MARK DUTTON

SECOND EDITION

ORTHOPAEDICS

FOR THE PHYSICAL THERAPIST ASSISTANT

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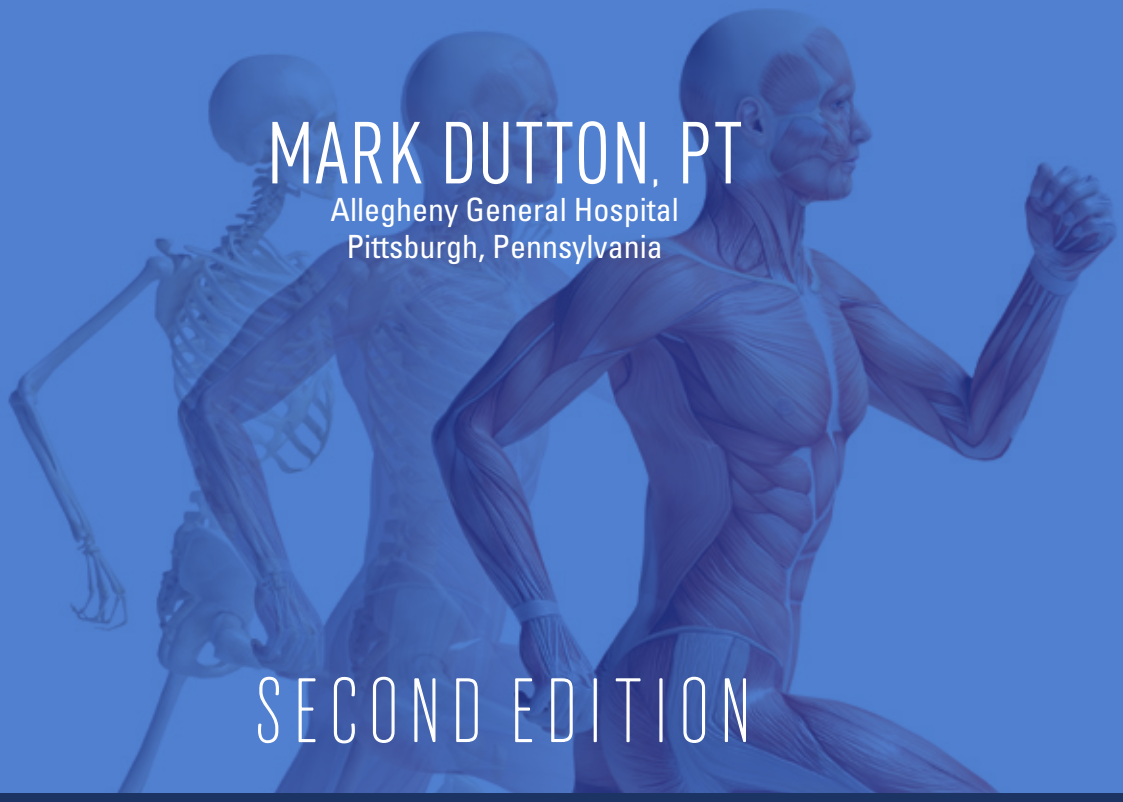
Pittsburgh, Pennsylvania



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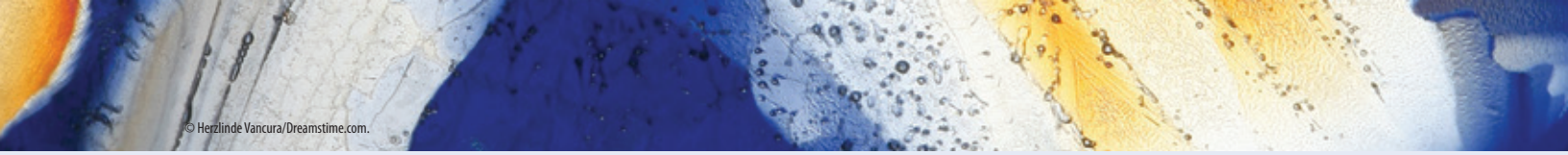
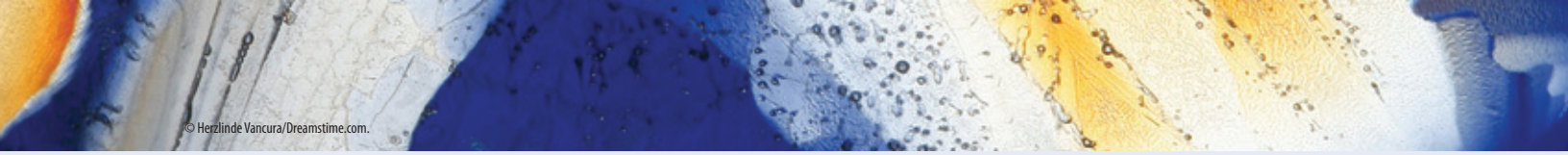
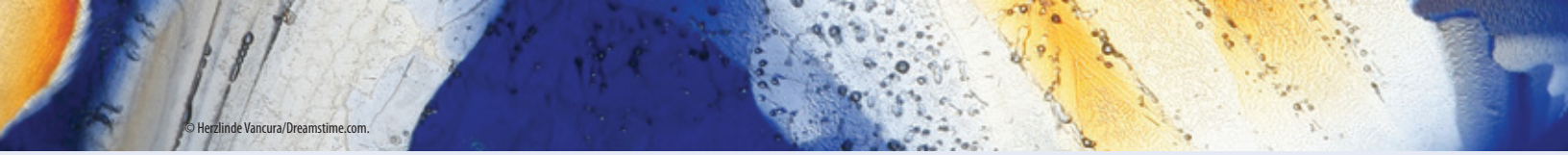
To my Mum, who is no longer around to do those things that Mums do best.



Brief Contents



Contents



Preface

The aim of the first edition of *Orthopaedics for the Physical Therapist Assistant* was to fill a void in the literature for the physical therapist assistant (PTA) student or clinician studying orthopaedics. The scope of practice for the PTA continues to evolve, requiring the PTA to stay current with the field of physical therapy. There is a vast amount of information available related to orthopaedics, and with both an ever-increasing demand for instant results and continuing advances in technology, the PTA is tasked with providing an efficient level of care while working with other members of the healthcare team.

Although the medical profession is moving toward an increased reliance on the findings from imaging studies, such as computed axial tomography (CAT) and magnetic resonance imaging (MRI), physical therapy continues to rely on the subjective and objective findings from the physical examination. For any patient interaction to be successful, an accurate diagnosis is essential, and through the move toward evidence-based testing, the accuracy of the physical therapy diagnosis continues to be enhanced.

Once the correct diagnosis has been established, a carefully planned and specific rehabilitation program for both the affected area and its related structures must follow. This approach must take into consideration the anatomy and biomechanics of the involved structures and the stage of healing. Each intervention must be individualized to the patient, which requires an eclectic approach, because no single method works all of the time.

This text attempts to provide the student with the essential information regarding evidence-based guidelines for the assessment and rehabilitation of the orthopaedic patient.

New to the *Second Edition*

The feedback from the *First Edition* determined the modifications and additions for this edition. In this edition, three new chapters have been developed: one on general orthopaedic conditions that can impact multiple joints and systems (Chapter 5), another on the critical decision-making processes concerning how to progress a patient (Chapter 8), and a third that addresses cardiovascular conditioning, enhancing the focus that the previous edition had on therapeutic exercise (Chapter 15). In addition, information has been added throughout the text to help the PTA better understand the role of the physical therapist (PT) and to describe the majority of tests that they use as part of their examination and evaluation. As in the *First Edition*, the focus remains on evidence-based practices, and Key Points are used throughout to emphasize important concepts. From an aesthetic viewpoint, the photos and figures are now in color.

Some of the most significant updates to the *Second Edition* include the following:

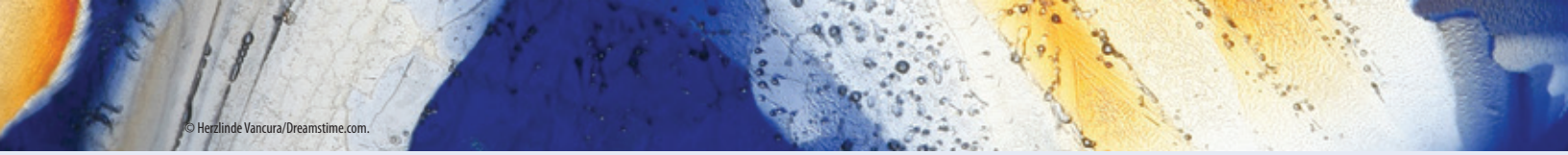
- Chapter 1 has been modified so that information on capsular patterns, manual muscle testing, and open- and close-packed positions has been transferred to the relevant chapters.
- Chapter 2 has condensed the information about the anatomy and biomechanics of the various musculoskeletal tissues so that the remaining chapters can focus more on orthopaedic assessment and treatment-related topics.
- Chapter 3 now includes updated details about the ever-evolving subject of concussion.
- Chapter 5 discusses the more common orthopaedic conditions that the PTA is likely to encounter. Because these conditions impact the whole body, they are afforded their own chapter.
- Chapter 6 provides much more detail about the physical therapist examination process in order to help the PTA understand the purposes behind each component.
- Chapter 8 was written to help the student PTA tackle what is perhaps one of the most difficult aspects of treatment—deciding how and when to progress a patient. Signs and symptoms that can act as guidelines are provided to help in that process.
- The chapters covering therapeutic exercise have been expanded to provide more examples, and a chapter about cardiovascular conditioning (Chapter 15) has been added. These chapters now

incorporate an enhanced explanation of exercise progressions, beginning with lower levels and progressing through the rehabilitation process to higher levels. Some more specific information related to exercise prescription, theory, and evidence is also included.

- Each of the joint chapters includes updated information on the pertinent anatomy and biomechanics, examination process, and a guide to the correct rehabilitation progression. At the end of each of these chapters, case studies are presented to help the student with the decision-making process.

I hope this text will be seen as the best available textbook, guide, review, and reference for orthopaedic students and practicing clinicians alike.

Mark Dutton



Features and Benefits

This text includes a range of pedagogical features to improve learning and retention.

Chapter Objectives are listed at the beginning of each chapter to guide the reader through the content and set the stage for focused reading. The Chapter Objectives are provided as a guide to assist students in identifying key learning outcomes.

CHAPTER OBJECTIVES

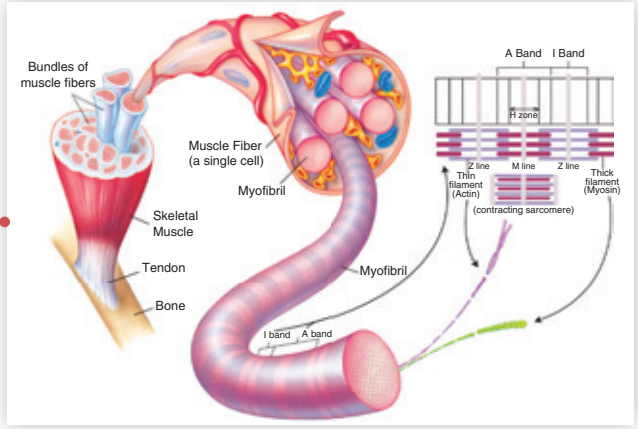
At the completion of this chapter, the reader will be able to:

1. Discuss the impact that direct access is having on the physical therapy profession.
2. Define evidence-based practice (EBP).
3. Describe the role of the physical therapist assistant (PTA) in the orthopaedic setting.
4. List the different members of the orthopaedic rehabilitation team and describe their respective roles.
5. Describe the model of disablement used by the *Guide to Physical Therapist Practice*.
6. Discuss the potential barriers to patient motivation and compliance.
7. Discuss the importance of cultural diversity.
8. Describe the various ways that the clinician can demonstrate empathy.
9. Describe the various components of patient education.
10. Discuss the recent changes in reimbursement (G-codes) and how productivity standards can impact reimbursement and patient care.

Overview

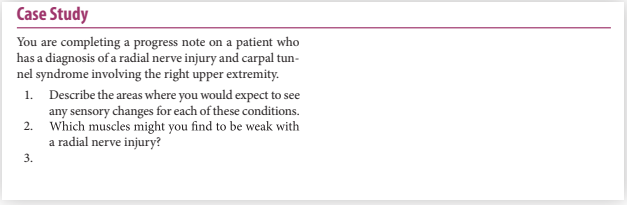
The American Physical Therapy Association (APTA) Vision Statement describes physical therapists (PTs) and physical therapist assistants (PTAs) as health-care professionals who are "transforming society by optimizing movement to improve the human experience." The physical therapy team plays vital roles in today's healthcare environment, and it is recognized as an essential provider of rehabilitation and habilitation, performance enhancement, and prevention and risk-reduction services.[1] The management of the orthopaedic patient involves a complex relationship

The **Overview** at the beginning of each chapter provides the reader with an introductory synopsis of the content to be covered.



This edition features **full-color photographs and illustrations** that showcase relevant anatomy as well as a range of assessment and rehabilitation techniques.

Key Point boxes throughout the text emphasize important concepts.

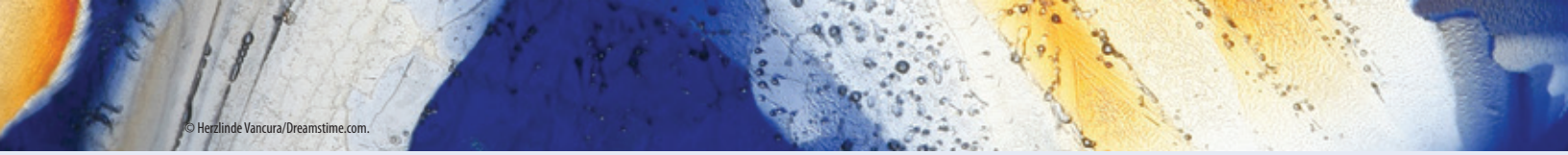

Case Study

You are completing a progress note on a patient who has a diagnosis of a radial nerve injury and carpal tunnel syndrome involving the right upper extremity.

1. Describe the areas where you would expect to see any sensory changes for each of these conditions.
2. Which muscles might you find to be weak with a radial nerve injury?
3.

The **Case Study** at the end of each chapter allows students to apply their knowledge to realistic scenarios through stimulating critical thinking questions.

End-of-chapter **Review Questions** test the student's retention of key concepts, and they can be checked against the end-of-text **Answer Key**.



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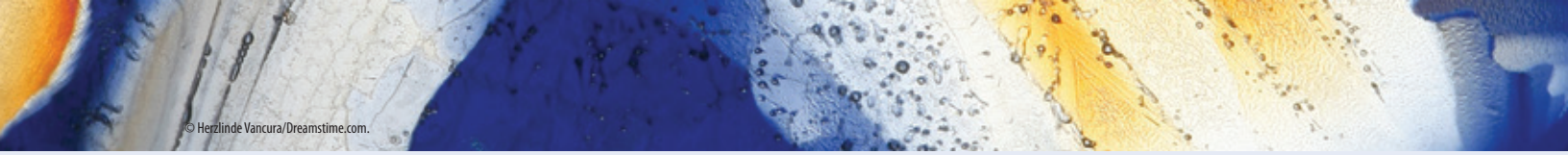

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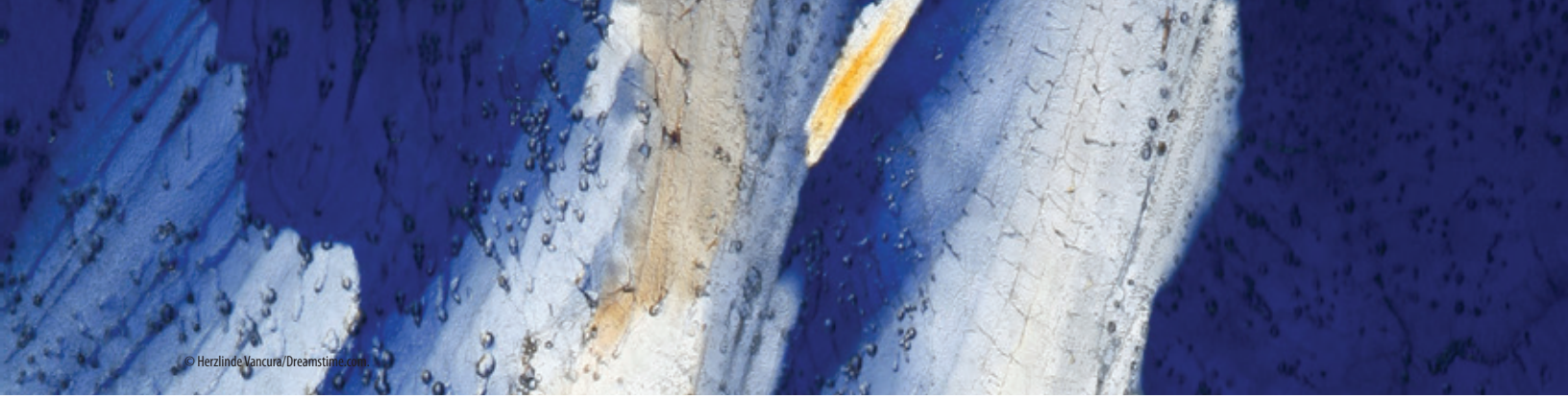
SECTION I

Fundamentals



CHAPTER 1

The Physical Therapist Assistant's Role in Orthopaedics

CHAPTER OBJECTIVES

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10. Discuss the recent changes in reimbursement (G-codes) and how productivity standards can impact reimbursement and patient care.

Overview

The American Physical Therapy Association (APTA) Vision Statement describes physical therapists (PTs) and physical therapist assistants (PTAs) as healthcare professionals who are "transforming society by optimizing movement to improve the human experience." The physical therapy team plays vital roles in today's healthcare environment, and it is recognized as an essential provider of rehabilitation and habilitation, performance enhancement, and prevention and risk-reduction services.[1] The management of the orthopaedic patient involves a complex relationship between the PT, the PTA, and the patient/client (while PTs see both patients and clients, for ease of reading, the term "patient/client" has been modified to "patient" throughout this text). The aim of the patient management process is to develop a rapport between the physical therapy team and the patient, while providing an efficient and effective exchange. The success of this process involves myriad skills. Successful physical therapy teams demonstrate effective teamwork and communication skills, clinical reasoning, critical judgment, creative decision making, knowledge, and competence. The PTA is an important member of this team. In addition to being responsible for an

appropriate level of patient supervision, the PTA must work closely with the PT, with the PT guiding the PTA when modifications or adjustments need to be made in the patient's plan of care (POC).

Direct Access

At present, there is some form of direct access in all 50 states, the District of Columbia, and the U.S. Virgin Islands. However, there are only 18 states in which there is "unrestricted" patient access, and 26 states that have "patient access with provisions." The APTA has made it clear that the ultimate objective is unrestricted direct access in every state and locality. In those states where there is unrestricted patient access, PTs now have the primary responsibility for being the gatekeepers of health care, and for making medical referrals. A critical role for both the PT and PTA is to be able to recognize signs and symptoms that indicate serious pathology, the so-called *red flags*. Red flag findings are symptoms or conditions that may require immediate attention, and which supersede physical therapy being the primary provider of service, as they are typically indicative of non-neuromusculoskeletal conditions or pathologies of visceral origin. Detection of a red flag findings can be made when testing for vital signs (see Chapter 6) or from observation of the patient. For example, the presence of any of the following findings may indicate serious pathology requiring a medical referral:

- Fevers, chills, or reports of night sweats
- Recent unexplained weight changes
- Malaise or fatigue
- Unexplained nausea or vomiting
- Reports of unilateral, bilateral, or quadrilateral paresthesias
- Shortness of breath
- Dizziness
- Nystagmus
- Reports of bowel or bladder dysfunction, severe pain, and/or radiculopathy

Such findings necessitate the PTA to contact the PT immediately.

Evidence-Based Practice

Evidence-based practice (EBP) involves the integration of three key elements: (1) best research evidence from systematic research, (2) clinical expertise, and (3) patient values. Judging the strength of the evidence becomes an important part of the decision-making process.[2] The decision-making process as it relates to the PTA is described in Chapter 8.

One of the major problems in evaluating studies is that the volume of literature makes it difficult for the busy clinician to obtain and analyze all of the necessary evidence. Additionally, an understanding of how to appraise the quality of the evidence offered by clinical studies and deciding whether the results from the literature are definite enough to indicate an effect other than chance is essential.[3]

The Role of the Physical Therapist Assistant

A Normative Model of Physical Therapist Assistant Education[4] is a consensus-based report developed by the APTA that establishes educational outcomes and performance expectations for the entry-level PTA. The purpose of the document is to consistently define and describe entry-level PTA professional education by providing details on primary content, instructional objectives, terminal behavioral objectives, and clinical education. The Normative model states:

> The mission of PTA professional education is to graduate knowledgeable, service-oriented, self-assured, adaptable, reflective practitioners who, by virtue of critical and integrative thinking, lifelong learning, and ethical values, render independent judgments concerning patient/client needs that are supported by evidence; promote the health of the client; and enhance the professional, contextual, and collaborative foundations for practice.

The first principle of APTA's vision for the profession is to transform society by optimizing movement to improve the human experience. Accordingly, the foundation and core of physical therapy practice, education, and research is the movement system, a complex behavior within a particular context. Members of the physical therapy profession are trained to have a unique knowledge of the movement system so that they can detect abnormalities and then correct those abnormalities using movement-related interventions.

The *Guide to Physical Therapist Practice* was developed by the APTA to describe physical therapist practice and to briefly outline the roles of PTs and PTAs across a broad range of settings and practice opportunities.[1] The *Guide* describes three main practice areas:[1]

- *Primary care*. "The provision of integrated, accessible healthcare services by clinicians who are

accountable for addressing a large majority of personal healthcare needs, developing a sustained partnership with patients, and practicing within the context of family and community."[5]

- *Secondary care*. Provided by PTs in a wide range of settings, including acute care and rehabilitation hospitals, outpatient clinics, home health, and school systems.
- *Tertiary care*. Provided by PTs in highly specialized, complex, and technology-based settings (e.g., heart and lung transplant services, burn units) or in response to the requests of other healthcare practitioners for consultation and specialized services (e.g., for individuals with spinal cord lesions or closed head trauma).

PTAs, under the direction and supervision of the PT, are the only individuals who assist a PT in the provision of selected interventions.

☑ KEY POINT

The APTA House of Delegates (HOD) first authorized the training of PTAs at the 1967 Annual Conference by adopting the policy statement *Training and Utilization of the Physical Therapist Assistant*. In 1977, the Commission on Accreditation in Education (CAE), the precursor to the Commission on Accreditation in Physical Therapy Education (CAPTE), was established and recognized by the U.S. Department of Education and by the Council on Postsecondary Accreditation. The activities of the CAE included accreditation of programs for PTAs.

☑ KEY POINT

Supervision of the PTA is governed by several factors including the following:

- APTA standards.
- Individual state and federal laws regulating practice acts, including administrative rules for practice. Supervision of the PTA may be spelled out separately from other support personnel, or the PTA may be included in language that defines supervision for all support personnel. When state laws do not delineate supervision requirements, PTs and PTAs should rely on the APTA guidelines. State regulations always supersede the APTA guidelines.
- Specifications of entitlement programs, such as Medicare.

It is the responsibility of the PT to examine the patient; evaluate the data and identify problems; determine the diagnosis, prognosis, and POC; and implement the POC (intervention).[1] (See Chapter 6 and Chapter 8.)

The PTA may help the PT with the initial examination, gathering specific data that the PT requests (**TABLE 1.1**). Following the initial examination, the PT evaluates the results of data collection and makes a judgment about data value. The PTA does not interpret the results of the initial examination. The PT establishes the goals or outcomes to be accomplished by the POC and treatment plan, and the PT and PTA perform the patient's interventions with the PTA performing selected interventions as directed by the PT. The PTA must always recognize when involvement of the PT is warranted.

☑ KEY POINT

The PTA is responsible for data collection; establishing and enhancing rapport, trust, and confidence with the patient; carrying out the PT's POC, assisting in the management of the patient by providing proper patient supervision, educating the patient, communicating with the PT; recording the patient's progress or lack of progress since the initial examination and evaluation, and providing clinical observation during treatment sessions. The PTA also may ask the PT to perform a reexamination as appropriate.

☑ KEY POINT

When performing data collection, it is important for the PTA to consider why a change in patient status has occurred. For example, when the PTA is using a goniometer to measure a patient's knee range of motion and finds that the patient is unable to perform the last 5 degrees of extension, the PTA should begin thinking about the possible reasons why the patient is unable to achieve full knee extension (e.g., swelling, pain, contracture, etc.). However, the PTA is obligated to consult with the supervising PT before making any changes outside of the POC.

Strong interpersonal communication between the patient and the PTA, together with keen observation skills, are needed for the PTA to function effectively and efficiently in conjunction with the PT. Sharp observation involves the PTA closely monitoring the

TABLE 1.1 Essential Data Collection Skills for the PTA Carrying Out an Orthopaedic Plan of Care

Aerobic Capacity and Endurance
Measures standard vital signs
Recognizes and monitors responses to positional changes and activities
Observes and monitors thoracoabdominal movements and breathing patterns with activity

Anthropometrical Characteristics
Measures height, weight, length, and girth

Arousal, Mentation, and Cognition
Recognizes changes in the direction and magnitude of patient's state of arousal, mentation, and cognition

Assistive, Adaptive, Orthotic, Protective, Supportive, and Prosthetic Devices
Identifies the individual's and caregiver's ability to care for the device
Recognizes changes in skin condition while using devices and equipment
Recognizes safety factors while using the device

Gait, Locomotion, and Balance
Describes the safety, status, and progression of a patient while engaged in gait, locomotion, and balance

Integumentary Integrity
Recognizes absent or altered sensation
Recognizes normal and abnormal integumentary changes

Joint Integrity and Mobility
Recognizes normal and abnormal joint movement

Muscle Performance
Measures muscle strength by manual muscle testing
Observes the presence or absence of muscle mass
Recognizes normal and abnormal muscle length
Recognizes changes in muscle tone

Pain
Administers standardized questionnaires, graphs, behavioral scales, or visual analog scales for pain
Recognizes activities, positioning, and postures that aggravate or relieve pain or altered sensations

Posture
Describes resting posture in any position
Recognizes alignment of trunk and extremities at rest and during activities

Range of Motion
Measures functional range of motion
Measures range of motion using a goniometer

Applicable Standards
Adjusts interventions within the POC established by the PT in response to patient clinical indications and reports this to the supervising PT
Recognizes when an intervention should not be provided due to changes in the patient's status, and reports this to the supervising PT
Reports any changes in the patient's status to the supervising PT
Recognizes when the direction to perform an intervention is beyond that which is appropriate for a PTA and initiates clarification with the PT
Participates in educating patients and caregivers as directed by the supervising PT
Provides patient-related instruction to patients, family members, and caregivers to achieve patient outcomes based on the plan of care established by the PT
Takes appropriate action in an emergency situation
Completes thorough, accurate, logical, concise, timely, and legible documentation that follows guidelines and specific documentation formats required by state practice acts, the practice setting, and other regulatory agencies
Participates in discharge planning and follow-up as directed by the supervising PT
Reads and understands the healthcare literature

patient's response to any of the interventions, and taking the necessary action to alert the supervising PT. In addition, much of what the PTA does involves sound decision-making (see Chapter 8) based on the recognition of subtle or profound changes in a patient's status, results from the vital signs (see Chapter 6), and correct interpretation of patient reports of items such as pain, fatigue, shortness of breath, and dizziness that may need to be reported to the PT.

Appearance

The appearance of the clinician is important to project a professional image. With each interaction, the patient is, consciously or subconsciously, formulating an opinion about the clinic environment and the entire clinical staff, from the receptionist to all members of the rehabilitation team. These patient observations continue throughout each session irrespective of whether a staff member is interacting directly with the patient, conversing with another patient, or communicating with another staff member. The patient also is likely to notice any nonverbal cues, such as voice volume, postures, mannerisms, gestures, and eye contact. Nonverbal cues are especially important as they often are performed subconsciously and can be misinterpreted. (See Chapter 6.) Most clinical facilities have a dress code in addition to a mandatory name tag. A dress code is designed to not offend patients or other members of the rehabilitation team and typically includes instructions on how to achieve the following:

- To prevent overexposure of the clinician. Most clinics do not allow the staff to wear clothing that exposes their midriff or armpits. Some clinics have strict guidelines for the number and location of exposed piercings and tattoos, hair color, and the use of nail polish.
- To prevent injury to a patient or staff member from jewelry, such as dangling earrings, necklaces, or bracelets.

The Rehabilitation Team

The responsibility for the patient's care is shared by the entire rehabilitation team, of which the PTA is a vital member (**TABLE 1.2**). As with the remainder of the team, the PTA must be responsible and accountable. The responsibility for the patient's care, however,

TABLE 1.2 Potential Key Members of the Orthopaedic Rehabilitation Team

Personnel	Function
Orthopaedic surgeon	Concerned with conditions involving the musculoskeletal system. Orthopaedic surgeons use both surgical and nonsurgical approaches to treat musculoskeletal trauma, sports injuries, degenerative diseases, infections, tumors, and congenital disorders.
Physiatrist	A physician specializing in physical medicine and rehabilitation, certified by the American Board of Physical Medicine and Rehabilitation. The primary role of the physiatrist is to diagnose and treat patients with disabilities involving musculoskeletal, neurological, cardiovascular, or other body systems.
Primary care physician (PCP)	A practitioner, usually an internist, general practitioner, or family medicine physician, providing primary care services and managing routine healthcare needs. Most PCPs serve as gatekeepers for managed-care health organizations, providing authorization for referrals to other specialty physicians or services, including physical therapy.
Chiropractor (DC)	A doctor trained in the science, art, and philosophy of chiropractic. A chiropractic evaluation and treatment provides a structural analysis of the musculoskeletal and neurological systems of the body. According to chiropractic doctrine, abnormal function of these two systems may affect function of other systems in the body.

(continues)

TABLE 1.2 Potential Key Members of the Orthopaedic Rehabilitation Team *(continued)*

Personnel	Function
Physical therapy director/manager	Typically a PT who has demonstrated qualifications based on education and experience in the field of physical therapy and who has accepted the inherent responsibilities of the role. He or she establishes guidelines and procedures that will delineate the functions and responsibilities of all levels of physical therapy personnel in the department and the supervisory relationships inherent to the functions of the department and the health system. This person also ensures that the objectives of the service are efficiently and effectively achieved within the framework of the stated purpose of the organization and in accordance with safe physical therapist practice, interprets administrative policies, acts as a liaison between line staff and administration, and fosters the professional growth of the staff.
Staff physical therapist (PT)	The staff PT is responsible for the examination, evaluation, diagnosis, prognosis, and intervention of patients. He or she assists in the supervision of physical therapy personnel in the service.
Physical therapist assistant (PTA)	A PTA works under the supervision of a PT. Care provided by a PTA may include teaching patients/clients exercises for mobility, strength, and coordination, and training patients for activities such as walking with crutches, canes, or walkers, and using adjunctive interventions. The PTA may modify an intervention only in accordance with changes in patient status and within the established plan of care developed by the PT.
PT/OT aide	Aides are support personnel who may be involved in support services directed by PTs and PTAs. They receive on-the-job training and are permitted to function only with continuous on-site supervision by a PT, or in some cases, a PTA. Their duties are limited to those methods and techniques that do not require clinical decision making or clinical problem solving by a PT or a PTA.
PT or PTA student	The PT or PTA student can perform duties commensurate with their level of education. The PT clinical instructor (CI) is responsible for all actions and duties of the affiliating student, and can supervise both PT and PTA students. (A PTA may only supervise a PTA student, not a PT student.)
Volunteer	A member of the community who is interested in assisting with rehab departmental activities. Responsibilities include taking phone messages and basic nonclinical/secretarial duties. Volunteers may not provide or set up patient treatment, transfer patients, clean whirlpools, or maintain equipment.
Occupational therapist (OT)	Assess functioning in activities of everyday living, including dressing, bathing, grooming, meal preparation, writing, and driving, which are essential for independent living. The minimum educational requirements for the registered OT are described in the current *Essentials and Guidelines of an Accredited Educational Program for the Occupational Therapist*.
Certified OT assistant (COTA)	Works under the direction of an OT. He or she performs a variety of rehabilitative activities and exercises as outlined in an established treatment plan. The minimum educational requirements for the COTA are described in the current *Essentials and Guidelines of an Accredited Educational Program for the Occupational Therapy Assistant*.

TABLE 1.2 Potential Key Members of the Orthopaedic Rehabilitation Team *(continued)*

Personnel	Function
Certified orthotist (CO)	Designs, fabricates, and fits orthoses (e.g., braces, splints, collars, corsets), prescribed by physicians, to patients with disabling conditions of the limbs and spine.
Certified prosthetist (CP)	Designs, fabricates, and fits prostheses for patients with partial or total absence of a limb.
Physician assistant (PA)	A medically trained professional who can provide many of the healthcare services traditionally performed by a physician, such as taking medical histories and doing physical examinations, making a diagnosis, and prescribing and administering therapies.
Nurse practitioner (NP)	A registered nurse with additional specialized graduate-level training who can perform physical exams and diagnostic tests, counsel patients, and develop treatment programs.
Athletic trainer–certified (ATC)	A professional specializing in athletic health care. In cooperation with the physician and other allied health personnel, the athletic trainer functions as an integral member of the athletic healthcare team in secondary schools, colleges and universities, sports medicine clinics, professional sports programs, and other athletic healthcare settings.

also requires the active participation of the patient. **TABLE 1.3** provides the standards for the PTA's role in administering physical therapy.

☑ KEY POINT

The PTA should always be looking for ways to establish relationships with the other team members and to use the resources that they can provide.

TABLE 1.3 The PTA's Role in Administration

Administration

Standard 3.3.2.21. Interacts with other members of the healthcare team in patient-care and non–patient-care activities

Standard 3.3.2.22. Provides accurate and timely information for billing and reimbursement purposes

Standard 3.3.2.23. Describes aspects of organizational planning and operation of the physical therapy service

Standard 3.3.2.24. Participates in performance improvement activities (quality assurance)

Data from Accreditation Handbook: PTA Criteria, Appendix A-3.

Fundamental differences involving protocols and treatment approaches can exist among the members of the rehabilitation team due to different backgrounds and types of education; these can place the PTA in uncomfortable situations. For example, when transferring the patient from a bed to a chair, a nurse may insist that the PTA transfers the patient using a technique that the PTA considers will put the patient at increased risk. Differences also may exist within the physical therapy team, as most PTs have a varied background in terms of extracurricular education and experience, which can make them lean toward certain treatment philosophies. For example, a PT that is certified in the McKenzie method may approach a patient differently than a PT who uses the Maitland approach. The PTA must use these scenarios as opportunities for communication, learning, and increased understanding of the other team members.

Models of Disablement

A disablement model is designed to detail the functional consequences of and relationships among disease, impairment, and functional limitations (**TABLE 1.4**). The PTA's understanding of the process

TABLE 1.4 Disablement Model Comparisons

The International Classification of Functioning, Disability, and Health (ICFDH-I)	Nagi Disablement Model	The International Classification of Functioning, Disability, and Health (ICFDH-II)
Disease The intrinsic pathology or disorder	Pathology/Pathophysiology Interruption of or interference with normal processes and efforts of an organism to regain normal state	Health Condition Dysfunction of a body function and/or structure
Impairment Loss or abnormality of psychological, physiologic, or anatomic structure or function	Impairment Anatomic, physiologic, mental, or emotional abnormalities or loss	Impairment Problems in body function or structure such as a significant deviation or loss
Disability Restriction or lack of ability to perform an activity in a normal manner	Functional Limitation Limitation in performance at the level of the whole organism or person	Activity Limitation Limitation in execution of a task or action by an individual
Handicap Disadvantage or disability that limits or prevents fulfillment of a normal role (depends on age, gender, and sociocultural factors for the person)	Disability Limitation in performance of socially defined roles and tasks within a sociocultural and physical environment	Participation Restriction Prevents fulfillment of involvement in a life situation

of disablement, and the factors that affect its development, is crucial to achieving the goal of restoring or improving function and reducing disability in the individual. The *Guide to Physical Therapist Practice* employs terminology from the Nagi disablement model (an example of which is shown in **TABLE 1.5**),[6] but also describes its framework as being consistent with other disablement models.[7] In 1980, the Executive Board of the World Health Organization (WHO) published a document for trial purposes, the *International Classification of Functioning, Disability, and Health* (ICFDH-I or ICF). In 2001, a revised edition was published (ICFDH-II). In 2008, the APTA HOD endorsed the ICF because of its focus on the components of health rather than on the consequences of disease, and because environmental and personal factors were considered as important determinants of health functioning.[8]

The ICF has two major parts:[1]

- Part 1 is a description of the components of functioning and disability that are associated with a health condition and includes body functions and body structures and the changes that occur in them, activities that the person carries out, and the participation of the person in life situations. Activities and participation can be further qualified by

TABLE 1.5 Example of Nagi Disablement Model

Pathology/Pathophysiology	Impairment	Related Functional Limitation	Disability
Osteoarthritis	Loss of range of motion (ROM) Muscle weakness	Slow, painful gait—unable to ambulate 20 feet in 9 seconds Unable to rise from chair Unable to ascend/descend 10 steps	Does not leave house

considering a person's capacity (i.e., what could be done in a controlled environment), and performance (i.e., what the person actually does in his or her current environment). Functioning is used to encompass all body functions and structures, activities, and participation; conversely, disability is used to encompass impairments of body functions and structures, activity limitations, and participation restrictions. Functioning and disability exist along a continuum of health.

- Part 2 is a description of the contextual factors. Among contextual factors are external environmental factors (e.g., social attitudes, architectural characteristics, legal and social structures, and climate and terrain) and internal personal factors (e.g., gender, age, coping styles, social background, education, profession, past and current experience, overall behavior pattern, character, and other factors) that influence how disability is experienced by the individual. Personal factors are not yet classified by the ICF, but do influence functioning.

Personality

A clinician's personality type can influence the interactions with patients in terms of reassurance and trust. Personality has been studied for centuries and several models have gained more popularity. One commonly used model, based on the work of psychologist William Marston, is known as the DISC personality model.

- *Dominance*. Relates to exerting control, power, and assertiveness. The clinician must be aware that there is a possibility that this trait can be interpreted as demonstrating hostility and indifference.
- *Influence*. Relates to an individual's ability to control social situations and communication. This personality trait can be useful for the clinician.
- *Steadiness*. Relates to patience, persistence, and thoughtfulness. These are key traits for a clinician to possess.
- *Compliance*. Relates to structure and organization.

Ideally, the clinician's personality should be a blend of these traits so that he or she purveys an air of interest, acceptance, and especially, empathy.

Values and Beliefs

Throughout life, every individual consciously or otherwise develops a system of values and beliefs that have been honed by prior experiences. Values and beliefs guide actions and behavior and help to form attitudes toward different people and situations. Values are characteristics that are considered important to an individual. Examples include concepts like loyalty, perseverance, honesty, and effort. Beliefs are expectations that are made based on life experiences. Examples include racial equality, gender bias, and religion. Bias, whether it be positive or negative, can impact someone's beliefs. The most common negative biases of healthcare workers involve the following:

- Race/ethnicity
- Gender
- Ageism
- Obesity
- Disability

It is important that the PTA forms judgments that are not critical, biased, or based on disapproval. Instead, conscious effort should be made to accept differences that serve the well-being of the patients.

Cultural Influences

It is important that clinicians are sensitive to cultural issues in their interactions with patients. Cultural influences shape the framework within which people view the world, define and organize reality, and function in their everyday life. In many cases individuals group themselves on the basis of cultural similarities, and as a result, form cultural groups.

☑ KEY POINT

Ethnocentrism is the tendency to believe that one's ethnic or cultural group is centrally important, and that all other groups are measured in relation to one's own. The ethnocentric individual will judge other groups relative to his or her own particular ethnic group or culture, especially with concern to language, behavior, customs, and religion. An example would be a patient believing they would receive a better level of care if they are seen by a clinician of the same race and religion.

Cultural groups share behavioral patterns, symbols, values, beliefs, and other characteristics that distinguish them from other groups. At the group level, cultural differences are generally variations of differing emphasis or value placed on particular practices. Whenever possible, the PTA should use any available resource, such as an interpreter.

In a similar fashion, PTAs need to be sensitive to the needs of lesbian, gay, bisexual, and transgender

(LGBT) patients and treat them as individuals. This is particularly true with regard to transgender patients, who often face healthcare discrimination, due in part to a lack of transgender-specific initiatives within healthcare institutions or professional associations. Although the APTA Code of Ethics does not specifically address people who are transgender, Principle 1 states that "Physical therapists shall respect the inherent dignity and rights of all individuals." Principle 1A adds, "Physical therapists shall act in a respectful manner toward each person regardless of age, gender, race, nationality, religion, ethnicity, social or economic status, sexual orientation, health condition, or disability." To help bridge the gap and to decrease concerns, clinicians should attend cultural competency training. In addition, clinics can modify their intake forms to include questions such as "What was your gender assigned at birth?" and "What is your current gender identity?" and, where feasible, have gender-neutral restrooms. What follows are some terms related to transgender issues:

- *Transgender*. This term is used for people whose gender identity and/or expression is different from cultural expectations based on the gender they were assigned at birth. This population may identify as straight, gay, lesbian, bisexual, etc.
- *Gender identity*. This is how people perceive themselves: as male, female, a blend of both, or neither. One's gender identity can be different or the same from their gender assigned at birth.
- *Gender expression*. This is how an individual expresses themselves through behavior, clothing, hairstyle, and/or voice.

Motivation and Compliance

Many factors can contribute to the patient's resistance to improvement. In some cases, it may be an individual factor that, when eliminated, will allow the patient to respond well. In the majority of cases, the resistance to improvement is based on the interaction of multiple factors, which must be recognized and corrected. Patient motivation and compliance are paramount in the rehabilitation program.

Motivation

Anecdotally, unmotivated patients may progress more slowly. Much literature has conceptualized or reported poor motivation in rehabilitation as secondary to patient-related factors, including depression, apathy, cognitive impairment, low self-efficacy (e.g., low confidence in one's ability to successfully rehabilitate), fatigue, and personality factors.[9]

Compliance

Compliance is vitally important and varies from patient to patient. Several factors that have been outlined to improve compliance are as follows:[10–12]

- Involving the patient in the intervention planning and goal setting
- Setting realistic short- and long-term goals
- Promoting high expectations regarding final outcome
- Promoting perceived benefits
- Projecting a positive attitude
- Providing clear instructions and demonstrations with appropriate feedback
- Keeping the exercises pain-free or with a low level of pain
- Encouraging patient problem solving

☑ KEY POINT

Various studies have found that compliance with physical therapy programs is approximately 40 percent.

Patient Education

Patient-related instruction forms the cornerstone of every intervention and POC (**TABLE 1.6**). It is imperative that the PTA spend time educating the patient about his or her condition, so the patient can fully understand the importance of his or her role in the rehabilitation process and become an educated consumer. Educating the patient about strategies to adopt in order to prevent recurrences and to self-manage his or her condition is also important to ensure an interactive environment. The aim of patient education is to create independence, not dependence, and to foster an atmosphere of learning in the clinic. A detailed explanation should be given to the patient in a language

TABLE 1.6 The Role of the PTA in Patient Education

Education
Standard 3.3.2.19. Under the direction and supervision of the physical therapist, instructs other members of the healthcare team using established techniques, programs, and instructional materials commensurate with the learning characteristics of the audience
Standard 3.3.2.20. Educates others about the role of the physical therapist assistant

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that he or she can understand. This explanation should include the following:

- *The name of the structure(s) involved, and the cause of the problem.* Whenever possible, an illustration or model of the involved structure should be shown to the patient to explain principles in layperson's terms.
- *Information about the interventions that are planned, and the PT's prognosis for the problem.* An estimation of healing time is useful for the patient, so he or she does not become frustrated at a perceived lack of progress.
- *What the patient can and cannot do.* This includes the allowed use of the joint or area, and a brief description about the relevant stage of healing and the vulnerability of the various structures during the pertinent healing phase. This information makes the patient aware and more cautious when performing activities of daily living (ADLs), recreational activities, and the home exercise program. Emphasis should be placed on dispelling the myth of "no pain, no gain." Instead, patients should be encouraged to respect pain. Also, patients often have misconceptions about when to use heat and ice, and it is the role of the clinician to clarify such issues.
- *Home exercise program.* Before instructing a patient on his or her home exercise program (HEP), the PTA should take into consideration the time that will be needed to perform the program. In addition, the level of tolerance and motivation for exercise varies among individuals, and it is based on their diagnosis and stage of healing. A short series of exercises, performed more frequently during the day, should be prescribed for patients with poor endurance or when the emphasis is functional reeducation. Longer programs, performed less frequently, are aimed at building strength or endurance. Each HEP needs to be individualized to meet the patient's specific needs. The patient's HEP should start on the first day of intervention and continue through and beyond the day of discontinuation of physical therapy. At the earliest opportunity, the patient must be educated about the signs and symptoms that warrant discontinuation of an exercise and when the PT or physician should be contacted. The HEP must be modified continuously and follow the guidelines in **TABLE 1.7**. Any prescribed exercise should be simple, and instructions should include the frequency, number of repetitions, number of sets, how long to hold, the amount of exercise resistance, and the position for performing the exercise. Whenever possible, pictures of the exercises should be provided to maximize carryover.

TABLE 1.7 Basic Requirements for the Home Exercise Program (HEP)

The HEP should be organized, concise, and written in layperson's terms (fifth- or sixth-grade reading level) using a font size of 12 points or larger.
The HEP should represent an extension of the interventions.
The HEP should include uncomplicated diagrams or pictures.

Data from Dreeben O: *Introduction to physical therapy for physical therapist assistants.* Sudbury, MA, Jones & Bartlett Learning, 2007.

☑ KEY POINT

Educational materials need to be written in plain language, and they must use the same words consistently. Sentences should be short and simple, with each item preceded by a bullet point. Instructions should be taught one step at a time using appropriate demonstrations and descriptions.

There are probably as many ways to teach as there are to learn. The PTA needs to be aware that people may have different preferences for how, when, where, and how often to learn. It is not within the scope of this text to discuss all of the theories on learning, but an overview of the major concepts is merited. Litzinger and Osif[13] organized individuals into four main types of learners, based on instructional strategies:

1. *Accommodators.* This type of learner relies heavily on other people for information rather than on their own analytic ability, often enjoy being active participants in their learning, and will ask many questions, such as, "What if?" and "Why not?" For example, when instructing such a patient about the precautions following a total hip replacement, the patient may ask why they are being told not to place any weight through the involved hip. (See Chapter 23.)
2. *Divergers.* This type is motivated to discover the relevancy of a given situation and prefers to have information presented in a detailed, systematic, and reasoned manner. For example, this type of learner prefers to have the information provided in a sequential fashion with the rationale for each stage.

3. *Assimilators.* This type is motivated to answer the question, "What is there to know?" These learners like accurate, organized delivery of information, and they tend to respect the knowledge of the expert. They are perhaps less instructor-intensive than some other types of learners and will carefully follow prescribed exercises, provided a resource person is clearly available and able to answer questions. For example, this type would respond well to clear verbal and written instructions, the rationale behind the exercises, and specific details regarding how often the exercises should be performed.
4. *Convergers.* This type of learner can make decisions and apply practical ideas to solve problems. Generally, these people can organize knowledge by using hypothetical deductive reasoning. The instructions given to this type of learner should be interactive, not passive. For example, this type responds well to being asked to demonstrate an exercise rather than hearing a description.

Another frequently used way of classifying learners describes three common learning styles:

1. *Visual.* As the name suggests, the visual learner assimilates information by observation, using visual cues and information such as pictures, anatomic models, and physical demonstrations.
2. *Auditory.* Auditory learners prefer to learn by having things explained to them verbally.
3. *Tactile.* Tactile learners, who learn through touch and interaction, are the most difficult of the three groups to teach. Close supervision is required with this group until they have demonstrated to the clinician that they can perform the exercises correctly and independently. Proprioceptive neuromuscular facilitation (PNF) techniques, with the emphasis on physical and tactile cues, often work well with this group. (See Chapter 9.)

A patient's learning style can be identified by asking how he or she prefers to learn. Some patients prefer a simple handout with pictures and instructions; others prefer to see the exercises demonstrated and then be supervised while they perform the exercises. Some may want to know why they are doing the exercises, which muscles are involved, why they are doing three sets of a particular exercise, and so on. Others will require less explanation.

☑ KEY POINT

When educating a patient who has a hearing impairment, the PTA should choose a quiet environment, face the patient, and speak clearly without exaggerating the pronunciation.

If in doubt about the patient's learning style, it is recommended that each exercise first be demonstrated by the clinician and then by the patient, both at the end of a session and at the beginning of the next session. The rationale and purpose behind each of the exercises must be given, as well as the frequency and intensity expected.

☑ KEY POINT

The PTA should always consider cultural diversity and pay attention to nonverbal communication such as voice volume, postures, gestures, and eye contact.

It is important that the patient view his or her rehabilitative progression with a healthy respect for pain, combined with the importance of returning to normal levels of function as early as possible. The assessment of pain is described in Chapter 6. Pain is, unfortunately, a necessary component of the healing process; however, the patient needs to be educated about what constitutes healing pain in comparison to harmful pain (an increase in pain that lasts more than 2–4 hours). Clear instructions must be given to the patient on how to recognize injurious pain and how to avoid additional strain.

The frequency and duration of the patient's care need to be addressed with the PT. The common practice is to see patients two to three times per week; however, this is not always necessary, particularly with well-motivated patients. It is the duty of all clinicians to make the patient's visit meaningful. Clinic visits must include a level of skilled intervention that the patient cannot receive in the home environment. Placing the patient on a hot pack and then having him or her perform a routine rehabilitation program that is not constantly being updated or modified is a waste of the patient's time and does little to foster public confidence in the profession. Each session must have a purpose. The PTA should attempt to explain any gains or losses the patient has made since the previous session and provide the possible reasons. New goals should be

discussed, and any changes to the intervention plan and their rationale should be discussed with the PT and then the patient.

Privacy and Patient Confidentiality

A patient's privacy and dignity should be maintained at all times. Whenever appropriate, the clinician should ask permission from the patient before carrying out an action (moving the patient's belongings, sitting down, etc.). The full name of the patient is considered Protected Health Information (PHI) under the Health Insurance Portability and Accountability Act (HIPAA). Therefore, many facilities use the first name only, or the first name and middle or last initial.

In the majority of situations, the patient's written authorization is required for the release of medical information. For example, authorization is required for the release of medical information for the following reasons:

- To any member of the patient's family (except where a member of the family has received durable power of attorney for healthcare agencies)
- To the patient's attorney or insurance company
- To the patient's employer (unless a workers' compensation claim is involved)

Reimbursement

The Middle Class Tax Relief and Jobs Creation Act (MCTRJCA) of 2012 amended the Social Security Act to require a claims-based data collection system for outpatient therapy services (Medicare and Medicaid services), including physical therapy (PT), occupational therapy (OT), and speech-language pathology (SLP) services. The system collects data included on Medicare claim forms to better understand beneficiary conditions, outcomes, and expenditures to establish an evidence-based connection between rehab therapy treatment and patient progress. Originally, inclusion of the G-codes was required to fulfill requirements for Physician Quality Reporting System (PQRS) and Functional Limitation Reporting (FLR). Physical therapists in private practice have participated in the PQRS since 2007. However, effective January 1, 2017, PQRS was moved into the Merit-based Incentive Payment System (MIPS) which, in turn, is part of the new Quality Payment Program (QPP) created by the Medicare Access and Children's Health Insurance Program (CHIP) Reauthorization Act of 2015 (MACRA). Although rehab therapists currently no longer have to report G-codes for PQRS, they still have to submit the FLR G-codes, at least for the time being (PTs are not yet included in mandated reporting under MIPS but are likely to be added in 2019).

Beneficiary function information is reported using 42 nonpayable FLR G-codes (14 sets of three codes each) and seven severity/complexity modifiers on claims for PT, OT, and SLP services. Eight sets of G-codes generally describe SLP functional limitations, while six of the G-code sets generally describe PT and OT functional limitations. (See Appendix G for further information.) Clinicians must report functional limitation data in the form of G-codes together with the corresponding severity and therapy modifiers at the initial examination, at a minimum of every tenth visit, and at discharge for all patients who have Medicare proper as their primary or secondary insurance. Medicare does not reimburse providers who submit claims lacking FLR data.

Once MIPS is introduced into physical therapy practices, there will be four distinct performance categories:

- *Quality*. Includes clinical process and outcome measures, many of which were reported under the PQRS requirements. The goal will be to decrease provider burden, while preserving independent clinical practice.
- *Cost*. Promotes the adoption of alternative payment models (APMs) to align incentives across all healthcare stakeholders, which are based on the severity of specific conditions or diseases, episodes of care, or different patient populations. In essence, the APMs are designed to offer participating clinicians incentive payments for improving quality while reducing care costs. Advanced APMs offer participants opportunities to earn higher incentive payments for taking on additional risks based on patient outcome measures.
- *Advancing care information*. Promotes patient engagement and the electronic exchange of information using certified electronic health record technology.
- *Improvement activities*. Includes activities that improve clinical practice, such as shared decision making, increasing practice access, patient safety population management, and care coordination.

Private practices will have two tracks from which to choose:

- *MIPS*. Under the MIPS, an eligible practice earns points in each performance category to produce a total annual MIPS score, which determines whether the practice earns a payment incentive, remains neutral in payment, or is subject to a penalty.
- *Advanced APM*. Under this system, practices may earn a Medicare incentive payment for participating

in an existing innovative payment model or one that the practice proposes and is approved. Currently, providers are eligible to take part in an advanced APM if they receive at least 25 percent of their Medicare part B payments through the advanced APM, or if they deliver care to at least 20 percent of their Medicare patients through the advanced APM.

Productivity

In an era of increased demands for efficiency, the performance of PTAs is increasingly being judged by employer-established productivity standards. Productivity is essentially a balance between quality and quantity and can be measured by employers in a variety of ways. For example, productivity can be measured by patients per day or by number of charges (CPT codes) per patient.

These productivity standards can place the clinician in a difficult position, especially when the clinician feels that he or she has to perform interventions that are not evidence-based and not beneficial for the patient in order to generate a sufficient number of charges. Productivity standards have a tendency to switch the emphasis from patient-focused to volume-driven patient care, and they can create conflict between the need for more revenue and the importance placed on the clinician's clinical judgment and professional expertise.

If the goal is to improve individual patient outcomes, improve the health of populations, and reduce costs, then quality must be measured over quantity and value over volume. One of the issues with productivity standards when they use the number of CPT codes charged per patient by a clinician is that time spent on patient education, meeting with the patient's family or social worker, and documentation are not taken into consideration. Another issue with this method is that it does not take into account the type of patient being seen by the clinician. For example, a clinician seeing an orthopedic patient who has significant comorbidities requires more time to rest between activities than a young, athletic patient. Finally, in an outpatient setting the cancellation/no-show rate can significantly impact productivity. The PTA can play a vital role in maintaining appropriate productivity by being efficient with documentation, preparing equipment necessary for patient care ahead of time, and by appropriately delegating tasks to physical therapy aides.

Summary

The role of the PTA in the orthopaedic setting continues to evolve, and the responsibilities placed on the PTA continue to increase. With this increased responsibility comes the need to be fully prepared by having a sound knowledge base from which to work. However, what has not changed is the importance of communication among the PTA, the PT, the patient, and other members of the healthcare team.

Learning Portfolio

Case Study

A new manager has been appointed at your clinic and she has been reviewing the productivity levels of the department. She calls a morning staff meeting and decides to give the staff the option to vote between two productivity standards: (1) patients per day and (2) charges per patient.

1. If you were voting, which of the two options would you choose? Why?

Later that morning, a patient who is not on the schedule comes into the clinic and asks to speak with a staff member. Because you are the only one available, you meet with the patient, who proceeds to tell you that she is a member of the LGBT community and wants to know your clinic's policy on seeing this population.

2. What is your response to the patient?
3. Is this a matter that requires you to inform your supervising PT? Why or why not?

That afternoon, you notice a patient on a schedule from a PT who is not your regular supervising therapist and you note that the PT has prescribed a manual therapy technique with which you are not familiar.

4. What is your best course of action?

Review Questions

1. A physical therapist asks you to perform a joint mobilization. Whether you can perform the mobilization depends which of the following?
   a. Ethical principles
   b. State licensure laws
   c. Departmental procedures
   d. Whether the patient has medical insurance
2. Which of the following was developed to "encourage a uniform approach to physical therapist practice and to explain to the world the nature of that practice"?
   a. State licensure laws
   b. The *Guide to Physical Therapist Practice*
   c. National Physical Therapy Examination
   d. Medicare Act of 1973
3. What is the function of the Commission on Accreditation in Physical Therapy Education (CAPTE)?
   a. To design policies and procedures with regard to physical therapy
   b. To make autonomous decisions concerning the accreditation status of continuing education programs for physical therapists and physical therapist assistants
   c. To design questions for the National Physical Therapy Examination
   d. To oversee state licensing laws
4. A loss or abnormality of anatomic, physiological, or psychological structure or function is a description of which category of the disablement model?
   a. Impairment
   b. Functional limitation
   c. Disability
   d. None of the above
5. Which of the following statements is true about the plan of care?
   a. It is based on the examination, evaluation, diagnosis, and prognosis, including the predicted level of optimal improvement.
   b. It describes the specific interventions to be used and the proposed frequency and duration of the interventions that are required to reach the anticipated goals and expected outcomes.
   c. It includes plans for discharge of the patient, taking into consideration achievement of anticipated goals and expected outcomes, and provides for appropriate follow-up or referral.
   d. All of the above.
6. **True or false:** A PTA may modify an intervention only in accordance with changes in patient status and within the established plan of care developed by the physical therapist.
7. A physical therapist assistant legally cannot perform which of the following duties?
   a. Call a physician about a patient's status
   b. Add 3 pounds to a patient's current exercise protocol
   c. Allow a patient to increase in frequency from 2 times per week to 3 times per week
   d. Perform an ultrasound on a patient
8. A PTA is performing a chart review and discovers that lab results reveal that the patient has malignant cancer. When later treating the patient, the PTA is asked by the patient, "Did my lab results come back?" Which of the following is the appropriate response for the physical therapist assistant?
   a. To inform the patient about the results and contact the social worker to assist in consultation of the family
   b. To inform the patient that it would be inappropriate for you to comment on the lab results before the physician has assessed the lab results and spoken to the patient
   c. To inform the patient that he or she has a malignant cancer
   d. To tell the patient the results are in, but that PTAs are not allowed to comment on the results

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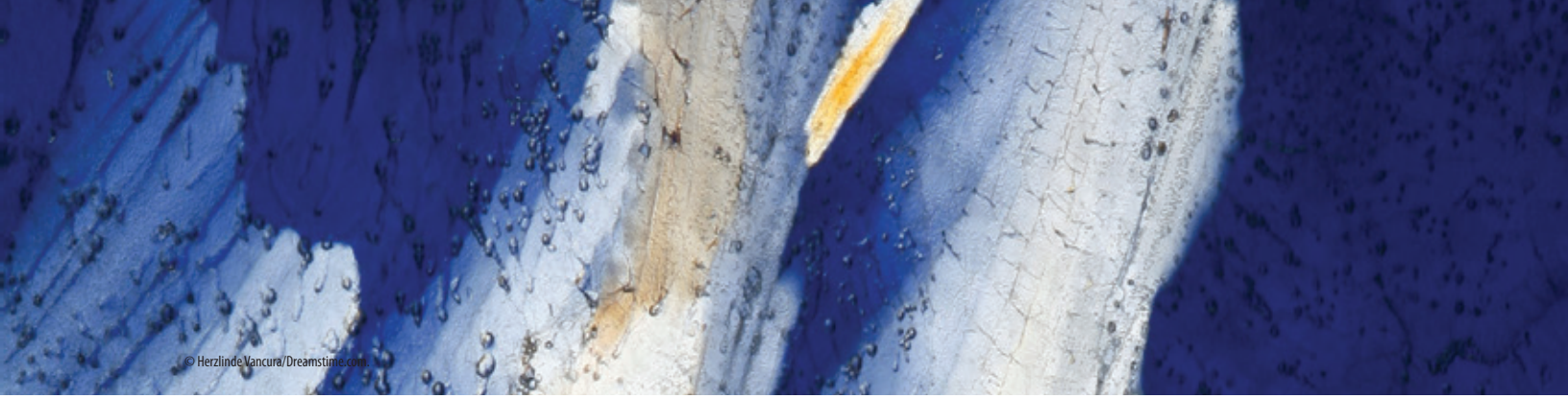

CHAPTER 2

Anatomy and Biomechanics of the Musculoskeletal System

CHAPTER OBJECTIVES

At the completion of this chapter, the reader will be able to:

1. Describe the various structures of the musculoskeletal system.
2. Describe the types of connective tissue related to orthopaedics.
3. Outline the function of the various components of connective tissue, including collagen and elastin.
4. Describe the structural differences and similarities among fascia, tendons, and ligaments.
5. Describe the structure and function of a bone as it relates to physical therapy.
6. Outline the different types of cartilage tissue.
7. Define the main constituents of a synovial joint.
8. Describe the main cellular components of skeletal muscle.
9. Outline the sequence of events involved in a muscle contraction.
10. Summarize some key terms used in the study of biomechanics.
11. Define the impact that various forces can have on the body and how those forces can result in injury.
12. Define the terms *osteokinematic motion* and *arthrokinematic motion*.
13. Differentiate between the different types of arthrokinematic motions that can occur at the joint surfaces.
14. Describe the basic biomechanics of joint motion regarding their concave–convex relationships.
15. Discuss the differences between hypomobility, hypermobility, and instability.

Overview

A working knowledge of the musculoskeletal system forms the foundation of every orthopaedic assessment and intervention by a physical therapist assistant (PTA). A basic tenet in the study of anatomy and biomechanics is that design relates to function, in that the purpose of a structure determines its design and vice versa. The word *kinesiology* derives from the Greek *kinesis*, to move, and *ology*, to study. The science of kinesiology involves the application of mechanical principles to the study of the structure and function of movement.

Musculoskeletal Tissue

By design and function, the tissues of the body originate from four basic kinds: epithelial, nervous, connective, and muscle.

- *Epithelial tissue.* Found throughout the body in two forms: membranous and glandular. Membranous epithelium forms such structures as the outer layer of the skin, the inner lining of the body cavities and lumina, and the covering of visceral organs. Glandular epithelium is a specialized tissue that forms the secretory portion of glands.
- *Nervous tissue.* Helps coordinate movements via a complex motor control system of prestructured motor programs and a distributed network of reflex pathways mediated through the autonomic, peripheral, and central nervous systems.[1] (See Chapter 3 for further description.)
- *Connective tissue.* Found throughout the body, it is divided into subtypes according to the matrix that binds the cells. Connective tissue provides structural and metabolic support to other tissues and organs of the body. It includes bone, cartilage, tendons, ligaments, fascia, and blood tissue. The properties of connective tissue are described in the next section of this chapter.
- *Muscle tissue.* Responsible for the movement of circulatory materials through the body, the movement of one part of the body on another, and locomotion. There are three types of muscle tissue: smooth, cardiac, and skeletal. In this chapter, human skeletal muscle tissue is described.

☑ KEY POINT

Together, connective tissue and skeletal muscle tissue make up the musculoskeletal system. The musculoskeletal system functions intimately with nervous tissue to produce coordinated movement and adequate joint stabilization and feedback during sustained positions and purposeful movements, such as when climbing or dancing.

Connective Tissue

TABLE 2.1 summarizes the anatomic and functional characteristics of the four types of connective tissue that predominate in the joints of the musculoskeletal system.

The primary types of connective tissue cells are fibroblasts; macrophages, which function as phagocytes to clean up debris; and mast cells, which release chemicals associated with inflammation.[2] (See Chapter 4.) Differentiation of the connective tissue types is according to the extracellular matrix (ECM) that binds the cells.

Fibroblasts (**FIGURE 2.1**) produce collagen, elastin, and reticulin fibers. All connective tissues are made up of varying levels of collagen, elastin, and reticulin:

- *Collagen fibers.* The most common fibers in connective tissue proper are long, straight, and unbranched. The collagens are a family of ECM proteins that play a dominant role in maintaining the structural integrity of various tissues and in providing tensile strength to tissues. **TABLE 2.2** outlines the most common forms of collagen (types I–IV).[3]
- *Elastic fibers.* Containing the protein elastin, they are branched and wavy. Elastin is synthesized and secreted from several cell types, including chondroblasts, myofibroblasts, and mesothelial and smooth muscle cells. As its name suggests, elastic properties are provided to the tissues in which elastin is situated.[4] Elastin fibers can stretch, but they typically return to their original shape when the tension is released. The presence of elastin determines the patterns of distention and recoil in most organs, including the skin and lungs, and blood vessels. These characteristics can be useful in preventing injury because they allow the tissues to deform significantly before breaking.
- *Reticular fibers.* The least common of the three, they are thinner than collagen fibers and form a branching, interwoven network in various organs, which provides structural support.

☑ KEY POINT

Collagen can be visualized as being like the little strands that run through packing tape.

☑ KEY POINT

Collagen and elastin fibers are embedded within a water-saturated matrix known as *ground substance*, which is composed primarily of glycosaminoglycans, water, and solutes. These materials allow many fibers of the body to exist in a fluid-filled environment that disperses millions of repetitive forces affecting the joints throughout a lifetime.[3]

Fascia

Fascia is an example of loose connective tissue. From the functional point of view, the fascia in the body is a continuous laminated sheet of connective tissue that extends without interruption from the top of the head to the tips of the toes. It surrounds and permeates every other tissue and organ of the body, including nerves, vessels, tendons, aponeuroses, ligaments, capsules, and the fundamental components

TABLE 2.1 Types of Connective Tissue That Form the Structure of Joints

Tissue Type	Anatomic Location	Fibers	Mechanical Specialization
Dense irregular connective tissue (CT)	Composes the external fibrous layer of the joint capsule Forms ligaments, fascia, tendons, and fibrous membranes	High type I collagen fiber content; low elastin fiber content	*Ligament:* Binds bones together and restrains unwanted movement at the joints; resists tension in several directions *Tendon:* Attaches muscle to bone *Fascia:* A layer of fibrous tissue that permeates the human body and that performs some functions, including enveloping and isolating the muscles of the body, providing structural support and protection
Fibrocartilage	Composes the intervertebral disks and the disk within the pubic symphysis Forms the intraarticular disks (menisci) of the tibiofemoral, sternoclavicular, acromioclavicular, and distal radioulnar joints Forms the labrum of the glenoid fossa and the acetabulum	Multidirectional bundles of type I collagen	Provides some support and stabilization to joints; primary function is to provide "shock absorption" by resisting and distributing compressive and shear forces
Bone	Forms the internal levers of the musculoskeletal system	Specialized arrangement of type I collagen to form lamellae and osteons and to provide a framework for hard mineral salts (e.g., calcium crystals)	Resists deformation; strongest resistance is applied against compressive forces due to body weight and muscle force Provides a rigid lever to transmit muscle force to move and stabilize the body

of muscle.[5,6] Theoretically, injury, inflammation, disease, surgery, and excess strain of the fascia can cause it to scar and harden. This can create tension not only in adjacent, pain-sensitive structures but also in other areas of the body. This is because of the complete integration of fascia with all of the other systems. Myofascial release is a form of soft tissue therapy used to treat dysfunction and accompanying pain and restriction of motion by relaxing contracted muscles, increasing circulation, increasing venous and lymphatic drainage, and stimulating the stretch reflex of muscles and overlying fascia. See Chapter 9 for a more detailed discussion of myofascial release.

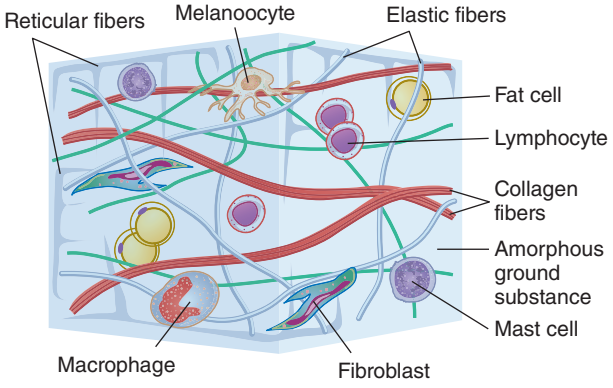

FIGURE 2.1 Typical connective tissue.

Tendons

A tendon (**FIGURE 2.2**), which is a type of dense connective tissue, is a cordlike structure that attaches muscle to bone. Tendons are made up of densely packed parallel-oriented bundles of fibers. The predominant type of collagen fiber in a tendon is type I.

The thickness of each tendon varies and is proportional to the size of the muscle from which it originates. In addition to the primary load bearing part of the tendon, there is an extensive network of

TABLE 2.2 Major Types of Collagen

Type	Description/Location
I	Thick and rough Designed to resist elongation Found in bone, skin, ligament, and tendon
II	Thinner and less stiff than type I fibers Provide a framework for maintaining the general shape and consistency of structures such as hyaline cartilage and nucleus pulposus
III	A small and slender fiber of collagen Found in extensible connective tissues such as skin, lung, and the vascular system
IV	Overall arrangement causes the collagen to form in a sheet. Found primarily in the basement membrane (a thin sheet of fibers that underlies the epithelium, which lines the cavities and surfaces of organs, or the endothelium, which lines the interior surface of blood vessels)

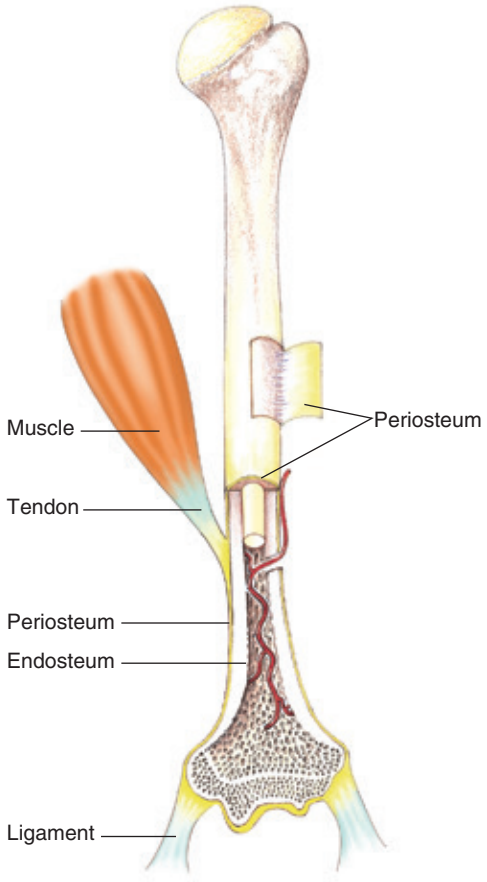

FIGURE 2.2 Tendon, ligament, bone, and muscle.

septae (endotendon), where the nerves and vessels are mainly located.[7] Tendons deform less than ligaments under an applied load.[8] However, tendons transmit forces from muscle to bone and are subject to significant tensile stresses. At low rates of loading, tendons are more viscous or ductile and, consequently, can absorb more energy compared to high loading rates.[9] At higher levels of loading, however, tendons become more brittle and absorb less energy, but they are more efficient at transferring loads.[9]

☑ KEY POINT

Although tendons withstand substantial tensile forces well, they resist shear forces less well and provide little resistance to a compression force.

As the tendon joins the muscle, it fans out into a much wider and thinner structure. The site where the muscle and tendon meet is called the *myotendinous junction (MTJ)*. Despite its viscoelastic mechanical characteristics, the MTJ is very vulnerable to tensile failure. Indeed, the MTJ is the location of the most common muscle strains caused by tensile forces.[8,10] The majority of muscles have distinct tendinous attachments to bones, but only a few tendons develop painful conditions. Patients with tendinopathy display tendons that are thicker, but with reduced energy storing capacity, meaning that for the same load, the tendons exhibit higher strains than those of healthy individuals.[7] (See Chapter 4.)

☑ KEY POINT

A tendency for a tear near the MTJ has been reported in the biceps and triceps brachii, rotator cuff muscles, flexor pollicis longus, fibularis (peroneus) longus, medial head of the gastrocnemius, rectus femoris, adductor longus, iliopsoas, pectoralis major, semimembranosus, and the entire hamstring group.[11–13]