



ELIAS B. HANNA

PRACTICAL CARDIOVASCULAR MEDICINE

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Practical Cardiovascular Medicine

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Practical Cardiovascular Medicine

*To my mother Marie, my sister Eliana, and my beautiful niece Clara and nephew Marc-Elias,
the constant light in my life*

To my mentors and my fellows, and to all those who share my love for cardiology

Preface

You should learn solely in order to create. For willing is creating.

Friedrich Nietzsche, Thus Spoke Zarathustra

Work without ceasing. If you remember in the night, "I have not done what I ought to have done," rise up at once and do it. Believe to the end, even if all men went astray and you were left the only one faithful.

Fyodor Dostoevsky, The Brothers Karamazov

Practical Cardiovascular Medicine is a comprehensive yet practical review of *all* fields of cardiovascular medicine. It addresses various cardiac diseases and presentations using both pathophysiology and clinical evidence, and expands from basic concepts to advanced ones. It should therefore prove useful to experienced physicians as well as trainees. In fact, there is a particular emphasis on the knowledge gaps of cardiologists and cardiology fellows. Organizing fellowship conferences and working with cardiology and interventional cardiology fellows has helped me perceive common deficiencies and focus on them.

Colleagues who read the book will find that it provides them with an in-depth understanding that translates into better patient management. My aim has also been to improve on pre-existing knowledge of pathophysiology and clinical trials. The book follows a comprehensive yet easy, practical, and illustrated flow. To facilitate learning, bottom-line approaches are consistently provided throughout the 38 chapters. There is an extra emphasis on concepts that are frequently misunderstood by practitioners.

Throughout, I have tried to answer daily, practical questions that may not be addressed in any other book. Even classic topics, such as ST-segment elevation myocardial infarction, heart failure, arrhythmias, atrial fibrillation, cardiac catheterization, or electrocardiography are discussed from a different, fresh, and contemporary viewpoint. The book is comprehensive, and many of its chapters could even stand alone as separate books.

In order to consolidate the understanding of complex topics, review questions with detailed answers are provided at the end of clinical chapters, mainly in a clinical vignette format (approximately 400 questions overall). The book will serve cardiologists and cardiology fellows, but will also be valuable to internists, internal medicine residents, and all professionals caring for patients with cardiovascular disease. I have written this book in an effort to embrace the magic and evolving depths of cardiovascular diseases. It is written with love, and with the hope of improving patients' outcomes.

Elias B. Hanna
August 2016

Abbreviations

3D	three-dimensional
AAD	antiarrhythmic drug
AAA	abdominal aortic aneurysm
ABI	ankle-brachial index
ACC	American College of Cardiology
ACCP	American College of Chest Physicians
ACE-I	angiotensin converting enzyme inhibitor
ACS	acute coronary syndrome
ACT	activated clotting time
ADHF	acutely decompensated heart failure
ADP	adenosine diphosphate
AF	atrial fibrillation
Aflutter	atrial flutter
AHA	American Heart Association
AI	aortic insufficiency
AIVR	accelerated idioventricular rhythm
AM	acute marginal
ANA	antinuclear antibodies
Ao	aorta
AoV	aortic valve
AP	accessory pathway
AP	anteroposterior view
ARB	angiotensin-II receptor blocker
ARDS	acute respiratory distress syndrome
ARVC	arrhythmogenic right ventricular cardiomyopathy
ARVD	arrhythmogenic right ventricular dysplasia
AS	aortic stenosis
ASD	atrial septal defect
AT	anterior tibial artery
AT	atrial tachycardia
AT1 receptor	type receptor of angiotensin 2
AT2 receptor	type 2 receptor of angiotensin 2
AT III	antithrombin III
AV	atrioventricular
AV block	atrioventricular block
AVA	aortic valve area
AVNRT	atrioventricular nodal reentrant tachycardia
AVR	aortic valve replacement
AVRT	atrioventricular reciprocating tachycardia
BBB	bundle branch block
BiPAP	bilevel positive airway pressure
BiV	biventricular
biVAD	biventricular assist device
BMS	bare-metal stent
BNP	brain natriuretic peptide
BP	blood pressure
bpm	beats per minutes
BSA	body surface area
BUN	blood urea nitrogen
Ca	calcium
CABG	coronary artery bypass grafting
CAD	coronary artery disease
CBC	complete blood count
CCB	calcium channel blockers
CEA	carotid endarterectomy
CIA	common iliac artery

CK	creatine kinase
CK-MB	creatine kinase MB
CKD	chronic kidney disease
CHF	congestive heart failure
CO	cardiac output
COPD	chronic obstructive pulmonary disease
CPAP	continuous positive airway pressure
CRP	C-reactive protein test
CRT	cardiac resynchronization therapy
CT	computed tomography
CTA	computed tomography angiography
CTI	cavotricuspid isthmus
CTO	chronic total occlusion
CTPH	chronic thromboembolic pulmonary hypertension
CVP	central venous pressure
CW	continuous wave Doppler
CYP 450	cytochrome P450
CXR	chest X-ray
DAD	delayed afterdepolarization
DBP	diastolic blood pressure
DC cardioversion	R-wave synchronized direct-current cardioversion
DCM	dilated cardiomyopathy
DES	drug-eluting stent
DHP	dihydropyridine (calcium channel blocker)
dP/dt	delta pressure/delta time (sharpness of rise in pressure over time)
DTI	direct thrombin inhibitor
DTS	Duke treadmill score
DVT	deep vein thrombosis
EAD	early afterdepolarization
ECG	electrocardiogram
echo	echocardiogram
ECMO	extracorporeal membrane oxygenation
ED	emergency department
EF	ejection fraction
EIA	external iliac artery
EP	electrophysiological
ERO	effective regurgitant orifice
ESC	European Society of Cardiology
ESR	erythrocyte sedimentation rate
ESRD	end-stage renal disease
FFR	fractional flow reserve
FiO ₂	fraction of inspired oxygen
FMD	fibromuscular dysplasia
GFR	glomerular filtration rate
GI	gastrointestinal
GPI	glycoprotein IIb–IIIa inhibitor
Hb	hemoglobin
HbA1c	glycosylated hemoglobin
HCM	hypertrophic cardiomyopathy
HCTZ	hydrochlorothiazide
HDL	high-density lipoprotein
HF	heart failure
HFpEF	heart failure with preserved ejection fraction
HFrfEF	heart failure with reduced ejection fraction
HIT	heparin-induced thrombocytopenia
HIV	Human immunodeficiency virus
HOCM	hypertrophic obstructive cardiomyopathy
HR	heart rate
hs-CRP	high sensitivity C-reactive protein test
HTN	hypertension
IABP	intra-aortic balloon pump
ICD	implantable cardioverter defibrillator
ICU	intensive care unit

INR	international normalized ratio
IV	intravenous or intravenously
IVC	inferior vena cava
IVC-	isovolumic contraction
IVCT	isovolumic contraction time
IVR	isovolumic relaxation
IVRT	isovolumic relaxation time
IVUS	intravascular ultrasound
JVD	jugular venous distension
JVP	jugular venous pressure
K	potassium
LA	left atrium
LAA	left atrial appendage
LAFB	left anterior fascicular block
LAD	left anterior descending artery
LAO	left anterior oblique
LBBB	left bundle branch block
LCx	left circumflex coronary artery
LDL	low-density lipoprotein
LHC	left heart catheterization and coronary angiogram
LIMA	left internal mammary artery
LLSB	left lower sternal border
LM	left main
LMWH	low-molecular-weight heparin
LPFB	left posterior fascicular block
LV	left ventricle or left ventricular
LVAD	left ventricular assist device
LVEDD	left ventricular end-diastolic diameter
LVEDP	left ventricular end-diastolic pressure
LVEF	left ventricular ejection fraction
LVESD	left ventricular end-systolic diameter
LVH	left ventricular hypertrophy
LVOT	left ventricular outflow tract
MAP	mean arterial pressure
MAT	multifocal atrial tachycardia
MET	metabolic equivalent of task
mph	miles per hour
MI	myocardial infarction
MR	mitral regurgitation
MRA	magnetic resonance angiography
MRI	magnetic resonance imaging
MS	mitral stenosis
MV	mitral valve
MV O ₂	mixed venous oxygen saturation
MVA	mitral valve area
MVP	mitral valve prolapse
MVR	mitral valve replacement
Na	sodium
NO	nitric oxide
NSAID	non-steroidal anti-inflammatory drug
NSTEMI	non-ST-segment elevation myocardial infarction
NSVT	non-sustained ventricular tachycardia
NT pro-BNP	amino-terminal pro-brain natriuretic peptide
NTG	nitroglycerin
NYHA	New York Heart Association
OCT	optical coherence tomography
OM	obtuse marginal branch of the left circumflex
P	pressure
PA	pulmonary arterial or pulmonary artery
PA O ₂	pulmonary arterial oxygen saturation
PAC	premature atrial complex
PaCO ₂	partial pressure of carbon dioxide in arterial blood
PAD	peripheral arterial disease

PAH	pulmonary arterial hypertension
PAI	plasminogen activator inhibitor
PaO ₂	arterial oxygen pressure
P _A O ₂	alveolar oxygen pressure
PCI	percutaneous coronary intervention
PCSK9	Proprotein convertase subtilisin/kexin type 9
PCWP	pulmonary capillary wedge pressure
PDA	patent ductus arteriosus
PDA	posterior descending artery branch of the right coronary artery or left circumflex
PE	pulmonary embolism
PEA	pulseless electrical activity
PET	positron emission tomography
PFO	patent foramen ovale
PFT	pulmonary function testing
PH	pulmonary hypertension
PHT	pressure half-time
PISA	proximal isovelocity surface area
PJRT	permanent junctional reciprocating tachycardia
PLB	posterolateral ventricular branches of the right coronary artery or left circumflex
PM	pacemaker
PMBV	percutaneous mitral balloon valvuloplasty
PMT	pacemaker-mediated tachycardia
PND	paroxysmal nocturnal dyspnea
POTS	postural orthostatic tachycardia syndrome
PPD	purified protein derivative for <i>Mycobacterium tuberculosis</i>
PPI	proton pump inhibitor
PPM	patient/prosthesis mismatch
PR	pulmonic regurgitation
PS	pulmonic stenosis
PT	posterior tibial artery
PTT	partial thromboplastin time
PV loop	pressure–volume loop
PV O ₂	pulmonary venous oxygen saturation
PVARP	post-ventricular atrial refractory period
PVC	premature ventricular complex
PVR	pulmonary vascular resistance
PW	pulsed wave Doppler
Qp	pulmonary blood flow
Qs	systemic blood flow
QTc	corrected QT interval
RA	right atrium
RAAS	renin-angiotensin-aldosterone system
RAO	right anterior oblique
RAS	renal artery stenosis
RBBB	right bundle branch block
RCA	right coronary arteryRHC right heart catheterization
RIMA	right internal mammary artery
rPA	reteplase
rpm	revolutions per minute
r-tPA	recombinant tissue plasminogen activator
RUSB	right upper sternal border
RV	right ventricle/ventricular
RVAD	right ventricular assist device
RVEDP	right ventricular end-diastolic pressure
RVH	right ventricular hypertrophy
RVOT	right ventricular outflow tract
SA	sinoatrial
SA O ₂	systemic arterial oxygen saturation
SAM	systolic anterior motion
SaO ₂	arterial oxygen saturation
SBE	subacute bacterial endocarditis
SBP	systolic blood pressure
SCD	sudden cardiac death

SIRS	systemic inflammatory response syndrome
SFA	superficial femoral artery
SNRT	sinus node reentrant tachycardia
SPECT	single photon emission computed tomography (nuclear imaging)
SQ	subcutaneously
STEMI	ST-segment elevation myocardial infarction
STS	Society of Thoracic Surgeons
SV	stroke volume
SVC	superior vena cava
SVG	saphenous venous graft
SvO ₂	mixed venous oxygen saturation
SVR	systemic vascular resistance
SVT	supraventricular tachycardia
TAA	thoracic aortic aneurysm
TdP	torsades de pointes
TEE	transesophageal echocardiogram
TGA	transposition of great arteries
TIA	transient ischemic attack
TID	transient ischemic dilatation
TR	tricuspid regurgitation
TSH	thyroid stimulating hormone
TTE	transthoracic echocardiogram
UA	unstable angina
UFH	unfractionated heparin
VAD	ventricular assist device
V/Q scan	lung ventilation/perfusion scan
VF	ventricular fibrillation
VLDL	very-low-density lipoprotein
Vp	velocity of propagation
VSD	ventricular septal defect
VSR	ventricular septal rupture
VT	ventricular tachycardia
VTI	velocity-time integral
WPW	Wolff–Parkinson–White

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