

Index

a

- abnormal rhythms, hemodynamics
 - of 15–18
- ACIST system, power injection
 - transducer performance 151
- ACS *see* acute coronary syndromes
- acute aortic insufficiency 104–107, 109–112
- acute coronary syndromes (ACS)
 - fractional flow reserve 324–325
 - see also* coronary stenosis
- acute left ventricular failure, shock
 - due to 404–405
- acute myocardial infarction (AMI)
 - pressure–volume loops 7
 - right ventricular ischemia 235–248
 - ventricular failure 13–14
- acute right ventricular failure
 - core concepts 13–14
 - mechanical support 242–244
 - shock due to 405–406
 - see also* right ventricular infarction
- adenosine, coronary vasodilatory
 - flow reserve 336–337
- adult congenital anomalies
 - 361–378
 - atrial septal defect 367–371
 - case studies 367–375
 - common forms 376–377
 - Ebstein's 363–364
 - intracardiac shunts 364–371
 - preductal coarctation of aorta 371–372, 376
 - ventricular septal defects 372–375, 376
- advanced imaging techniques
 - restrictive cardiomyopathies 227–228, 233
 - see also* computed tomography; Doppler echocardiography; magnetic resonance imaging; non-invasive assessment
- alcohol-induced septal ablation
 - hypertrophic obstructive cardiomyopathy 165, 181–191
 - case study 188–191
 - comparative efficacy 186–188
 - complications 188
 - methodologies 181–183
 - Valsalva maneuver 183–186
- LVOT obstruction 165
- allograft rejection, pericardial
 - disease 209–211
- AMI *see* acute myocardial infarction
- amyloidosis, restrictive
 - cardiomyopathies 222–223, 232
- anatomic–pathophysiological
 - assessment 411–426
 - bedside evaluations 420
 - depressed cardiac output 421–423
 - diastole/systole and compliance 413
 - dyspnea 416–420
 - general examination approaches 415–416
 - low output/hypotension 420
 - mechanical functions 412–413
 - myocardial abnormalities 415
 - pericardial disease 415
 - preload assessment 420–422
 - right-heart failure 423–426
 - valvular pathophysiology 415
 - venous circulation 413–414
 - waveforms 414
- angina, nitroglycerin 60–61
- aortic end-diastolic pressure 7, 105–106
- aortic insufficiency *see* aortic regurgitation
- aortic preductal coarctation 371–372, 376
- aortic pressure
 - aortic regurgitation 108–109
 - cardiac rhythms 89–90
 - nitroglycerin 61–62
- aortic regurgitation (AR) 101–117
 - acute 104–107, 109–112
 - with aortic stenosis 91, 112–116
 - chronic 101–104
 - dyspnea 418
 - episodic 29
 - grading 107
 - invasive assessment 107–108
 - key points 116
 - late-rising central pressures 29–32
 - with mitral regurgitation 148
 - natural history 104
 - paravalvular, post TAVR 264–265, 271
 - peripheral pressure amplification 109
 - peripheral pulse amplification 104
 - post aortic root reconstruction 112–116
 - presentations of 108–109
 - transaortic valve replacement 264–266, 271–272
 - valve area calculation 108
- aortic root reconstruction, post-operative stenosis and regurgitation 112–116

- aortic stenosis (AS) 81–100
 - with aortic regurgitation 91, 112–116
- artifacts 91
- cardiac rhythms 89–90
- disappearing gradients 88–89
- disappearing, hypertrophic obstructive cardiomyopathy 166–168
- Doppler echocardiography 82–83
- invasive assessment 83–85, 88–89
- low-flow, low-gradient 90–91
 - paradoxically severe 87–88
- transaortic valve replacement 263–264, 269
- mitral valve prostheses case 144–145
- with mitral valve stenosis 148–152
- nitroglycerin 60–61
- percutaneous balloon valvuloplasty 251–260
 - case studies 257–260
 - screening 251–257
- peripheral arterial wave summation 91–94
- post aortic root reconstruction 112–116
- pressure recovery 82
- prosthetic valves 94–98
- transaortic valve replacement 261–273
- types 81–82
- zero drift methods 91–94
- aortic valve area (AVA) 81, 83, 85–87, 108
- aortic valve prostheses 94–98
 - balloon mitral valvuloplasty 286–292
 - stenosis, with mitral prosthesis stenosis also 152–156
- AR *see* aortic regurgitation
- arrhythmias 67–78
 - atrial waveforms 69
 - first-degree A–V block 78
 - key points 78
 - low output/hypotension 420
 - pacemakers 73–78
 - premature ventricular contractions 67
 - QRS complexes 68–73
 - wide QRS 69–73
- arterial pressure, heterotopic transplantation 379–382
- arterial wall abutment, tip damping 344
- arterial waveforms
 - anatomic–pathophysiological assessment 414
 - concepts 5–6
 - summation 91–94
- artifacts
 - aortic stenosis 91
 - core concepts 25–27
 - differentiation 29–33
 - intramyocardial pressure 175
 - right-heart hemodynamics 21–25
 - transducer disequilibrium 32–33
- AS *see* aortic stenosis
- ASD *see* atrial septal defects
- atrial compensation, right ventricular ischemia 238–239, 244–245
- atrial fibrillation, coronary blood flow 331
- atrial pressure
 - heterotopic transplantation 384–385
 - ventricular electrograms 361–364
 - X and Y troughs 20
- atrial septal defects (ASD)
 - right-heart failure 425
 - with ventricular diastolic dysfunction 367–371
- atrial systole
 - pacemakers 76
 - V waves 38–39
- atrial waveforms
 - anatomic–pathophysiological assessment 413–414
 - arrhythmias 69
 - cardiac mechanical function 10–11
 - pacemaker activity 73–74
- atrioventricular (A–V) block
 - first degree, left ventricular pressure 78
 - right ventricular infarction 239
- Austin–Flint murmurs 104
- AVA *see* aortic valve area
- A–V block *see* atrioventricular block
- A waves
 - acute aortic insufficiency 109–112
 - concepts 4–5, 11
 - normal patterns 35–36
- b**
- backward heart failure, core concepts 14
- balloon dilation, mitral valvuloplasty 277–279
- bicuspid valvular aortic stenosis 81–82
 - see also* congenital valvular aortic stenosis
- bioprosthetic mitral valves 132–134
- bisferiens pulse 104
- bradycardia, right ventricular infarction 239
- brisk carotid waveforms, dyspnea 418
- bundle branch block
 - left ventricular end-diastolic pressure 46
 - parallel ventricular pressures 50–52
 - pulmonary stenosis 297
- c**
- calcific aortic stenosis 81
- calibration, pressure wave artifacts 23–25
- cancer, pericardial disease 213–217
- cardiac compliance
 - anatomic–pathophysiological assessment 413
 - core concepts 9–10
 - preload assessment 420–422
 - see also* compliance
- cardiac mechanical function
 - anatomic–pathophysiological assessment 412–413
 - atrial waveforms 10–11
 - tricuspid regurgitation 18–21
 - venous circulations 11–12
 - waveforms 3–5
- cardiac output (CO), core principles 4–5
- cardiac rhythms, aortic pressure gradients 89–90
- cardiac tamponade 199–217
 - allograft rejection 209–211
 - assessment of 207–208
 - atypical syndromes 206–207
 - case studies 209–217
 - Doppler echocardiography 203–204
 - hemodynamic effects 200–202
 - low-pressure 206

- malignant tumor-induced 213–217
 - pathophysiology 199–200
 - pericardiocentesis 208–209
 - phases 205
 - pulsus paradoxus 202–203, 211–213
- cardiopulmonary support (CPS) 389–392
- carotid waveforms
 - dyspnea 418–419
 - hypotension/low output 422–423
- catheter fling, pressure wave artifacts 23
- chest X-rays, restrictive cardiomyopathy differentiation 227
- chronic aortic insufficiency 101–104
- chronic pericardial compression 207
 - see also* cardiac tamponade; pericardial disease
- chronic right ventricular failure, core concepts 14
- cinefluoroscopy, mitral valve prostheses 135
- clinical outcomes
 - pulmonary balloon valvuloplasty 305
 - renal artery stenosis 359
- CO *see* cardiac output
- coarctation of the aorta 371–372, 376
- “common chamber” during diastole 9
- complete support devices 385
- compliance
 - anatomic–pathophysiological assessment 413
 - core concepts 9–10
 - pericardial 197–198
 - preload assessment 420–422
 - ventricular
 - hypertrophic obstructive cardiomyopathy 175–176
 - pacemakers 76–78
- complications
 - alcohol-induced septal infarction 188
 - left ventricular puncture 156–157
 - pulmonary balloon valvuloplasty 306
 - rheumatic mitral stenosis 148
 - right ventricular infarction 239–240
- computed tomography (CT), restrictive cardiomyopathy differentiation 227–228
- conduction abnormalities
 - bundle branch block 46, 50–52, 297
 - left ventricular end-diastolic pressure 45–46
 - parallel ventricular pressures 50–52
- congenital anomalies 361–378
 - atrial septal defects 367–371
 - case studies 367–375
 - common forms 376–377
 - Ebstein’s 363–364
 - intracardiac shunts 364–371
 - preductal coarctation of aorta 371–372, 376
 - ventricular septal defects 372–375
- congenital heart disease, pulmonary balloon valvuloplasty 303–305
- congenital valvular aortic stenosis 81–82
 - see also* bicuspid valvular aortic stenosis
- congestive heart failure
 - double prosthetic valve stenosis 152–156
 - left ventricular end-diastolic pressure 44–45
- constrictive pericarditis (CP)
 - algorithmic differentiation 232–233
 - non-invasive assessment 227–228
 - respiratory oscillations 223, 225–227
 - restrictive cardiomyopathy differentiation 219–234
 - ventricular pressures 224–225, 230–231
- co-pulsation, heterotopic transplantation 382–383
- CORAL study 350
- coronary artery, fractional flow reserve 313–314
- coronary blood flow 311–348
 - atrial fibrillation 331
 - case studies 341–344
 - catheter tip pressures 341–344
 - Doppler velocimetry 328–334
 - fractional flow reserve 312–328
- nitroglycerin 59–60
- resistance 311–313
- respiratory oscillations 330–331
- thermodilution technique 336
- vasodilatory flow reserve 311, 326–328, 334–340
- ventricular tachycardia 331–334
- coronary stenosis
 - acute syndromes 324–325
 - catheter tip pressures 341–344
 - coronary vasodilatory flow reserve 326–328
 - diffuse coronary disease 323
 - Doppler velocimetry 328–334
 - fractional flow reserve 312–328
 - hyperemic evaluation 336–340
 - instantaneous wave-free pressure ratios 314–316
 - intermediately severe 317–319
 - “jailed” side branches 323–324
 - microvascular disease 340
 - morphology 312–313
 - multivessel disease 319–321
 - nonhyperemic indices of severity 314–316
 - pressure loss 311–312
 - serial lesions 322–323
 - thermodilution technique 336
 - vasodilatory flow reserve 311, 326–328, 334–340
- coronary vasodilatory flow reserve (CFR) 334–340
 - damping 342–344
 - definition 311
 - heart rate 336
 - hyperemic evaluation 336–340
 - microvascular disease 340
 - myocardial perfusion imaging 316–317
 - normal variation 335–336
 - post-myocardial infarction 326–328
 - thermodilution technique 336
 - ventricularization 341–344
- Corrigan’s pulse 104, 109
- counter-pulsation, heterotopic transplantation 382–383
- CPS *see* cardiopulmonary support
- Cui mean mitral valve gradient calculation 131–132
- C waves, core concepts 17

d

damping, coronary blood flow
measurement 342–344

data collection
aortic regurgitation 107–108
aortic stenosis 82–85, 88–89,
91–94, 251–260
artifacts 29–33
Doppler velocimetry 329
methodology 27–29
parallel ventricular pressures 49
prosthetic aortic valve assessment
94–98
transducer disequibration 32–33

DDD pacing *see* dual-chamber pacing

decrecendo diastolic murmur, aortic
insufficiency 104

degenerative aortic stenosis 81
see also calcific aortic stenosis

deMusset's sign 104, 109

depressed cardiac output, anatomic–
pathophysiological assessment
421–423

depressed carotid waveforms,
dyspnea 418

diastolic dysfunction, definition
9–10

diastolic function
anatomic–pathophysiological
assessment 413
“common chamber” 9
concepts 4, 5
core concepts 9–10
Frank–Starling relationship 9–10
hypertrophic obstructive
cardiomyopathy 175–176
parallel ventricular interactions 14
pericardial pressure 198–199
phases 9
transaortic valve replacement
264–266, 270, 272

diastolic murmur, pulmonary stenosis
163–164, 298–299

diastolic pressure, generation 9–10

diastolic suction, left ventricle 8

differential diagnosis
anatomic–pathophysiological
approach 411–426
left ventricular end-diastolic
pressure 43–46
pulmonary hypertension 425–426
restrictive cardiomyopathies
219–234
right ventricular infarction 244

differentiation
preload and filling pressures 10
pressure wave artifacts 29–33

diffuse coronary disease, fractional
flow reserve 323

“dip and plateau” patterns, restrictive
cardiomyopathies 220–222

dipyridamole, coronary vasodilatory
flow reserve 337–338

disappearing aortic stenosis,
hypertrophic obstructive
cardiomyopathy 166–168

disappearing gradients, aortic
stenosis investigations 88–89

disequibration, transducers 32–33

distensibility, peripheral arterial
tree 5, 7

dobutamine
balloon mitral valvuloplasty
284–286
coronary vasodilatory flow
reserve 338

dopamine, renal artery flow 349, 352

Doppler echocardiography
aortic stenosis 82–83
cardiac tamponade 203–204
mitral valve area 127
prosthetic aortic valves 97
pulmonary stenosis and
insufficiency 297–298
restrictive cardiomyopathy
differentiation 227, 233
transaortic valve replacement
261–273

Doppler velocimetry
atrial fibrillation 331
coronary blood flow 328–334
flow reserve 335–336
principles 328–329
respiratory oscillations 330–331
signal components 329–330
ventricular tachycardia 331–334

double prosthetic valve stenosis, left
ventricular puncture
assessment 152–156

dual-chamber pacing (DDD pacing),
hypertrophic obstructive
cardiomyopathy 177–181,
186–187

Duroziez's sign 104, 109

dynamic left ventricular outflow tract
gradients, causes of 171–175

dyspnea evaluation 416–420

dyssynchrony, pacemakers 74–76

e

Ea *see* effective arterial resistance

Ebstein's anomaly 363–364

EDP *see* end-diastolic pressure

Edwards Sapien bioprosthesis
261–273

effective arterial resistance (Ea),
principles 7

effective orifice area (EOA), aortic
stenosis 81

effusion
malignant tumors 213–217
pericardial disease 206–208,
213–217
see also cardiac tamponade

effusive-constrictive pericarditis
206–207

elastic constriction, pericardial
disease 207

electrocardiograms (ECGs)
anatomic–pathophysiological
assessment 413–414

arrhythmias 68–69

pulmonary stenosis 160–162,
295–297

Wiggers diagrams 4–5
see also A waves; P waves; QRS
complexes; S waves; T waves;
V waves

E_{max} *see* left ventricular
contractility

end-diastolic pressure (EDP)
constrictive pericarditis
vs. restrictive
cardiomyopathies 224
core concepts 9

end-systolic pressure–volume (ESPV)
point 7

end-systolic pressure–
volume relationship
(ESPVR) 7

EOA *see* effective orifice area

epicardial coronary arteries 311

episodic aortic insufficiency 29

ESPV *see* end-systolic pressure–
volume point

ESPVR *see* end-systolic pressure–
volume relationship

excessive catheter fling 23

exercise
left ventricular assist devices
385–389
mitral valve stenosis 136
normal cardiac function 12

“extra” hearts 379–399
 cardiopulmonary bypass
 389–392
 heterotopic transplantation
 379–385
 left ventricular assist devices
 385–389
 mechanical circulatory support
 devices 392–398

f

FA *see* femoral arterial pressure
 Fallot’s tetralogy 377
 FAME study 320
 FAME II study 320–321
 felodipine, renal artery stenosis
 349–350
 femoral arterial (FA) pressure, aortic
 regurgitation 104–105,
 108–109
 fenoldopam, renal artery flow 352
 “fern” patterns 37
 FFR *see* fractional flow reserve
 filling pressure, preload 10
 first-degree atrioventricular block,
 left ventricular pressure 78
 forward failure, core concepts
 12–14
 fractional flow reserve (FFR)
 312–328
 clinical applications 316–324
 coronary artery 313–314
 diffuse coronary disease 323
 guidewire pressure measurement
 312–314
 intermediately severe angiographic
 stenosis 317–319
 intracoronary pressure
 312–316
 intravascular imaging 317
 “jailed” side branches 323–324
 left main coronary artery disease
 321–322
 multivessel disease 319–321
 myocardial perfusion imaging
 316–317
 ostial lesions 323–324
 renal artery stenosis 350, 353,
 355–356
 safety 319
 serial lesions 322–323
 STEMI patients 324–325
 Frank–Starling relationship 5, 9–10
 functional preload, definition 9

g

general cardiovascular
 examination 415–416
 glomerular circulation, renal artery
 stenosis 349–350
 Gorlin equation 85–87, 124
 gradient augmentation, hypertrophic
 obstructive cardiomyopathy
 168–170
 grading, aortic regurgitation 107
 guidewire pressure measurement,
 fractional flow reserve
 312–314

h

heart failure
 backward 14
 diastolic function 10
 ejection fractions and diastolic
 function 10
 forward 12–14
 heart rate
 coronary vasodilatory flow
 reserve 336
 mitral stenosis 291–292
 mitral valve area
 determination 127
 heterotopic transplantation
 379–385
 arterial pressure 379–382
 atrial pressure 384–385
 co-pulsation/counter-pulsation
 382–383
 Hill’s sign 104
 HOCM *see* hypertrophic obstructive
 cardiomyopathy
 HSPG *see* hyperemic systolic pressure
 gradients
 hyperemia
 coronary vasodilatory flow
 reserve 336–340
 microvascular disease 340
 renal artery stenosis 349–353
 hyperemic systolic pressure gradients
 (HSPG), renal artery stenosis
 349, 352, 354–359
 hypertension, parallel ventricular
 pressures 49–50
 hypertrophic obstructive
 cardiomyopathy (HOCM)
 165–193
 alcohol-induced septal infarction
 181–191
 diastolic function 175–176

disappearing aortic stenosis
 166–168
 dual-chamber pacing 177–181,
 186–187
 dynamic gradients, causes of
 171–175
 intracavitary pressure difference
 initiation 168–170
 preload alterations 170–171
 Valsalva maneuver 177–181,
 183–186
 hypertrophy, left ventricular end-
 diastolic pressure 43–44, 46
 hypotension
 anatomic–pathophysiological
 assessment 412, 420
 bedside evaluation 420

i

IABP *see* intra-aortic balloon pumps
 iFR *see* instantaneous wave-free
 pressure ratios
 Impella hemodynamic support system
 392–394, 396, 405–406
 IMR *see* index of microvascular
 resistance
 index of microvascular resistance
 (IMR) 340
 indocyanine green dye dilution
 364–367
 Inoue balloon technique, mitral
 valvuloplasty 278–279
 instantaneous wave-free pressure
 ratios (iFR) 314–316
 intermediately severe angiographic
 stenosis 317–319
 intra-aortic balloon pumps
 (IABP) 392–394, 396
 intracardiac shunts 364–377
 atrial septal defects 367–371
 post-operative ventricular
 tachycardia 372–375
 preductal coarctation of aorta
 371–372
 intracavitary pressure difference
 initiation 168–170
 intracoronary pressure, fractional
 flow reserve 312–316
 intramyocardial pressure,
 intraventricular pressure
 gradients 175
 intrapericardial pressure (IPP)
 atrial waveforms 11
 respiratory oscillation 12

- intrapulmonary hypertension, core concepts 13
 - intrathoracic pressure (ITP)
 - anatomic–pathophysiological assessment 413
 - constrictive pericarditis vs. restrictive cardiomyopathies 223, 225–227
 - respiratory oscillations 11–12
 - intravascular imaging
 - fractional flow reserve 317
 - renal artery stenosis 352–353, 355–359
 - intravascular ultrasound (IVUS), renal artery stenosis 352–353, 355–359
 - intraventricular gradients, hypertrophic obstructive cardiomyopathy 170–171
 - intraventricular pressure gradients, intramyocardial pressure 175
 - invasive assessment
 - aortic regurgitation 107–108
 - aortic stenosis 83–85
 - balloon mitral valvuloplasty 275–277
 - dyspnea 419–420
 - intracardiac shunts 364–367
 - mitral regurgitation 136–138
 - percutaneous balloon aortic valvuloplasty 251–260
 - prosthetic aortic valves 97
 - pulmonary stenosis 295–296
 - renal artery stenosis 349–359
 - right-heart failure 421, 426
 - shock 401–407
 - transaortic valve replacement 261–273
 - IPP *see* intrapericardial pressure
 - ischemia, nitroglycerin 59–60
 - ischemic right-heart dysfunction 235–248
 - atrial compensation 238–239
 - ventricular 235–238
 - see also* right ventricular infarction
 - isovolumetric force, principles 5
 - isovolumetric relaxation period, concepts 4
 - isovolumic relaxation, concepts 9
 - ITP *see* intrathoracic pressure
 - IVUS *see* intravascular ultrasound
- j**
- “jailed” side branches, fractional flow reserve 323–324
 - jugular pulse, diagnostic features 19
 - jugular venous pressure (JVP) 423–426
 - JVP *see* jugular venous pressure
- k**
- Kussmaul’s sign 22–23
- l**
- large A waves, acute aortic insufficiency 109–112
 - latency, ACIST system power injection transducers 151
 - late-rising central aortic pressures, differentiation 29–32
 - Law of Laplace 5
 - left anterior descending (LAD) artery, post-operative shock 401–403
 - left atria 35–42
 - A waves, normal 35–36
 - dyspnea evaluation 417
 - mitral regurgitation 38
 - PCWP/LVEDP correspondence 36–37
 - V waves
 - alternans 40
 - mitral regurgitation 38
 - morphology 39–40
 - normal 35–36
 - size of 37–38
 - systole 38–39
 - left atrial pressure, mitral stenosis 130–131, 136
 - left bundle branch block
 - left ventricular end-diastolic pressure 46
 - parallel ventricular pressures 50
 - left heart inflow obstruction 421–422
 - left main coronary artery disease, fractional flow reserve 321–322
 - left ventricle (LV), rotational mechanics 8–9
 - left ventricular afterload, low output 422
 - left ventricular assist devices (LVAD) 385–389, 392–394, 396, 405–406
 - left ventricular contractility (E_{max}) 7, 422
 - left ventricular diastolic dysfunction
 - dyspnea evaluation 418
 - relaxation impairment 175–177
 - left ventricular end-diastolic pressure (LVEDP) 43–47
 - acute myocardial infarction 7
 - aortic regurgitation 102, 105–107
 - in comparison to RVEDP 44–46
 - concepts 4
 - CP vs. RCM 224
 - differential diagnosis 43–46, 224
 - factors influencing 46
 - mean left ventricular pressure calculation 131
 - PCWP correspondence 36–37
 - pericardial pressure 198–199
 - transaortic valve replacement 262–263, 268
 - ventricular filling 10
 - left ventricular end-diastolic volume (LVEDV), aortic regurgitation 102
 - left ventricular failure
 - preload assessment 421–422
 - shock 404–405
 - left ventricular hypertrophy, left ventricular end-diastolic pressure 43–44, 46
 - left ventricular outflow tract (LVOT) obstruction
 - alcohol-induced septal infarction 181–191
 - augmentation 168–170
 - dual-chamber pacing 177–181, 186–187
 - dynamic 171–175
 - hypertrophic obstructive cardiomyopathy 165–193
 - mechanical treatments 165, 186–188
 - prosthetic aortic valves 94–98
 - repaired ventricular septal defects 373–375
 - septal myectomy 187
 - left ventricular pressure
 - atrial systole, pacemakers 76
 - constrictive pericarditis vs. restrictive cardiomyopathies 224–225
 - first-degree A–V block 78
 - pericardial pressure 198–199

- right ventricular pressure
 - interactions 49–65
 - see also* parallel ventricular interactions
 - see also* left ventricular end-diastolic pressure
 - left ventricular puncture
 - complications of 156–157
 - double prosthetic stenosis
 - assessment 152–156
 - left ventricular systolic dysfunction, right ventricular infarction 240–242
 - low-flow, low-gradient aortic stenosis 90–91
 - paradoxically severe 87–88
 - transaortic valve replacement 263–264, 269
 - low output
 - anatomic–pathophysiological assessment 412, 420
 - bedside evaluation 420
 - low-pressure cardiac tamponade 206
 - lusitropic function *see* isovolumic relaxation
 - LV *see* left ventricle
 - LVAD *see* left ventricular assist devices
 - LVEDP *see* left ventricular end-diastolic pressure
 - LVEDV *see* left ventricular end-diastolic volume
 - LVOT *see* left ventricular outflow tract
- m**
- magnetic resonance imaging (MRI)
 - renal artery stenosis 354
 - restrictive cardiomyopathy
 - differentiation 227–228
 - malignant tumors, cardiac
 - tamponade 213–217
 - MAP *see* mean arterial pressure
 - MCS *see* mechanical circulatory support devices
 - mean arterial pressure (MAP), pulse amplification 6–7
 - mean mitral valve gradient (MVG)
 - simple calculation of 131–132
 - see also* mitral valve area
 - mechanical aortic valves, balloon
 - mitral valvuloplasty 286–292
 - mechanical circulatory support devices (MCS) 392–398
 - mechanical mitral valves
 - construction 134
 - dysfunctions 135–138
 - mechanical support, right ventricular
 - infarction 242–244
 - mechanical treatments, LVOT
 - obstruction 165, 186–188
 - methodologies
 - aortic regurgitation 107–108
 - aortic stenosis measurement 82–85, 88–89, 91–94
 - Doppler velocimetry 329
 - intracardiac shunt diagnosis 364–367
 - parallel ventricular pressures 49
 - percutaneous balloon mitral valvuloplasty 275–279
 - prosthetic aortic valve
 - assessment 97
 - transluminal alcohol septal ablation for HOCM 181–183
 - MIBI-SPECT
 - multivessel disease 319–321
 - STEMI patients 324–325
 - microcirculatory resistance 311, 340
 - mitral regurgitation
 - with aortic regurgitation 148
 - balloon mitral valvuloplasty 280–281, 283
 - invasive assessment 136–138
 - left ventricular end-diastolic pressure 44–45
 - with mitral stenosis 124, 148
 - percutaneous balloon aortic valvuloplasty 259–265
 - repaired ventricular septal defects 372–375
 - transaortic valve replacement 263, 266, 269, 273
 - V waves 38
 - mitral stenosis 119–141
 - 2D echocardiographic
 - planimetry 127
 - anatomic–pathophysiological assessment 417–418
 - with aortic stenosis 148–152
 - balloon valvuloplasty 275–294
 - balloon dilation 277–279
 - case studies 281–283
 - dobutamine stress
 - testing 284–286
 - mechanical aortic valve patient
 - study 286–292
 - pulmonary capillary wedge
 - pressure 283–285
 - screening 275–277
 - Doppler echocardiography 127
 - dyspnea evaluation 417–418
 - heart rate 291–292
 - left atrial pressure vs PCWP 130–131, 136
 - parallel ventricular pressures 53–54
 - pathophysiology 124
 - pressure half-time methods 126–127
 - prostheses 132–138, 143–148
 - pulsus alternans 127–130
 - with regurgitation 124, 148
 - simplified gradient method 131–132
 - valve area calculation 123–127
 - V waves 119–122
- mitral valve area
- balloon mitral valvuloplasty 275–279, 284–286, 292
 - calculation 123–127, 131–132
 - Doppler echocardiography 127
 - echocardiographic
 - planimetry 127
 - heart rate 127
 - pressure half-time methods 126–127
 - simplified gradient method 131–132
- mitral valve prostheses 132–138, 143–148, 152–156
- dysfunction assessment 135–138, 145–148
 - failure mechanisms 135
 - post-operative multiple heart murmurs 143–148
 - stenosis, with aortic prosthetic stenosis also 152–156
 - types 134
- mixed venous oximetry 365
- moniker pulsus paradox 12
- morphology, coronary stenosis 312–313
- “M” patterns, restrictive cardiomyopathies 222
- MRI *see* magnetic resonance imaging
- Muller’s sign 104, 109

multivalvular regurgitant lesions 143–158
 double prosthetic valve stenosis 152–156
 left ventricular puncture assessment 152–156
 mitral valve prostheses 143–148
 native aortic and mitral stenosis 148–152
 surgical outcomes 148
 multivessel disease, fractional flow reserve 319–321
 muscular septal defects, intracardiac shunts 365
 MVG *see* mean mitral valve gradient
 myocardial ischemia
 anatomic–pathophysiological assessment 415
 left ventricular assist devices 385–389
 nitroglycerin 59–60
 myocardial perfusion imaging, fractional flow reserve 316–317

n

nitroglycerin 56–63
 aortic pressure waveforms 61–62
 aortic stenosis 60–61
 coronary blood flow 59–60
 coronary vasodilatory flow reserve 338
 effects of 56–59
 hypertrophic obstructive cardiomyopathy 170–171
 non-hemodynamic investigations 415–416, 420
 non-invasive assessment
 aortic stenosis 82–83
 mitral regurgitation 136–137
 prosthetic aortic valve assessment 97
 renal artery stenosis 354
 restrictive cardiomyopathies 227–228, 233
 transaortic valve replacement 261–273
see also individual methods...
 normal carotid waveforms, dyspnea 419

o

Ohm's law 3
 oscillations, respiratory 11–12

ostial lesions, fractional flow reserve 323–324
 ostium primum/secundum 376
 overdamped waveforms 26–27
 oximetry, intracardiac shunt diagnosis 364–365

p

pacemakers
 arrhythmias 73–78
 atrial systole 76
 atrial waveforms 73–74
 dyssynchrony 74–76
 hypertrophic obstructive cardiomyopathy 177–181, 186–187
 parallel ventricular pressures 52–53
 ventricular compliance 76–78
 papaverine
 coronary vasodilatory flow reserve 340
 renal artery flow 352
 paradoxically severe aortic stenosis 87–88
 paradoxical pulse 12
 parallel ventricular pressures 49–65
 bundle branch block 50–52
 conduction abnormalities 50–52
 hypertension 49–50
 interactions 14–15
 key points 63
 measurement methodology 49
 mitral stenosis 53–54
 nitroglycerin 56–63
 pacemaker pressure responses 52–53
 pericardial pressure 198–199
 pulsus alternans 54–56
 paravalvular aortic regurgitation, transaortic valve replacement 264–265, 271
 paricardial compliance 197–198
 paricardium, anatomy 197–199
 partial support devices 385
 PASP *see* pulmonary artery systolic pressure
 patent ductus arteriosus (PDA) 376
 pathophysiology
 acute aortic insufficiency 105–107
 cardiac tamponade 199–200
 chronic aortic insufficiency 101–104

mitral stenosis 124
 restrictive cardiomyopathies 220–223
 PBAV *see* percutaneous balloon aortic valvuloplasty
 PBMV *see* percutaneous balloon mitral valvuloplasty
 PBV *see* pulmonary balloon valvuloplasty
 PCI *see* percutaneous coronary intervention
 PCWP *see* pulmonary capillary wedge pressure
 PDA *see* patent ductus arteriosus
 percutaneous balloon aortic valvuloplasty (PBAV) 251–274
 case studies 257–260
 key points 273
 mitral regurgitation reduction 259–265
 principles 251
 screening 251–257
 very elderly patient case study 257–259
 percutaneous balloon mitral valvuloplasty (PBMV) 275–294
 balloon dilation 277–279
 case studies 280–292
 dobutamine stress testing 284–286
 Inoue technique 278–279
 key points 292
 mechanical aortic valve patient study 286–292
 mitral regurgitation 280–281, 283
 mitral stenosis case studies 281–283
 pulmonary capillary wedge pressure 283–285
 screening 275–277
 percutaneous coronary intervention (PCI), multivessel disease 319–321
 pericardial disease 197–218
 allograft rejection 209–211
 anatomic–pathophysiological assessment 415
 assessment of 207–208
 atypical compression syndromes 206–207
 case studies 209–217
 Doppler echocardiography 203–204

- malignant tumors 213–217
 - pericardiocentesis 208–209
 - pulsus paradoxus 202–203, 211–213
 - see also* cardiac tamponade
- pericardial pressure, ventricular diastole 198–199
- pericardiocentesis 208–209
- peripheral amplification, concepts 6–7
- peripheral arterial tree, distensibility 5, 7
- peripheral arterial wave summation, aortic stenosis 91–94
- peripheral pressure amplification, aortic regurgitation 109
- peripheral pulse amplification, aortic regurgitation 104
- persistent arterial ducts, coarctation of aorta 371–372
- porcine mitral valves 132–134, 143–148
- portable cardiopulmonary bypass 389–392
- post-capillary pulmonary hypertension, core concepts 14
- post-myocardial infarction, flow reserve measurements 326–328
- post-operative assessment
 - aortic root reconstruction 112–116
 - aortic valve prostheses 94–98
- power injection transducers, ACIST system performance 151
- precapillary pulmonary hypertension 13, 311
- preductal coarctation of aorta 371–372
- preload
 - compliance properties 420–422
 - diastolic function 9–10
 - filling pressures 10
 - hypertrophic obstructive cardiomyopathy 170–171
 - nitroglycerin 58–59
- premature ventricular contractions (PVCs), arrhythmias 67
- pressure damping, coronary blood flow 342–344
- pressure gradients, renal artery stenosis 349–352
- pressure half-time methods, mitral valve area 126–127
- pressure loss, coronary stenosis 311–312
- pressure recovery
 - aortic stenosis 82
 - transaortic valve replacement 263, 268
- pressure ventricularization, coronary blood flow 341–344
- pressure–volume (PV) loops 7–8
- pressure–volume (P–V) relationships, V waves 37–38
- pressure wave artifacts
 - calibration 23–25
 - core concepts 25–27
 - differentiation 29–33
 - intramyocardial pressure 175
 - right-heart hemodynamics 21–25
- prosthesis–patient mismatch, aortic valves 98
- prosthetics
 - aortic root reconstruction 112–116
 - aortic valves
 - balloon mitral valvuloplasty 286–292
 - left ventricular outflow tract gradients 94–98
 - patient mismatches 98
 - stenosis, with mitral prosthesis stenosis also 152–156
- double stenosis, left ventricular puncture assessment 152–156
- mitral valves 132–138
 - dysfunction assessment 135–138, 145–148
- porcine 132–134, 143–148
- stenosis, with mitral prosthesis stenosis also 152–156
- pulmonary artery systolic pressure (PASP), restrictive cardiomyopathies 230–231
- pulmonary balloon valvuloplasty (PBV) 299–306
 - case studies 300–305
 - clinical outcomes 305
 - complications 306
 - key points 306
 - repaired congenital heart disease study 303–305
 - residual gradients 305–306
- pulmonary capillary wedge pressure (PCWP)
 - aortic regurgitation 102, 106
 - balloon mitral valvuloplasty 283–285
 - concepts 10
 - dyspnea evaluation 416–417, 419–420
 - intracardiac shunts 365
 - LVEDP correspondence 36–37
 - main utility 35
 - mitral stenosis 130–131, 136
 - post-capillary pulmonary hypertension 14
 - transaortic valve replacement 261, 267
- pulmonary hypertension
 - differential diagnosis 425–426
 - forms of 13
- pulmonary insufficiency, with pulmonary stenosis 162–163, 297–298
- pulmonary stenosis 159–164, 295–306
 - balloon valvuloplasty 299–306
 - case studies 300–305
 - complications and outcomes of PBV 305–306
 - congenital 377
 - diastolic murmur and RVEDP 163–164, 298–299
 - ECG abnormalities 160–162, 296–297
 - key points 306
 - post-operative gradients 305–306
 - presentations of 159–160, 295–297
 - with pulmonary insufficiency 162–163, 297–298
- pulmonary valves 159–164
 - see also* pulmonary stenosis
- pulse amplification, concepts 6–7
- pulsus alternans
 - mechanisms of 55–56
 - mitral stenosis 127–130
- parallel ventricular pressures 54–56
- pulsus paradoxus 202–203, 211–213
- P–V *see* pressure–volume relationships
- PVCs *see* premature ventricular contractions
- PV loops *see* pressure–volume loops
- P waves, concepts 4

q

QRS complexes

- arrhythmias 68–73
- concepts 4
- heterotopic transplantation 382–383
- wide patterns 69–73
- Quincke's sign 104, 109

rRAS *see* renal artery stenosisRCA *see* right coronary artery

regadenoson, coronary vasodilatory flow reserve 340

relaxation impairment, left

- ventricular diastolic waveform abnormalities 175–177

renal artery stenosis (RAS) 349–360

- case studies 354–359
- clinical outcomes 359
- glomerular circulation 349–350
- key points 359
- practical tips 352–354
- pressure gradients 349–352

renin 349

repaired congenital heart disease,

- pulmonary balloon valvuloplasty 303–305

reperfusion, right ventricular

- infarction 239

residual gradients, pulmonary balloon

- valvuloplasty 305–306

resistance

- coronary blood flow 311–313
- low output/hypotension 420

respiratory oscillations

- anatomic–pathophysiological assessment 413–414
- coronary blood flow 330–331
- restrictive cardiomyopathies 223, 225–227, 230–231
- venous circulations 11–12

resting systolic pressure gradients

- (RSPG), renal artery stenosis 353–359

restrictive cardiomyopathies (RCM)

- algorithmic differentiation 232–233
- amyloidosis 222–223, 232
- criteria limitations 228–229
- differentiation 219–234
- from systemic illness 231–232
- noninvasive imaging 227–228, 233
- pathophysiology 220–223

respiratory oscillations 223, 225–227, 230–231

ventricular pressures 224–225

rheumatic mitral stenosis 148

RHF *see* right-heart failure

rhythm disorders, right ventricular infarction 239

right atria

- right ventricular ischemia 238–239, 244–245

systolic regurgitation 20

right atrial–right ventricular

- gradients, tricuspid valve dysfunction 21

right bundle branch block

- parallel ventricular pressures 51–52

pulmonary stenosis 297

right coronary artery (RCA), right

- ventricular ischemia 235–248

right-heart failure (RHF)

- abnormal rhythms 15–18
- fundamentals of 15–25
- invasive assessment 421, 426
- jugular venous pressure 423–426
- preload assessment 421
- pressure wave artifacts 21–25
- shock 405–406
- tricuspid regurgitation 18–21

right ventricles

- acute failure, core concepts 13–14
- chronic failure, core concepts 14
- right ventricular end-diastolic pressure (RVEDP) in comparison to LVEDP 44–46
- constrictive pericarditis vs. restrictive cardiomyopathies 224, 230–231
- pericardial pressure 198–199
- pulmonary stenosis 163–164, 298–299

right ventricular free wall (RVFW)

- dysfunction

acute myocardial infarction

- 235–238

core concepts 14–15

right ventricular hypertrophy,

- pulmonary stenosis 297

right ventricular infarction

- core concepts 13–14
- mechanical support 242–244
- right ventricular infarction (RVI) 235–248

acute ventricular dysfunction 236–238

atrial compensation and ischemia 238–239, 244–245

case studies 244–245

differential diagnosis 244

hemodynamic manifestations 245–247

left ventricular systolic dysfunction 240–242

mechanical complications 239–240

mechanical support 242–244

pulmonary stenosis 297

reperfusion 239

rhythm disorders 239

shock 405–406

right ventricular pressure

- constrictive pericarditis vs. restrictive cardiomyopathies 224–225

left ventricular pressure

- interactions 49–65
- see also* parallel ventricular interactions

pericardial pressure 198–199

preload assessment 421

rigid constriction, pericardial disease 207

“ringing” artifacts 23–25

rotational mechanics, left ventricle 8–9

RSPG *see* resting systolic pressure gradientsRVFW *see* right ventricular free wallRVI *see* right ventricular infarction**s**

safety, intracoronary lesion

- assessment 319

screening

- aortic stenosis, PBAV 251–257
- mitral stenosis, PBMV 275–277

septal-mediated ventricular

- interactions, core concepts 14–15

septal myectomy, hypertrophic

- obstructive cardiomyopathy 187

serial lesions, fractional flow

- reserve 322–323

severe left ventricular systolic dysfunction 240–242

severe right ventricular infarction 244

- shock
 - acute left ventricular failure 404–405
 - acute right-heart failure 405–406
 - invasive assessment 401–407
 - shunts 364–377
 - atrial septal defects 367–371
 - post-operative ventricular tachycardia 372–375
 - preductal coarctation of aorta 371–372
 - signal components, Doppler velocimetry 329–330
 - simultaneous right/left data collection 28–29
 - single pacing modes
 - dyssynchrony 74–76
 - ventricular compliance 76–78
 - single-photon emission computed tomography (SPECT)
 - multivessel disease 319–321
 - STEMI patients 324–325
 - sinus venosus 376
 - sodium nitroprusside 338–339
 - SPECT *see* single-photon emission computed tomography
 - “square root” patterns, restrictive cardiomyopathies 220–222
 - STEMI *see* ST-segment elevated myocardial infarctions
 - stenosis *see* aortic stenosis; coronary stenosis; mitral valve stenosis; renal artery stenosis; tricuspid valve stenosis
 - stenotic bioprosthetic mitral valves, evaluation of 132–138
 - stress, normal cardiac function 12
 - stroke volume (SV)
 - acute myocardial infarction 7
 - core concepts 4
 - low output/hypotension 420
 - ST-segment elevated myocardial infarctions (STEMI)
 - fractional flow reserve 324–325
 - right ventricular 240–242
 - subacute pericardial compression 207
 - see also* cardiac tamponade; pericardial disease
 - subaortic stenosis, repaired
 - ventricular septal defects 372–375
 - subvalvular aortic stenosis 81
 - supravalvular aortic stenosis 81
 - surgical myomectomy, LVOT obstruction 165, 188
 - SV *see* stroke volume
 - S waves, tricuspid regurgitation 19
 - systemic illness, restrictive cardiomyopathies 231–232
 - system resonance, pressure wave artifacts 26–27
 - systolic function
 - anatomic–pathophysiological assessment 413
 - atrial, V waves 38–39
 - concepts 5
 - parallel ventricular interactions 14
 - systolic regurgitation, right atria 20
 - systolic twist, left ventricle 8
- t**
- tachycardia, coronary vasodilatory flow reserve 336
 - Tandem Heart extracorporeal bypass system 392, 394–398
 - TASH *see* transluminal alcohol septal ablation for HOCM
 - TAVR *see* transaortic valve replacement
 - TEE *see* transesophageal echocardiography
 - tetralogy of Fallot 377
 - thermodilution technique, coronary vasodilatory flow reserve 336
 - Torricelli’s law 86
 - total blood volume, preload assessment 421
 - transaortic valve replacement (TAVR) 261–273
 - aortic regurgitation 264–266, 271–272
 - diastolic function 264–266, 270, 272
 - key points 274
 - low flow, low gradient aortic stenosis 263–264, 269
 - mitral regurgitation 263, 266, 269, 273
 - paravalvular aortic regurgitation 264–265, 271
 - pressure recovery 263, 268
 - transcatheter waveforms, transaortic valve replacement 261–273
 - transducer disequibration 32–33
 - transesophageal echocardiography (TEE)
 - mitral valve prostheses 135
 - transaortic valve replacement 262, 268
 - transiently wide pulse pressures, differentiation 29
 - transluminal alcohol septal ablation for HOCM (TASH) 181–191
 - case study 188–191
 - comparative efficacy 186–188
 - complications 188
 - methodologies 181–183
 - Valsalva maneuver 183–186
 - transplantation, allograft rejection 209–211
 - Traube’s sign 104, 109
 - tricuspid regurgitation
 - mitral valve prostheses 144
 - pulsatile venous waves 21
 - right atrial–right ventricular gradients 21
 - vena caval pressure 18–19
 - tricuspid valves, normal function 19–20
 - T waves, concepts 4
 - two-dimensional echocardiographic planimetry, mitral valve 127
- u**
- underdamped waveforms 26–27
- v**
- Valsalva maneuver
 - hypertrophic obstructive cardiomyopathy 177–181
 - intracardiac shunts 367
 - transluminal alcohol septal ablation for HOCM 183–186
 - valves
 - anatomic–pathophysiological assessment 415
 - aortic
 - area calculation 81, 85–87
 - prosthesis 94–98
 - basic functioning 5
 - see also* aortic... bicuspid... multivalvular regurgitant lesions; mitral...; pulmonary...; transaortic valve replacement; tricuspid...
 - valvular aortic stenosis 81
 - vascular resistance, low output/hypotension 420

vasodilation
 nitroglycerin 56–63
 renal artery flow 349, 352
 velocimetry, Doppler, coronary blood
 flow 328–334
 vena caval pressure, tricuspid
 regurgitation 18–19
 venous circulations
 anatomic–pathophysiological
 assessment 413–414
 cardiac mechanical function
 11–12
 pulsatile waves 21
 respiratory oscillations 11–12
 ventricles
 interactions 12–15
 pacemakers 76–78
 parallel interactions 14–15
 restrictive cardiomyopathies 220,
 230–231
 see also left ventricles; right
 ventricles
 ventricular compliance
 hypertrophic obstructive
 cardiomyopathy 175–176
 pacemakers 76–78
 ventricular diastolic dysfunction,
 with atrial septal defect
 367–371
 ventricular electrograms, atrial
 pressure 361–364

ventricular ischemia
 atrial compensation and
 ischemia 238–239, 244–245
 reperfusion 239
 right-sided 235–248
 see also right ventricular infarction
 ventricularization, coronary blood
 flow measurement 341–344
 ventricular septal defects (VSD)
 372–376
 ventricular tachycardia
 coronary blood flow 331–334
 repaired ventricular septal
 defects 372–375
 ventricular unloading,
 nitroglycerin 56–63
 ventricular waveforms
 anatomic–pathophysiological
 assessment 414
 concepts 5
 very elderly patients, percutaneous
 balloon aortic
 valvuloplasty 257–259
 VSD *see* ventricular septal defects
 VVI pacemakers
 dyssynchrony 74–76
 ventricular compliance 76–78
 V waves
 alternans 40
 atrial systole 38–39
 concepts 4–5

 factors influencing size 37–38
 mitral regurgitation 38
 mitral stenosis 119–122
 morphology 39–40
 normal patterns 35–36
 tricuspid regurgitation 19

W

water-hammer pulses 104
 waveforms, concepts 4–5
 Wiggers diagrams, core principles
 4–5

X

X descent 9
 atrial waveforms 11
 restrictive cardiomyopathies 222
 X-rays, restrictive cardiomyopathy
 differentiation 227
 X troughs, atrial pressure 20

Y

Y descent
 atrial waveforms 11
 restrictive cardiomyopathies 222
 Y troughs, atrial pressure 20

Z

zero drift, aortic stenosis 91–94
 Z point, left ventricular end-diastolic
 pressure 46