG	impaired fasting glucose	MDDT	maximum daily therapeutic dose
IGT	impaired glucose tolerance	MFS	Marfan syndrome
IHD	ischaemic heart disease	MHC	major histocompatibility complex
IMR	index of microvascular resistance	MI	myocardial infarction
INR	international normalized ratio	MIBG	meta-iodobenzylguanidine
IPAH	idiopathic pulmonary arterial hypertension	MMP	matrix metalloproteinase
		MPa	megapascal
IPT	interpersonal therapy	MPA	main pulmonary artery
ISH	International Society of Hypertension	MPS	myocardial perfusion scintigraphy
ITT	intention to treat	MR	magnetic resonance
IV	intravenous	MS	metabolic syndrome
IVUS	intravascular ultrasound	MSCT	multislice computed tomography
JLN	Jervell and Lange–Nielsen [syndrome]	MTWA	microvolt T-wave alternans
JVP	jugular venous pulse	MV	mitral valve
K/DOQI	Kidney Disease Outcome Quality Initiative	MVA	mitral valve area
		MVP	mitral valve prolapse
KCCQ	Kansas City Cardiomyopathy Questionnaire	n-3 PUFA	omega-3 polyunsaturated fatty acid
		NASPE	North American Society of Pacing and Electrophysiology
LA	left atrium/atrial	NFMI	non-fatal myocardial infarction
LAA	left atrial appendage	NFS	nephrogenic systemic fibrosis
LAD	left anterior descending	NGAL	neutrophil gelatinase-associated lipocalin
LBB	left bundle branch	NHLBI	National Heart, Lung, and Blood Institute
LBBB	left bundle branch block	NIDDK	National Institute of Diabetes and Digestive and Kidney Diseases
LCA	left coronary artery		
LCSD	left cardiac sympathetic denervation	NM	nuclear myocardial
LCX	left circumflex coronary artery	NNH	number needed to harm
LDL	low-density lipoprotein	NNT	number needed to treat
LDL-C	low-density lipoprotein cholesterol	NO	nitric oxide
LGE	late gadolinium enhancement	NOS	nitric oxide synthase
LGMD	limb girdle muscular dystrophy	NRT	nicotine replacement therapy
LIMA	left internal mammary artery	NSAID	non-steroidal anti-inflammatory drug
LMWH	low-molecular-weight heparin	NSTE-ACS	non-ST-elevated acute coronary syndrome
LOE	level of evidence		
LQTS	long QT syndrome	NSVT	non-sustained ventricular tachycardia
LV	left ventricle/ventricular	NT-proBNP	N-terminal prohormone brain natriuretic peptide
LVAD	left ventricular assist device		
LVEDP	left ventricular filling pressure		

NYHA	New York Heart Association	PPHN	persistent pulmonary hypertension of the neonates
OAC	oral anticoagulation therapy	PSS	post-systolic shortening
OCT	optical coherence tomography	PTA	percutaneous transluminal angioplasty
OFDI	optical frequency domain imaging	PTCA	percutaneous transluminal coronary angioplasty
OGTT	oral glucose tolerance test	PTEA	pulmonary thromboendarterectomy
OH	orthostatic hypotension	PTFE	polytetrafluorethylene
OR	odds ratio	PTH	parathyroid hormone
PA	pulmonary artery	PTS	post-thrombotic syndrome
PAC	premature atrial contraction	PTSD	post-traumatic stress disorder
$P_a\text{CO}_2$	arterial carbon dioxide tension	PV	pressure–volume
PAD	peripheral arterial disease	PVD	peripheral vascular disease
PAF	pure autonomic failure	PVR	pulmonary vascular resistance
PAH	pulmonary arterial hypertension	PW	pulsed-wave
PAI	plasminogen activator inhibitor	PWP	pulmonary wedge pressure
$P_a\text{O}_2$	arterial oxygen tension	QTL	quantitative trait loci
PAP	pulmonary artery pressure	RA	right atrium
PAR	pulmonary arteriolar resistance	RAA	renin–angiotensin–aldosterone
PASP	pulmonary artery systolic pressure	RAAS	renin–angiotensin–aldosterone system
PAV	percutaneous aortic valvuloplasty	RAS	renin–angiotensin system
PCCD	progressive cardiac conduction defect	RBB	right bundle branch
PCI	percutaneous coronary intervention	RBBB	right bundle branch block
PCM	physical counter-pressure manoeuvre	RCA	right coronary artery
PCR	polymerase chain reaction	ROC	receiver operating characteristic
PCW	pulmonary wedge pressure	ROS	reactive oxygen species
PDA	posterior descending artery	RR	relative risk
PDE	phosphodiesterase	RRR	relative risk reduction
PDE-5	phosphodiesterase type 5	rtPA	recombinant tissue plasminogen activator
PE	pulmonary embolism	RV	right ventricle/ventricular
PES	programmed electrical stimulation	RVA	right ventricular apex
PET	positron emission tomography	RVOT	right ventricular outflow tract
PF	physical functioning	SAECG	signal-averaged electrocardiogram
PFHB	progressive familial heart block	SAM	systolic anterior motion
PH	pulmonary hypertension	SAQ	Seattle Angina Questionnaire
PHQ	Patient Health Questionnaire	SBP	systolic blood pressure
PI	posteroinferior fascicle	SCD	sudden cardiac death
PIC	pro-inflammatory cytokine	SES	sirolimus-eluting stents <i>or</i> socio-economic status
PIH	pregnancy-induced hypertension	SF-36	Short Form Health Survey 36
PISA	proximal isovelocity surface area	SMR	standardized mortality ratio
PKC	protein kinase C	SNP	single nucleotide polymorphism
PMC	percutaneous mitral balloon commissurotomy	SPECT	single photon emission computed tomography
PMI	point of maximal impulse or perioperative myocardial infarction	SQTS	short QT syndrome
PMR	progressive muscle relaxation	SR	sustained release
PND	paroxysmal nocturnal dyspnoea	SR	sarcoplasmic reticulum
PO	per os [by mouth]	SSFP	steady state with free precession
POTS	postural orthostatic tachycardia syndrome	SSI	steady state inactivation
PPCM	peripartum cardiomyopathy		

SSRI	selective serotonin reuptake inhibitor	tPA	tissue plasminogen activator
SSS	sick sinus syndrome	TPG	transpulmonary pressure gradient
STEMI	ST-elevation myocardial infarction	TPR	total pulmonary resistance
STS	Society of Thoracic Surgeons	TR	tricuspid regurgitation
SV	stroke volume	TS	tricuspid stenosis
SVI	stroke volume index	TSH	thyroid-stimulating hormone
SVR	systemic vascular resistance	TTE	transthoracic echocardiography
SVT	supraventricular tachycardia	TTM	trans-telephonic monitoring
TAPVC	total anomalous pulmonary venous connection	TWA	T-wave alternans
TAVI	transcatheter aortic valve implantation	UFH	unfractionated heparin
TC	Takotsubo cardiomyopathy	VD	volume of distribution
TCA	tricyclic antidepressant	VEGF	vascular endothelial growth factor
TCMP	tachycardia-induced cardiomyopathy	VF	ventricular fibrillation
TCPC	total cavopulmonary connection	VHD	valvular heart disease
TDI	tissue Doppler imaging	VKA	vitamin K antagonist
TdP	Torsade de pointes	VLDL	very-low-density lipoprotein
TE	echo time	VPB	ventricular premature beat
TGA	transposition of the great arteries	VSD	ventricular septal defect
TIA	transient ischaemic attack	VT	ventricular tachycardia
TIMI	thrombolysis in myocardial infarction	VTE	venous thromboembolism
T-LOC	transient loss of consciousness	VVS	vasovagal syncope
TOE	transoesophageal echocardiography	WHO	World Health Organization
		WPW	Wolff–Parkinson–White syndrome