THERAPEUTIC EXERCISE

MOVING TOWARD FUNCTION
Lori Thein Brody, PT, PhD, SCS, ATC
Senior Clinical Specialist, Sports and Spine Physical Therapy
UW Health
Research Park Clinic
Madison, Wisconsin
Professor
Rocky Mountain University of Health Professions
Provo, Utah

Carrie M. Hall, PT, MHS
Physical Therapist
President, Movement Systems Physical Therapy, P.S.
Clinical Faculty
University of Washington
Seattle, Washington

with contributors
To my father, Jack, whose motto
“Never say can’t; do it and say it was hard”
has sustained me throughout my life,
and is carried forward by his grandchildren Nathaniel,
Louisa, Benjamin, and Ethan.
—Lori Thein Brody

I would like to dedicate this book to
my three daughters, Caroline, Gabrielle, and Jillian,
who encourage me daily to be my best; my patients, who continuously
teach me about the complexity of the movement system;
my amazing colleagues who challenge me to stay current
and maintain a growth mind-set;
and my mother Carol,
who lived her life with courage and resolve and continues to
serve as my daily inspiration.
—Carrie M. Hall
Contributors

**Kimberly D. Bennett, PT, PhD**
Physical Therapist and Lecturer with the Department of Rehabilitation Medicine
University of Washington
Owner Liberty Physical Therapy, PLLC
Seattle, Washington

**Janet R. Bezner, PT, DPT, PhD**
Associate Professor
Department of Physical Therapy
Texas State University
San Marcos, Texas

**Elizabeth A. V. Bloom, PT, DPT**
Physical Therapist, Advanced Clinician
UW Health Department of Orthopedics and Rehabilitation
Spine Physical Therapy
University of Wisconsin Hospital and Clinics
Madison, Wisconsin

**Lori Thein Brody, PT, PhD, SCS, ATC**
Senior Clinical Specialist, Sports and Spine Physical Therapy
UW Health
Research Park Clinic
Madison, Wisconsin
Professor
Rocky Mountain University of Health Professions
Provo, Utah

**Judith Dewane, PT, DSc, NCS**
Assistant Professor (CHS)
Physical Therapy Program
Department of Orthopedics and Rehabilitation Medicine
UW Health Department of Orthopedics and Rehabilitation
Madison, Wisconsin

**Rafael F. Escamilla, PhD, PT, CSCS, FACSM**
Professor
Department of Physical Therapy
California State University, Sacramento
Sacramento, California
Results Physical Therapy and Training Center
Sacramento, California

**Melissa Fischer, DPT**
Physical Therapist, Advanced Clinician
UW Health Department of Orthopedics and Rehabilitation
Sports Physical Therapy
University of Washington Hospital and Clinics
Madison, Wisconsin

**Lisa M. Flexner, DPT, DMT, CSCS, FAAOMPT**
Physical Therapist
Focus Physical Therapy
Part-time Instructor, Kinesiology Program
Oregon State University - Cascades
Bend, Oregon

**Colin R. Grove, PT, MS, NCS**
Physical Therapist
Department of Orthopaedics and Rehabilitation
Neuro Outpatient Rehabilitation
UW Health Rehabilitation Clinic
Middleton, Wisconsin

**Carrie M. Hall, PT, MHS**
Physical Therapist
President, Movement Systems Physical Therapy, P.S.
Clinical Faculty
University of Washington
Seattle, Washington

**Darlene Hertling, PT, Retired**
Lecturer, Division of Physical Therapy
Department of Rehabilitation Medicine
University of Washington School of Medicine
Seattle, Washington

**Sherri S. Holt, PT, DPT, MHSc, MTC, FAAOMPT**
Physical Therapist
UW Health Department of Orthopedics and Rehabilitation
Spine Physical Therapy
University of Wisconsin Hospital and Clinics
Madison, Wisconsin

**Lori Thein Brody, PT, PhD, SCS, ATC**
Senior Clinical Specialist, Sports and Spine Physical Therapy
UW Health
Research Park Clinic
Madison, Wisconsin
Professor
Rocky Mountain University of Health Professions
Provo, Utah

**Judith Dewane, PT, DSc, NCS**
Assistant Professor (CHS)
Physical Therapy Program
Department of Orthopedics and Rehabilitation Medicine
UW Health Department of Orthopedics and Rehabilitation
Madison, Wisconsin

**Rafael F. Escamilla, PhD, PT, CSCS, FACSM**
Professor
Department of Physical Therapy
California State University, Sacramento
Sacramento, California
Results Physical Therapy and Training Center
Sacramento, California

**Melissa Fischer, DPT**
Physical Therapist, Advanced Clinician
UW Health Department of Orthopedics and Rehabilitation
Sports Physical Therapy
University of Washington Hospital and Clinics
Madison, Wisconsin

**Lisa M. Flexner, DPT, DMT, CSCS, FAAOMPT**
Physical Therapist
Focus Physical Therapy
Part-time Instructor, Kinesiology Program
Oregon State University - Cascades
Bend, Oregon

**Colin R. Grove, PT, MS, NCS**
Physical Therapist
Department of Orthopaedics and Rehabilitation
Neuro Outpatient Rehabilitation
UW Health Rehabilitation Clinic
Middleton, Wisconsin

**Carrie M. Hall, PT, MHS**
Physical Therapist
President, Movement Systems Physical Therapy, P.S.
Clinical Faculty
University of Washington
Seattle, Washington

**Darlene Hertling, PT, Retired**
Lecturer, Division of Physical Therapy
Department of Rehabilitation Medicine
University of Washington School of Medicine
Seattle, Washington

**Sherri S. Holt, PT, DPT, MHSc, MTC, FAAOMPT**
Physical Therapist
UW Health Department of Orthopedics and Rehabilitation
Spine Physical Therapy
University of Wisconsin Hospital and Clinics
Madison, Wisconsin

**Carol N. Kennedy, BScPT, MCISc (Manipulative Therapy), FCAMPT**
Clinical Specialist - MSK
Physical Therapist
Partner, Treloar Physiotherapy Clinic
Vancouver, British Columbia

**Danny McMillian, PT, DSc, OCS, CSCS**
Clinical Associate Professor
Physical Therapy Program
University of Puget Sound
Tacoma, Washington

**Jill McVey, DPT, ATC**
Physical Therapist
Movement Systems Physical Therapy, P.S.
Seattle, Washington
**Elizabeth R. Shelly, PT, DPT, WCS, BC-BMD**

Physical Therapist  
Board certified specialist in women’s health  
Beth Shelly Physical Therapy  
Moline, Illinois

**M. J. Strauhal, PT**

Physical Therapist  
Clinical Specialist in OB-GYN and Women’s Health  
Providence St. Vincent Medical Center Rehabilitation Services  
Portland, Oregon

**Scott Tauferner PT, ATC**

Physical Therapist, Advanced Clinician  
UW Health Department of Orthopedics and Rehabilitation  
University of Wisconsin Hospital and Clinics  
Madison, Wisconsin

**Jill Thein-Nissenbaum, PT, DSc, SCS, ATC**

Associate Professor  
University of Wisconsin-Madison  
Doctor of Physical Therapy Program  
Madison, Wisconsin  
Staff PT, UW Athletics  
Badger Sports Medicine  
Madison, Wisconsin

**Kyle M. Yamashiro, PT, CSCS**

President  
Results Physical Therapy and Training Center  
Medical Adjunct Faculty  
Sacramento State University  
Program Coordinator  
SF Giants Sports Medicine Conference  
Physical Therapist Consultant  
Sacramento River Cats  
Rehab and Strength and Conditioning Consultant  
Sacramento Republic FC  
Rehab Consultant  
Oakland As
Reviewers

The publisher and authors gratefully acknowledge the many professionals who shared their expertise and assisted in developing this textbook, appropriately targeting our marketing efforts, creating useful ancillary products, and setting the stage for subsequent editions. These individuals include:

**FOURTH EDITION**

**Ellen Anderson, PT, MA, GCS**
Associate Professor
Rutgers School of Health Professions
Newark, New Jersey

**Suzanne Brown, PT, MPH, PhD**
College of Health and Human Services
School of Physical Therapy
Touro University Nevada
Henderson, Nevada

**Marcy Keefer Hutchison, PT, DPT, SCS, ATC, CMP**
Assistant Professor of Physical Therapy
George Fox University
Newberg, Oregon

**Joseph Kelly, MSPT**
Assistant Professor
Department of Physical Therapy & Health Science
Bradley University
Peoria, Illinois

**Jiu-Jenq Lin, PhD, PT**
School of Physical Therapy
National Taiwan University
Taipei City, Taiwan

**Daniel McGovern, PT, DPT, SCS**
Assistant Professor of Physical Therapy
School of Physical Therapy
Massachusetts College of Pharmacy and Health Sciences
University of Saint Francis
Fort Worth, Texas

**Becky Rodda, PT, DPT, OCS, OMPT**
Physical Therapy Department
School of Health Studies and Professions
University of Michigan – Flint
Flint, Michigan

**Yasser Salem, PT, PhD, NCS, PCS**
Associate Professor
Physical Therapy
University of North Texas Health Science Center
Fort Worth, Texas

**Mary Kay Solon, PT, MS**
Department Chair, Professor
Physical Therapist Assistant Studies
University of Saint Francis
Fort Wayne, Indiana

**Doreen Stiskal, PT, PhD**
Department Chair and Associate Professor
Department of Physical Therapy
Seton Hall University
South Orange, New Jersey

**Eddie Taylor**
Assistant Professor
School of Physical Therapy
Langston University
Langston, Oklahoma

**Gregory T. Thielman, EdD, MSPT, ATC**
Associate Professor
Department of Physical Therapy
University of the Sciences
Philadelphia, Pennsylvania

**Linda J. Tsoumas, PT, MS, EdD**
Professor of Physical Therapy
Boston University
Worcester, Massachusetts

**Krista Wolfe, PT, ATC**
Dean, Nursing and Health Sciences
Central Penn College
Summerdale, Pennsylvania

**THIRD EDITION**

**Cara Adams, PT, MS**
Associate Professor
Department of Rehabilitation Sciences
Division of Physical Therapy
The University of Alabama at Birmingham
School of Health Related Sciences
Birmingham, Alabama
Patricia M. Adams, MPT
Assistant Professor of Clinical Physical Therapy
Master of Physical Therapy Program
UMDMJ
Stratford, New Jersey

Karen Blaschke OTR/L, CHT
Occupational Therapist
Advance Clinical Hand and Upper Extremity Clinic
University of Wisconsin Hospital and Clinics
Madison, Wisconsin

Cynthia M. Chiarello, PT, PhD
Assistant Professor of Clinical Physical Therapy
Columbia University—Doctoral Programs in Physical Therapy
New York, New York

Lisa M. Dussault, OTR
Occupational Therapist
TMD Clinic
University of Wisconsin Hospitals and Clinics
Madison, Wisconsin

Joan E. Edelstein, PT, MA, FISPO
Director of Programming in Physical Therapy
Associate Professor of Clinical Physical Therapy
Columbia University
College of Physicians and Surgeons
New York, New York

Susan E. George, PT, MS
Associate Professor
Department of Physical Therapy
Southwest Texas State University
San Marcos, Texas

Terry Hooler, PT, MAE
Physical Therapist
University of Alabama at Birmingham
Birmingham, Alabama

Aimee Klein, PT, MS, OCS
Clinical Assistant Professor in Physical Therapy
MGH Institute of Health Professions
Senior Rehabilitation Services
Beth Israel Deaconess Medical Center
Boston, Massachusetts

Laura Knapp, PT, MS, OCS
Clinical Assistant Professor
Division of Physical Therapy
University of Utah
Salt Lake City, Utah

Robin L. Marcus, PT, MS, OCS
Clinical Assistant Professor
Division of Physical Therapy
College of Health
University of Utah
Salt Lake City, Utah

David J. Pezzullo, PT, MS, SCS, ATC
Clinical Assistant Professor
Department of Physical Therapy
University of Pittsburgh
Pittsburgh, Pennsylvania

Paul Rockar, PT, MS, OCS
Vice President, Human Resources
CORE Network, LLC
McKeesport, Pennsylvania

Richard Ruoti, PT, PhD, CSCS
Certified WATSU Practitioner
Cofounder of Aquatic Physical Therapy Section of APTA
Doylestown, Pennsylvania

Leslie Russek, PT, PhD, OCS
Associate Professor
Physical Therapy Department
Clarkson University
Potsdam, New York

Amy Schramm, PT
Senior Physical Therapist
JFK Medical Center
Edison, New Jersey

Mary Sesto, PT, PhD
Physical Therapist
Department of Occupational Medicine
University of Wisconsin
Assistant Researcher
Department of Industrial Engineering
University of Wisconsin
Madison, Wisconsin

Jamie Smith, MSPT, ATC, CSCS
Director of Physical Therapy/Instructor
Orthopedic Center for Sports Medicine and Reconstructive Surgery
Louisiana State University
Kenner, Louisiana

Gary Sutton, PT, MS, SCS, OCS, ATC, CSCS
Adjunct Clinical Assistant Professor
Department of Physical Therapy
Virginia Commonwealth University
Richmond, Virginia

C. Buz Swanić, PhD, ATC
Athletic Trainer
Temple University
Philadelphia, Pennsylvania

Linda J. Tsoumas, PT, MS
Chairperson and Associate Professor of Physical Therapy
Department of Physical Therapy
Springfield College
Springfield, Massachusetts

Cynthia Watson, PT, MS, OCS
Instructor, Department of Physical Therapy
University of Texas
Southwestern Medical Center
Dallas, Texas

Nancy J. Whitby, OTR, CHT
Lead Therapist
Hospital and Clinics
University of Wisconsin
Madison, Wisconsin
Preface to the First Edition

Choosing the title of this book was not easy, but once it was decided, the choice seemed obvious. *Therapeutic Exercise: Moving Toward Function* is the title that encapsulates the premise of this book. The emergence of managed care in the United States has altered the delivery of health care. Although value has always been important, its role in today’s health care management is even more critical. Value can be defined as patient satisfaction (i.e., functionally meaningful patient outcomes), divided by the financial and social costs of providing care (Kasman GS, Cram JR, Wolk SL. Clinical Applications in Surface Electromyography. Rockville: Aspen, 1998). Physical therapists are challenged daily to provide value to their patients in delivering care to improve function and quality of life. Among the many interventions available to the physical therapist, therapeutic exercise is the cornerstone in providing patients with the means to improve their functional capabilities and, ultimately, their quality of life. Although other interventions can improve these elements, it is the assumption of this book that only through careful therapeutic exercise prescription can an individual make the permanent changes necessary to maintain, optimize, or prevent future loss of function. It is the premise of this book to use therapeutic exercise for patients with musculoskeletal dysfunction for the sole purpose of achieving functionally meaningful patient outcomes.

It was our decision to write this book as a textbook and not a manual of activities and techniques. The latter deals with providing activities and techniques without the theoretic framework to make decisions about what would or could be the best possible course of treatment and the possible alternatives. *Therapeutic Exercise: Moving Toward Function* attempts to provide a conceptual framework for learning how to make clinical decisions regarding the prescription of therapeutic exercise—from deciding which exercise(s) to teach to how to teach them to the dosage required for the best possible outcome. The common thread throughout the text is to treat, with the use of therapeutic exercise and related interventions, the impairments that correlate with functional limitations and disability and to work toward the most optimal function possible.

Because this book was written primarily as a textbook, decisions were made to provide the reader and instructor with a variety of educational features:

- Extensively illustrated. Therapeutic exercise is a visual intervention. This book uses photographs and line drawings to illustrate examples of therapeutic exercises.
- Selected Interventions. Featured at the end of pertinent chapters, these are activities or techniques written for the student and are included to provide examples of application of the therapeutic exercise intervention model presented in Chapter 2. Faculty can use the Selected Interventions as models for the student to develop exercise prescriptions.
- Self-Management boxes. These are activities or techniques written for the patient. These are included as examples to show the student how to write an exercise for a patient so that all the important features of an exercise prescription are clearly understood.
- Patient-Related Instruction boxes. These are similar to Self-Management boxes. The primary difference is that these are not exercises, but rather educational features to assist in the carryover of exercise into functional activities.
- Key Points. This feature summarizes key concepts the author wants to convey in the chapter. A thorough understanding of the Key Points should be realized following the reading of each chapter.
- Critical Thinking Questions. These were provided to stimulate the reader’s thinking after studying the chapter. Case Studies are used to create hypothetical situations to which concepts can be applied.
- Lab Activities. These provide examples of applied use of the concepts to practice teaching and execution of selected activities and techniques.
- Case Studies. The final unit of the book provides the reader with a description of 11 cases. These cases are used in Critical Thinking Questions and Lab Activities to provide the student with real-life situations in which to apply concepts learned in the relevant chapter.

The book is organized into seven units. The purpose of each unit is as follows:

- Unit 1 provides the foundations of therapeutic exercise, beginning with a presentation of the disablement model to provide conceptual clarity for the remainder of the book, and ending with concepts of patient management. In the second chapter, a proposed therapeutic exercise intervention model is presented. This model attempts to separate the clinical reasoning process into the individual but cumulative steps to take in order to prescribe an effective therapeutic exercise. Chapter 3 describes two crucial elements of patient management: motor learning and self-management.
- Unit 2 provides the reader with a functional approach to therapeutic exercise for physiologic impairments. Although we attempted to include a somewhat extensive review of the scientific literature on muscle performance, balance, endurance, mobility, posture, movement, and pain, our purpose was not to publish a review of the material. Instead, we have selected pertinent literature to illustrate the concepts needed for a basic knowledge of physiologic impairments as it relates to therapeutic exercise prescription.
- Unit 3 presents special physiologic considerations to heed when prescribing therapeutic exercise. They include soft tissue injury, postoperative issues, arthritis, fibromyalgia
syndrome and chronic fatigue, and obstetrics. Although this list is not comprehensive, we chose these special considerations because of the frequency with which the clinician encounters them.

■ Unit 4 provides the reader with selected methods of intervention. Although there are numerous schools of thought regarding the prescription of exercise, we chose these methods to provide the reader with examples of a variety of contrasting methods—each has its own merits. The authors have attempted to illustrate how each method can be incorporated into a cohesive program of therapeutic exercise prescription.

■ Units 5 and 6 provide the reader with a regional approach to therapeutic exercise prescription. Each chapter is organized into a brief review of anatomy and kinesiology, examination and evaluation guidelines, therapeutic exercise for common physiologic impairments affecting the region, and therapeutic exercise for common medical diagnoses affecting the region. The anatomy, kinesiology, and examination and evaluation sections set the foundation for prescription of therapeutic exercise for physiologic impairments. Therapeutic exercise for physiologic impairments provides the reader with examples of exercises to improve physiologic capability and, ultimately, function. Therapeutic exercise for common medical diagnoses provides the reader with examples of comprehensive interventions, including therapeutic exercise for common medical conditions affecting the region.

■ Unit 7 consists of 11 Case Studies, which are used in Critical Thinking Questions and Lab Activities at the end of selected chapters. Faculty can use these Case Studies for a variety of learning experiences.

■ Appendices 1 and 2 give the student a quick reference for red flags of serious pathology or visceral referred symptoms and clinical actions to take in the event of serious signs and symptoms in the exercising patient.

We worked diligently to provide a comprehensive textbook designed to prepare the foundation of knowledge and skills necessary to prescribe therapeutic exercise. We urge our readers to write to us to tell us how well we accomplished our goal. We hope that subsequent editions can address your comments as well as the ever-changing needs of those involved in therapeutic exercise prescription.

Carrie M. Hall
Lori Thein Brody
Preface to the Fourth Edition

Therapeutic exercise remains the primary intervention provided by physical therapists and physical therapist assistants around the world. Although the exercises may appear simple in application, the processes that drive the decisions that ultimately result in an exercise program are complex. Therapeutic exercise is applied at the impairment, activity limitation, and participation restriction levels, and ranges from simple stretching to complex multijoint and system-level integrated activities. Therapeutic exercise is employed in the care of patients ranging from the youngest infants to the oldest seniors, across a broad range of abilities, needs, and goals, in a variety of settings.

This multidimensionality underscores the complexity of successful therapeutic exercise application in the patients we care for. Although determining that a patient with impaired quadriceps muscle performance needs quadriceps strengthening activities, choosing the appropriate type and dosage of therapeutic exercise is far more challenging. Consider the following examples of patients with impaired quadriceps performance: a young athlete post knee ligament reconstruction; an elderly woman recovering from a femur fracture resulting from a fall; a young man with a recent below knee amputation. The starting point, rate of progression, program focus, and goals may be different, and therefore require different exercise programs, all with the goal of improving an impairment. Remediation of the impairment is only one level of consideration; activity limitations (stair descent, rising from a chair, extending the knee during gait) and performance restrictions (return to sport, performing instrumental activities of daily living, return to work) are also part of the therapeutic exercise prescription. In addition, impairments rarely exist in singularity. The complexity of evaluation and therapeutic exercise prescription of the entire movement system, with integrated and interdependent impairments, is a complex, high-level decision-making process requiring skilled intervention to reach the desired outcome of function and participation in society. Choosing and dosing the exercise is only the beginning. The patient then must learn the motor control to carry out the specificity of the prescription, adhere to the dosage, and be progressed appropriately to reach his or her personal desired outcome. We continuously hear that students struggle with the daunting task of the decision-making process, teaching, and developing compliance with therapeutic exercise prescription in their varied patient populations. Although we are unable to fully impart all the skills necessary to prescribe and teach therapeutic exercise in a textbook, the fourth edition of Therapeutic Exercise: Moving Toward Function continues to emphasize the decision-making process necessary for successful outcomes of therapeutic exercise programs.

Successful outcomes require consideration of the therapeutic exercise prescription (exercise choices, frequency, intensity, duration, progression), motivators and barriers to adherence, adjunctive interventions, and evidence to support choices within the framework of a third-party payer system. The focus of this text is on providing the foundational information, and examples, to help clinicians decide where on the continuum of exercise to start a specific patient and how to progress that patient through rehabilitation to and including wellness. Although wellness has often been considered separate from rehabilitation, it should be considered concurrently with remediation of impairments and activity limitations. Wellness is multidimensional, including physical health, emotional health, spirituality, and social connectivity. Physical therapists who place therapeutic exercise within the context of wellness provide that patient with the opportunity to choose a lifetime of physical activity, which is a cornerstone of public health. Availability and individual preferences notwithstanding, consider the difference between an exercise program prescribed to be performed alone at home and one to be performed at a community center. A therapeutic exercise program that is initiated and/or progressed to an environment that allows a seamless transition to wellness is a successful program and one that is vital to the management and prevention of chronic disease.

The World Health Organization (WHO) (www.who.int) and the Centers for Disease Control and Prevention (www.cdc.gov) both emphasize the many facets of wellness including physical activity. The WHO’s International Classification of Functioning, Disability, and Health (ICF) includes all people in its classification from a continuum of people with no known disease to those with disease-related impairments, activity limitations, and participation restrictions. All people are served by participating in health and wellness-promoting activities, with some requiring the unique skills of a physical therapist in order to participate successfully. The WHO is currently in the process of developing a companion publication, the International Classification of Health Interventions (ICHI) that categorizes interventions associated with impairments of body structures and functions as well as interventions for activity limitations and participation restrictions. Like the ICF, the ICHI will provide a common language for further research into the effectiveness of different types and dosages of therapeutic exercise in patient groups.

With this backdrop, the changes to this edition of Therapeutic Exercise: Moving Toward Function capitalize on initiatives such as the ICF, ICHI, and work by the American Physical Therapy Association (APTA) and other professional organizations. Our goal is to deepen the reader’s understanding of the complexities of therapeutic exercise prescription in health care today, and to provide examples and evidence of its application to promote a healthy population.

Changes and Additions in the Fourth Edition

The changes and additions to the fourth edition of this text reflect extensive user feedback. These changes and additions
are consistent with commitment to improve the delivery of successful, evidence-based therapeutic exercise interventions to patients. Language used throughout the book is consistent with that of the ICF and the APTA’s Guide to Physical Therapist Practice. This provides a consistent and common language when discussing physical therapy interventions and evidence.

The therapeutic exercise model has been updated to improve clarity and ease of use. APTA has embraced the concept of the movement system as the primary system treated by physical therapists. The premise of the updated model is that ideal movement can be thought of as the result of a complex interaction of several subsystems (support, passive, active, neural, cognitive/emotional) of the larger encompassing movement system. Organizing impairments into subsystems of the movement system will assist the practitioner in systematizing the complex interaction of impairments and guide prioritization, sequencing, and progression of the therapeutic exercise intervention.

Chapter 3 has been expanded beyond patient-related education to include a broader range of information on improving patient outcomes. Patient education and instruction in home exercise programs are just a couple of the strategies to improve patient outcomes. Listening and the many components of communication are critical to ensure that information is delivered in a manner that respects and motivates patients. This chapter describes several opportunities to engage the patient in the therapeutic exercise decision-making process.

Chapter 14, previously labelled “Closed Kinetic Chain,” has been revised to “Kinetic Chain Applications in Functional Movement.” This change reflects further development in the body of evidence around the kinetic chain and functional movement assessments and interventions. This chapter includes an in-depth discussion of the rationale for and application of kinetic chain concepts, both open and closed kinetic chain. Integrating open and closed chain activities in functional movements is a foundational concept in therapeutic exercise prescription.

All chapters have expanded references and a new feature, Evidence and Research (EAR) Boxes. Each chapter continues to be extensively referenced to provide the best current evidence for the reader. We understand that the reader may want to know more details of some research studies. Rather than embedding extensive details in the body of the text, key research is highlighted in EAR boxes throughout the chapter. In this way, the interested reader can readily access the evidence supporting the chosen intervention. These boxes, along with the citations and reference lists, provide a strong evidence resource for the reader.

The look of the text has changed significantly, with more streamlined writing and bulleted lists for ease of finding information quickly. The easily identifiable boxes such as Patient-Related Instruction, Building Blocks, Case Studies, Self-Management, and Selected Interventions remain as strong pedagogical features designed to integrate therapeutic exercise applications into the many facets of effective patient care. ThePoint website contains videos of selected exercises to view and listen to a practitioner teach exercise. The website also contains supportive anatomy, kinesiology, and examination information that provides background knowledge as an easily accessible refresher for the reader. New to this edition is a change to full color images to provide greater clarity in photos and to better engage the reader.

We hope that these changes and additions will make for better reading and help to provide a comprehensive, effective therapeutic exercise program for patients and clients.

ONLINE INSTRUCTOR RESOURCES

Adopting instructors will be given access to the following resources on thePoint:

- Image Bank
- PowerPoint Presentations
- Test Generator
- Answers to Building Blocks

ONLINE STUDENT RESOURCES

Students who have purchased Therapeutic Exercise: Moving Toward Function, Fourth Edition, will have access to the following resources:

- Video clips showing various therapeutic exercise techniques
- Additional chapter material not found in text

Materials for students and instructors can be found online at thePoint.lww.com/BrodyHall4e.

Lori Thein Brody
Carrie M. Hall
In addition to all those individuals who helped create the first three editions, we wish to thank many people for their contributions to this revision. This book was made possible through the individual and collective contribution of many individuals. We are privileged to have had so many knowledgeable and dedicated chapter contributors. We are indebted to their contribution to the original work and revisions to create an outstanding fourth edition. We are also acutely aware that the fourth edition could not have been done without input from the reviewers. We appreciate the insights they offered to finalize the content and design of the text. A special thanks is extended to Jill Thein-Nissenbaum who provided additional expertise and extensive editing crucial to the consistency and structure of the fourth edition. A book of this magnitude with its large numbers of figures, legends, displays, tables, special feature boxes, and references cannot be produced without the cohesive efforts of the talented editorial and production teams. For this we thank the editorial and production staff and the art department at Lippincott, Williams & Wilkins. We would like to extend a special thanks to production manager, John Larkin, who, among many other vital functions, played the critical behind-the-scenes role of keeping us organized and on schedule in a professional, kind, and respectful manner.

We would like to extend our gratitude to our colleagues at the UW Health Research Park Clinic and Movement Systems Physical Therapy, P.S. in Seattle, WA, for the use of their facilities. We are also grateful for the time and energy provided by the models, videographers, and photographer Andy Manis, whose calm and organization helped us manage an extensive photo shoot. Over the course of a person’s career, many individuals assist in the development of a person’s theories, knowledge, and expertise. In the years between editions, we have continued to learn from the patients, students, and teachers who perpetually challenge our thoughts and decisions, and shape our skills.

Last, but most certainly not least, we would like to especially thank our family, friends, and colleagues who offered their emotional support and gave of their time generously to allow us to complete this project.

Lori Thein Brody
Carrie M. Hall

Each coauthor would like to extend her personal acknowledgments:

As we publish the fourth edition of our book, it is more evident now than ever that I am who I am because of the numerous influential and inspirational researchers, practitioners, instructors, business owners, administrators, and advocates, whom I have had the pleasure to work with over my 30+ year career. I was particularly fortunate to work with some of the best and brightest in our field during my formative years at Washington University in St. Louis. I would particularly like to thank Shirley Sahrmann, PhD, PT, FAPTA, for her incredibly insightful theories and devotion to the field of physical therapy. Her philosophy toward exercise prescription is woven into my thoughts and writing. Dr. Sahrmann has planted seeds that are found in research and clinical practice around the world. She is an icon in the field of physical therapy, and I am immensely indebted to her for teaching me how to view education, clinical practice, business acumen, and even advocacy through a movement system lens. I consider this book a result of the responsibility I feel to pay it forward to the next generation of practitioners whom I am confident will take the field of physical therapy into primary care and demonstrate our critical value to public health. I view therapeutic exercise as a cornerstone of our professional identity, and believe that movement is medicine and that physical therapists are uniquely qualified to integrate the biopsychosocial elements of the movement system into a therapeutic and transformative intervention.

The writing of a textbook takes tremendous time and energy away from work, friends, and family. Words cannot express my appreciation for my colleagues at Movement Systems Physical Therapy and my close friends whose support has been truly remarkable. I especially thank my clinic Administrator, Scott Spradling, who kept my business thriving during the hours I spent on research and writing, my three children whose unconditional love keeps me going every day, and my dog, Winston, who kept me running to maintain my fitness and mental clarity.

Carrie M. Hall

My life has been blessed with exceptional colleagues who have believed in and advocated for me as my career has wound its way through physical education, athletic training, physical therapy, preventive medicine, and adult education. My deepest gratitude goes to Peg Houglam, PT, ATC; Bill Flentje, PT, ATC; Susan Harris, PT, PhD, FAPTA; and Joseph PH Black, MDiv, PhD. These individuals provided examples of exceptional leadership and set the standard for professionalism and integrity. I am deeply grateful to them for their past and continued guidance. My sister, Jill Thein-Nissenbaum, PT, DSc, ATC, played a pivotal role, picking up the pieces Carrie and I left in our wake. She was there to take on just about anything, including moral support and providing that kind but critical “you already know that answer to that question, just do it” advice. I am truly blessed by her presence in my life.

Thanks to my colleagues at University of Wisconsin Research Park Clinic, particularly those who contributed to the writing and editing of chapters, and Carrie Schwoerer, who always had an ear or a box of tissues to lend.

I am also deeply grateful to the doctoral students at Rocky Mountain University of Health Professions. They are a remarkable group of bright, inquisitive current and future leaders who do justice to our profession. I am grateful for the opportunity to learn from each of them.

Lori Thein Brody
UNIT 1
Foundation of Therapeutic Exercise 1
CHAPTER 1
Introduction to Therapeutic Exercise and the Model of Functioning and Ability 2
CHAPTER 2
Patient Management 16
CHAPTER 3
Strategies for Improving Therapeutic Exercise Outcomes 39
CHAPTER 4
Prevention and the Promotion of Health, Wellness, and Fitness 57

UNIT 2
Impairments of Body Functions and Therapeutic Exercise 69
CHAPTER 5
Impaired Muscle Performance 70
CHAPTER 6
Impaired Aerobic Capacity/Endurance 116
CHAPTER 7
Impaired Range of Motion and Joint Mobility 140
CHAPTER 8
Impaired Balance and Mobility 187
CHAPTER 9
Impaired Posture and Movement 216
CHAPTER 10
Pain 240

UNIT 3
Special Physiologic Considerations in Therapeutic Exercise 281
CHAPTER 11
Soft-Tissue Injury and Postoperative Management 282
CHAPTER 12
Therapeutic Exercise for Arthritis 313
CHAPTER 13
Therapeutic Exercise in Obstetrics 330

UNIT 4
Sample Specialties of Therapeutic Exercise Intervention 357
CHAPTER 14
Kinetic Chain Applications in Functional Movement 358
CHAPTER 15
Proprioceptive Neuromuscular Facilitation 388
CHAPTER 16
Aquatic Therapeutic Exercise 413

UNIT 5
Functional Approach to Therapeutic Exercise of the Lower Extremities 433
CHAPTER 17
The Lumbopelvic Region 434
CHAPTER 18
The Pelvic Floor 488
CHAPTER 19
The Hip 526
CHAPTER 20
The Knee 586
CHAPTER 21
The Ankle and Foot 629

UNIT 6
Functional Approach to Therapeutic Exercise for the Upper Extremities 657
CHAPTER 22
The Temporomandibular Joint 658
CHAPTER 23
The Cervical Spine 684
CHAPTER 24
The Thoracic Spine 714
CHAPTER 25
The Shoulder Girdle 743
CHAPTER 26
The Elbow, Forearm, Wrist, and Hand 798
APPENDIX 3
2016 PAR-Q +: The Physical Activity Readiness Questionnaire for Everyone  881

INDEX  886
UNIT 1
Foundation of Therapeutic Exercise   1

CHAPTER 1
Introduction to Therapeutic Exercise and the Model of Functioning and Ability   2
LORI THEIN BRODY and CARRIE M. HALL
Definition of Physical Therapy   2
Therapeutic Exercise Intervention   2
The Language of Health: Abilities and Disabilities   3
   Terminology of the Biopsychosocial Model of Functioning and Disability   3
International Classification of Functioning, Disability, and Health   5
   Part 1: Functioning and Disability   5
   Part 2: Contextual Factors   8
Application of the Model to Physical Therapist Practice   8
   Health Conditions   11
   Impairments of Body Functions and Structures   11
   Activity Limitations, Participation Restrictions, and Quality of Life   11
   Contextual Factors and Interventions   12
   Prevention and the Promotion of Health, Wellness, and Fitness   13
Summary   13
Key Points   14

CHAPTER 2
Patient Management   16
CARRIE M. HALL
Patient Management Model   16
Examination   16
Evaluation   18
Diagnosis   21
   Prognosis and Plan of Care   22
   Intervention   22
   Outcome   24
   Modification   25
Clinical Decision-Making   26
Therapeutic Exercise Intervention   26
   Therapeutic Exercise Intervention Model   27
Summary   34
   Exercise Modification   34
   Adjunctive Interventions   36
Key Points   37

CHAPTER 3
Strategies for Improving Therapeutic Exercise Outcomes   39
LORI THEIN BRODY
Patient Education: Definition and Scope   39

UNIT 2
Impairments of Body Functions and Therapeutic Exercise   69

CHAPTER 5
Impaired Muscle Performance   70
LORI THEIN BRODY and CARRIE M. HALL
Definitions   70
   Strength   70
   Power and Work   71
   Endurance   71
   Muscle Actions   71
Physical Factors Affecting Muscle Performance   72
   Fiber Type   72
   Fiber Diameter   72
   Muscle Size   72
   Force–Velocity Relationship   73
CHAPTER 8
Impaired Balance and Mobility 187
COLIN R. GROVE, JUDITH DEWANE, and LORI THEIN BRODY
Definitions 187
Physiology of Balance 188
Biomechanical Contributions 189
Contributions of the Sensory Systems 189
Neural Integration and Processing of Sensory Information 190
Generating Motor Output—Movement Strategies 191
Control of Walking—Navigation 193
Higher-Level Influences 193
Causes of Impaired Balance 193
Examination and Evaluation of Impaired Balance and Mobility 194
Biomechanical Domain 195
Sensory Strategies Domain 196
Movement Strategies Domain 197
Dynamic Control Domain 197
Cognitive Domain 197
Affective Domain 197
Determining Risk for Falling 198
Treating Impaired Balance 198
Diagnosis and Prioritization 198
Customization 199
Environmental Context 199
Mode 199
Motor Learning 200
Intervention Strategies for Specific Systems—Examples 200
Sequencing Considerations 207
Feedback 208
Expanded Ecological Model of Balance Rehabilitation 208
Precautions and Contraindications 209
Patient Education 209
Falls—A Significant Problem 209
Effects of Training on Balance 210
Key Points 211

CHAPTER 9
Impaired Posture and Movement 216
CARRIE M. HALL
Definitions 218
Posture 218
Standard Posture 218
Deviations in Posture 220
Movement 221
Contributors to Impaired Posture and Movement 223
Range of Motion 224
Muscle Length 224
Joint Mobility 224
Muscle Performance 225
Pain 227
Anatomic Impairments and Anthropometric Characteristics 228
Psychologic Impairments 229
Lifespan Considerations 229
Environmental Influences 230
Examination and Evaluation 230
Posture 230
Movement 232
Intervention 233
The Movement System 233
Activity and Dosage 234
Patient-Related Instruction and Adjunctive Interventions 235
Key Points 236

CHAPTER 10
Pain 240
LORI THEIN BRODY
Definitions 240
Physiology of Pain 240
Sources of Pain 241
Pain Pathways 242
Pain Theory 243
Examination and Evaluation 244
Pain Scales 244
McGill Pain Questionnaire 245
Disability and Health-Related Quality of Life Scales 246
Therapeutic Exercise Intervention for Pain 250
Acute Pain 251
Chronic Pain 253
Therapeutic Exercise Guidelines for Patients with Chronic Pain 253
Adjunctive Agents 260
Transcutaneous Electrical Nerve Stimulation 261
Heat 261
Cold 261
Medication 261
Special Considerations in Chronic Pain: Complex Regional Pain Syndrome, Fibromyalgia, and Chronic Fatigue Syndrome 262
Complex Regional Pain Syndrome 262
Fibromyalgia Syndrome 264
Chronic Fatigue Syndrome 266
Therapeutic Exercise Interventions for Common Impairments 267
Impaired Muscle Power Functions 267
Exercise Tolerance Functions: Impaired Aerobic Capacity 268
Mobility of Joint Functions: Impaired Range of Motion 269
Muscle Endurance Functions: Impaired Posture 269
Emotional Functions: Impaired Response to Emotional Stress 271
Precautions and Contraindications 272
Pacing 272
Pharmacological and Psychological Intervention 272
Key Points 273

UNIT 3
Special Physiologic Considerations in Therapeutic Exercise 281
CHAPTER 11
Soft-Tissue Injury and Postoperative Management 282
LORI THEIN BRODY
Physiology of Connective Tissue Repair 282
Microstructure of Connective Tissues 282
UNIT 5

Functional Approach to Therapeutic Exercise of the Lower Extremities 433

CHAPTER 17

The Lumbopelvic Region 434
CARRIE M. HALL

Review of Anatomy and Kinesiology 435
  Myology 435
  Gait 438
Examination and Evaluation 439
  Patient History 440
  Screening Examination 441
  Tests and Measures 441
Therapeutic Exercise Intervention for Common Impairments of Body Functions 448
  Aerobic Capacity Impairment 448
  Balance and Coordination Impairment 449
  Muscle Performance Impairment 450
  Range of Motion, Muscle Length, and Joint Mobility 462
  Pain 464
  Posture and Movement Impairment 470
Therapeutic Exercise Intervention for Common Diagnoses 473
  Lumbar Disk Herniation 473
  Spinal Stenosis 477
  Spondylolisthesis and Spondylolysis 478
Key Points 479

CHAPTER 18

The Pelvic Floor 488
ELIZABETH R. SHELLY and SHERRI S. HOLT

Review of Anatomy and Kinesiology 488
  Skeletal Muscles 488
  Pelvic Diaphragm Muscles 489
  Pelvic Floor Function 491
  Physiology of Micturition 492
Impairments of Body Structures 493
  Birth Injury 493
  Neurologic Dysfunction 493
Impairments of Mental Functions 493
  Motivation 493
  Sexual Abuse 493
Examination/Evaluation 494
  Risk Factors 494
  Screening Questionnaires 495
  Results of the Internal Examination 496
  Patient Self-Assessment Tests 496
  Ultrasound Imaging for PFM Dysfunction 497
Therapeutic Exercise Interventions for Common Physiologic Impairments 497
  Impaired Muscle Performance 498
  Active PFEs 498
  Pain 501
  Joint Mobility and Range of Motion (Including Muscle Length) Impairments 503
  Posture Impairment 504
  Coordination Impairment 504
Clinical Classifications of Pelvic Floor Muscle Dysfunction 506
  Underactive PFM 506
  Overactive PFM 508
  Incoordination Dysfunction 509
  Visceral Dysfunction 510
Therapeutic Exercise Interventions for Common Diagnoses 510
  Incontinence 511
  Pelvic Organ Prolapse 513
  Chronic Pelvic Pain 514
  Levator Ani Syndrome 514
  Coccygodynia 514
  Vulvodynia 515
  Vaginismus 515
  Nonrelaxing Puborectalis Syndrome 516
  Dyspareunia 516
Adjunctive Interventions 516
  Biofeedback 516
  Basic Bladder Training 517
  Scar Mobilization 518
  Externally Palpating the Pelvic Floor Muscles 519
Key Points 520

CHAPTER 19

The Hip 526
CARRIE M. HALL

Impairments of Body Structures 526
  Angles of Inclination and Torsion 526
  Center Edge Angle or Angle of Wiberg 527
  Leg Length Discrepancy 527
  Cam and Pincer Morphology 528
Examination and Evaluation 529
  History 530
  Lumbar Spine Clearing Examination 530
  Other Clearing Tests 530
  Gait and Balance 530
  Joint Mobility and Integrity 531
  Muscle Performance 531
  Pain and Inflammation 531
  Posture and Movement 532
  Range of Motion and Muscle Length 532
  Work (Job/School/Play), Community, and Leisure Integration or Reintegration (Including Instrumental Activities of Daily Living) 533
  Special Tests 533
Therapeutic Exercise Interventions for Common Physiologic Impairments 535
  Pain 535
  Muscle Performance 536
  ROM, Muscle Length, Joint Mobility, and Integrity Impairments 549
  Balance 557
  Posture and Movement Impairment 562
Therapeutic Exercise Interventions for Common Diagnoses 563
  Osteoarthritis 563
  Iliotibial Band–Related Diagnoses 569
  Nerve Entrapment Syndromes 573
Key Points 577

CHAPTER 20
The Knee 586
JILL THEIN-NISSENBAUM and LORI THEIN BRODY
  Review of Anatomy and Kinesiology 586
    Anatomy 586
    Kinematics 587
    Kinetics 588
  Impairments of Body Structures 589
    Genu Valgum 589
    Genu Varum 590
  Examination and Evaluation 590
    Patient/Client History 590
    Tests and Measures 590
  Therapeutic Exercise Intervention for Body Function Impairments 590
    Mobility Impairment 590
    Muscle Performance Impairments 596
  Therapeutic Exercise Intervention for Common Diagnoses 600
    Ligament Injuries 600
    Treatment of Ligament Injuries 605
    Fractures 607
    Treatment of Fractures 609
    Meniscal Injuries 610
    Treatment 611
  Degenerative Arthritis Problems 612
    Articular Cartilage Lesions 612
    Surgical Procedures 613
    Interventions for Degenerative Arthritis Problems 615
  Tendinopathies 616
    Patellar Tendinopathy 616
    Iliotibial Band Syndrome 617
    Patellofemoral Pain Syndrome 617
Key Points 623

CHAPTER 21
The Ankle and Foot 629
JILL MCVEY and CARRIE M. HALL
  Common Foot Types 629
    Subtalar Varus 629
    Forefoot Varus 629
    Forefoot Valgus 629
    Ankle Equinus 630
  Examination and Evaluation 630
    Patient/Client History 630
    Balance 630
    Joint Integrity and Mobility 630
    Muscle Performance 630
    Pain 630
    Posture 630
    Range of Motion and Muscle Length 630
    Impairments of Body Structures 631
    Other Examination Procedures 631
  Therapeutic Exercise Intervention for Common Impairments of Body Functions 631
    Balance Impairment 631
    Muscle Performance 632
    Pain 635
    Posture and Movement Impairment 635
    ROM, Muscle Length, Joint Integrity, and Mobility 637
    Swelling 641
  Therapeutic Exercise Intervention for Common Ankle and Foot Diagnoses 641
    Ligament Sprains 642
    Ankle Fractures 644
    Functional Nerve Disorders 645
    Plantar Fasciitis 646
    Posterior Tibial Tendon Dysfunction 648
    Medial Tibial Stress Syndrome 649
    Achilles Tendinosis 649
    Postoperative Management 650
  Adjunctive Interventions 651
    Adhesive Strapping 651
    Wedges and Pads 651
    Biomechanical Foot Orthotics 652
    Heel and Full Sole Lifts 652
Key Points 653

UNIT 6
Functional Approach to Therapeutic Exercise for the Upper Extremities 657

CHAPTER 22
The Temporomandibular Joint 658
LISA M. FLEXNER and DARLENE HERTLING
  Review of Anatomy and Kinesiology 658
    The Temporomandibular Joint Structures 658
    Associated Structures 660
    Kinesiology 660
  Examination and Evaluation 662
    Subjective History 663
    Screening Exam for the TMJ 664
  Therapeutic Exercise for Common Impairments of Body Functions 664
    Mobility Impairments 664
    Posture Impairments 673
    Swallowing and Respiratory Impairments 674
    The Rocabado 6 × 6 675
  Therapeutic Exercise for Common Diagnoses 675
    Capsulitis and Retrodiskitis 676
    Internal Derangement of the Disk 676
    Degenerative Joint Disease/Osteoarthritis 678
    Postoperative Physical Therapy Following Surgical Intervention 678
  Adjunctive Therapies 679
Key Points 679

CHAPTER 23
The Cervical Spine 684
CAROL N. KENNEDY
  Review of Anatomy and Kinesiology 684
    Muscles 685
  Examination and Evaluation 686
    History and Clearing Tests 686
    Physical Examination 686
CONTENTS
xxiii

Adjunctive Interventions: Taping 786
  Scapular Corrections 787
  Prevention of Allergic Reaction 787
  Key Points 789

CHAPTER 26
The Elbow, Forearm, Wrist, and Hand 798
LORI THEIN BRODY
  Anatomy 798
  Elbow and Forearm 798
  Wrist 799
  Hand 801
  Regional Neurology 802
  Kinesiology 803
  Wrist 805
  Hand 805
  Examination and Evaluation 808
  History and Observation 808
  Mobility Examination 808
  Muscle Performance Examination 808
  Other Tests 809
  Therapeutic Exercise Interventions for Common Impairments of
  Body Functions 809
  Impaired Muscle Performance 810
  Impaired ROM, Muscle Length, and Joint Mobility/Integrity 722
  Pain 728
  Impaired Posture and Motor Function 728
  Therapeutic Exercise Intervention for Common Diagnoses 736
  Prevention and Intervention in Patients with
  Osteoporosis 736
  Exercise Management of Parkinson Disease 736
  Thoracic Outlet Syndrome 738
  Key Points 739

CHAPTER 25
The Shoulder Girdle 743
CARRIE M. HALL
  Review of Anatomy and Kinesiology 743
  Examination and Evaluation 743
  Patient/Client History 743
  Clearing Examinations 744
  Motor Function (Motor Control and Motor Learning) 744
  Muscle Performance 745
  Pain 745
  Peripheral Nerve Integrity 746
  Posture 746
  ROM, Muscle Length, Joint Mobility, and Joint Integrity 746
  Work (Job/School/Play), Community, and Leisure
  Integration or Reintegration (Including Instrumental ADLs) 747
  Therapeutic Exercise Interventions for Common Impairments of
  Body Structures and Functions 747
  Pain 747
  ROM and Joint Mobility Impairments 757
  Impaired Muscle Performance 761
  Posture and Movement Impairment 770
  Therapeutic Exercise Interventions for Common Diagnoses 771
  Rotator Cuff Disorders 771
  Pathomechanics 771
  Pathogenesis 773
  Glenohumeral Hypermobility/Instability 780
  Frozen Shoulder 783

UNIT 7
Case Studies 845
LORI THEIN BRODY, CARRIE M. HALL, and ELIZABETH A. V. BLOOM

APPENDIX 1
Red Flags: Recognizing Signs and Symptoms 872
DAVID MUSNICK and CARRIE M. HALL

APPENDIX 2
Red Flags: Potentially Serious Symptoms and Signs in Exercising Patients 877
SCOTT TAUFERNER and CARRIE M. HALL

APPENDIX 3
2016 PAR-Q +: The Physical Activity Readiness Questionnaire for Everyone 881
INDEX 886