

Preface v Kathy E. Sietsema, Darryl Y. Sue, William W. Stringer, Susan A. Ward
Acknowledgments vii

- 1 Exercise Testing and Interpretation 1 Kathy E. Sietsema, William W. Stringer, Darryl Y. Sue, Susan A. Ward
- 2 Physiology of Exercise 8 Susan A. Ward, Harry B. Rossiter

Contributors ix

- 3 Measurements During Integrative Cardiopulmonary Exercise Testing 59
  Susan A. Ward
- 4 Pathophysiology of Disorders Limiting Exercise 91
- Performance of Clinical Cardiopulmonary Exercise Testing 112 William W. Stringer, Janos Porszasz, Harry B. Rossiter
- **6** Approaches to Data Summary and Interpretation 135 Kathy E. Sietsema
- 7 Normal Values 159 Darryl Y. Sue
- 8 Clinical Applications of Cardiopulmonary Exercise Testing 189
  William W. Stringer, Darryl Y. Sue
- 9 Diagnostic Specificity of Exercise Intolerance: A Flowchart Approach 223 Darryl Y. Sue
- 10 Case Presentations 229

Kathy E. Sietsema, Darryl Y. Sue Case 1: Normal Man 231 (2) Case 2: Normal Athletic Man

Case 3: Normal Woman: Air and Oxygen Breathing Studies 234

Case 4: Normal Man 239 Case 5: Fit Cyclist 242

Case 6: Normal Individual: Cycle and Treadmill Studies 246

Case 7: Normal Individual: With and Without β-Adrenergic Blockade 251 Case 8: Normal Man With and Without Acute Cigarette Smoking 256

Case 9: Active Man With Dyspnea at High Altitude 262

Case 10: Active Woman With Patent Foramen Ovale 267

- @ Case 11: Normal Aging Athletic Man: Serial Tests Between Age 66 and 76
  - Case 12: Mild Airflow Obstruction and Hyperventilation 270
  - Case 13: A Submaximal Test 274
  - Case 14: A Long Test 278
  - Case 15: Chronic Heart Failure With Reduced Ejection Fraction 282
  - Case 16: Chronic Heart Failure With Reduced Ejection Fraction 285
  - Case 17: Chronic Heart Failure With Reduced Ejection Fraction and Pacemaker Dependence 289
  - Case 18: Chronic Heart Failure: Oscillatory Ventilation and Gas Exchange 294
  - Case 19: Chronic Heart Failure With Preserved Ejection Fraction (Exercise-Induced Pulmonary Venous Hypertension) 298
  - Case 20: Gas Exchange Evidence of Myocardial Ischemia 302
  - Case 21: Claudication: Gas Exchange Findings in Peripheral Arterial Disease 307
- Case 22: Exertional Chest Pain With Gas Exchange Evidence of Myocardial Ischemia
  - Case 23: Exercise-Induced Myocardial Ischemia 310
  - Case 24: Myocardial Ischemia With Diffuse Distal Coronary Artery Disease 314
  - Case 25: Myocardial Ischemia: Development of Inducible Myocardial Ischemia Over 3 Years 317
  - Case 26: Atrial Septal Defect and Hemochromatosis 323
  - Case 27: Symptomatic Chronic Mitral Insufficiency 327
  - Case 28: Congenital Heart Disease: Coarctation and Ventricular Septal Defect Surgically Repaired 330
  - Case 29: Congenital Heart Disease: Transposition of the Great Arteries With Surgical Repair 334
  - Case 30: Patent Ductus Arteriosus With Left-to-Right Shunt, Presurgical Closure 337
  - Case 31: Patent Ductus Arteriosus With Right-to-Left Shunt (Eisenmenger Ductus Syndrome) 341
  - Case 32: Bicuspid Aortic Valve With Aortic Regurgitation 344
- Case 33: Surgically Repaired Coarctation of the Aorta With Bicuspid Aortic Valve
  - Case 34: Fontan Circulation 348
  - Case 35: Ventricular Septal Defect With Eisenmenger Syndrome 352
  - Case 36: Tetralogy of Fallot, Surgically Repaired 356
  - Case 37: Tetralogy of Fallot, Unrepaired 360
  - Case 38: Amyloid Cardiomyopathy 364
  - Case 39: Athletic Man With Tachyarrhythmia 368
  - Case 40: Heart Rate Impairment Due to  $\beta$ -Adrenergic Blockade for Treatment of Hypertension 372
  - Case 41: Atrial Fibrillation With Rapid Ventricular Response During Exercise 378
- © Case 42: Chronotropic Insufficiency With Escape Rhythm
  - Case 43: Active Older Man With Second-Degree Heart Block 381
  - Case 44: Active Man With Cardiac Conduction Defects 385
  - Case 45: Early Onset of Exercise Lactic Acidosis: Differentiating Circulatory From Muscular Impairment 390
  - Case 46: Early Onset of Exercise Lactic Acidosis Suggesting Circulatory Impairment 395
  - Case 47: Mixed Connective Tissue Disease With Pulmonary Involvement 400
- Case 48: Pulmonary and Systemic Vasculitis: Air and Oxygen Breathing Studies
  - Case 49: Idiopathic Pulmonary Arterial Hypertension 404
  - Case 50: Severe Pulmonary Vascular Disease Secondary to Sarcoidosis: Air and Oxygen Breathing Studies 408
  - Case 51: Pulmonary Arterial Hypertension on Multidrug Therapy 413
  - Case 52: Pulmonary Hypertension, Patent Foramen Ovale, and Exercise-Induced Right-to-Left Shunt 418

- © Case 53: Idiopathic Pulmonary Arterial Hypertension Before and After Treatment
  - Case 54: Long-Standing Idiopathic Pulmonary Arterial Hypertension: Serial Tests Over 17 Years of Treatment 424
  - Case 55: Intrapulmonary Right-to-Left Shunt Due to Pulmonary Arteriovenous Fistulae 430
  - Case 56: Severe Interstitial Lung Disease 434
  - Case 57: Sarcoidosis 437
- @ Case 58: Interstitial Pneumonitis: Before and After Empiric Corticosteroid Therapy
- @ Case 59: Severe Interstitial Lung Disease: Air and Oxygen Breathing Studies
  - Case 60: Mild Pulmonary Asbestosis 441
  - Case 61: Severe Pulmonary Asbestosis 445
  - Case 62: Pleural and Pulmonary Asbestosis 449
  - Case 63: Mild Chronic Bronchitis With Normal Exercise Performance 452
  - Case 64: Emphysema With Mild Airway Obstruction 455
  - Case 65: Severe Combined Obstructive and Restrictive Lung Disease 458
  - Case 66: Severe Chronic Obstructive Lung Disease 462
  - Case 67: Emphysema, Untreated 465
  - Case 68: Severe Emphysema and Bronchitis: Air and Oxygen Breathing Studies 469
  - Case 69: Bullous Emphysema: Before and After Bullectomy 475
- @ Case 70: A Runner With Obstructive Lung Disease
  - Case 71: Mild Obstructive Airway Disease With Disproportionate Exertional Dyspnea 481
- @ Case 72: Obesity Contributing to Ventilatory Limitation
  - Case 73: Extrapulmonary Restriction: Ankylosing Spondylitis 485
- @ Case 74: Extrapulmonary Restriction: Scoliosis
  - Case 75: Interstitial Lung Disease and Hemidiaphragm Paralysis 489
  - Case 76: Active Man With Paralyzed Hemidiaphragm 492
  - Case 77: McArdle Disease 495
  - Case 78: Myopathy With Exertional Rhabdomyolysis 499
  - Case 79: Congenital Mitochondrial Myopathy 502
  - Case 80: Mitochondrial Myopathy 505
  - Case 81: Woman With Multiple Sclerosis and Dyspnea 508
  - Case 82: Congenital Myotonia 512
- @ Case 83: Mixed Disorder: Chronic Bronchitis and Obesity
  - Case 84: Mixed Disorder: Peripheral Arterial Disease, Anemia, Carboxyhemoglobinemia, and Cardiac Dysfunction 518
  - Case 85: Mixed Disorder: Mild Interstitial Lung Disease, Obstructive Airway Disease, and Myocardial Ischemia 522
  - Case 86: Chronic Heart Failure With Preserved Ejection Fraction and Obesity Hypoventilation Syndrome 525
- 🕝 Case 87: Mixed Disease: Aortic Stenosis, Mitral Stenosis, and Obstructive Airway Disease
- Case 88: Mixed Disorder: Obstructive Airway Disease, Talc Pneumoconiosis, and Pulmonary Vascular Disease
  - Case 89: Mixed Disorder: Peripheral Arterial Disease and Obstructive Lung Disease:

    Cycle and Treadmill Exercise 529
  - Case 90: Morbid Obesity and Aortic Valve Disease 534
  - Case 91: Morbid Obesity 537
- @ Case 92: Exercise Testing for Staging and Prognosis in Chronic Heart Failure
  - Case 93: Exercise Testing for Preoperative Evaluation for Lung Cancer Resection 541
  - Case 94: Exercise Testing for Evaluation of Work Fitness: Morbid Obesity 545

 Case 95: Exercise Testing for Assessment Before and After Pulmonary Rehabilitation for Chronic Obstructive Pulmonary Disease

Case 96: Evaluation of Unexplained Dyspnea: A Morbidly Obese Asthmatic 548
Case 97: Evaluation of Unexplained Dyspnea: Chronic Thromboembolic Pulmonary

Vascular Disease 552

Case 98: Evaluation of Unexplained Dyspnea: An Obese Woman at Risk for Pulmonary Hypertension 555

Case 99: Serial Tests: Active Man With CREST Syndrome 558

Case 100: Serial Tests: Delayed Cardiotoxicity From Chemotherapy 563

**Appendices** 568 Darryl Y. Sue, Susan A. Ward

Index 582 💿