Interventions for these clients can include any of the following:

- Education regarding body mechanics provided to a group of persons involved in strenuous occupational activity
- Preventative education and exercise prescription for persons diagnosed with a musculoskeletal disease such as rheumatoid arthritis
- Exercise recommended for a group of high-level athletes to prevent injury or enhance performance

Therapeutic exercise is considered a core element in most physical therapist plans of care and is defined as:

> The systematic performance or execution of planned physical movements, postures, or activities intended to enable the patient/client to (1) remediate or prevent impairments, (2) enhance function, (3) reduce risk, (4) optimize overall health, and (5) enhance fitness and well-being.[9]

Therapeutic exercise may include aerobic and endurance conditioning and reconditioning; balance, coordination, and agility training; body mechanics and posture awareness training; muscle lengthening; range of motion techniques; gait and locomotion training; movement pattern training; or strength, power, and endurance training.

Although therapeutic exercise can benefit numerous systems of the body, this text focuses primarily on treatment of the musculoskeletal system. Concepts of therapeutic exercise intervention specifically for the cardiovascular/pulmonary, neurologic, and integumentary systems are not covered in this text, except when they relate to impairments of the musculoskeletal system.

Decisions regarding therapeutic exercise intervention should be based on individual goals that provide patients or clients with the ability to achieve optimal functioning in home, work (job/school/play), and community/leisure activities. To implement goal-oriented treatment, the physical therapist must

- Provide comprehensive and personalized patient management sufficient to meet patient goals
- Rely on clinical decision-making skills
- Implement a variety of therapeutic interventions that are complementary (e.g., active warm-up before joint mobilization, followed by active exercise to use new mobility)
- Promote patient independence whenever possible through the use of home treatment (e.g., home spine traction, heat or cold therapy), self-management exercise programs (e.g., in the home, fitness club, community-sponsored group classes, school-sponsored or community-sponsored athletics), and patient-related instruction
- Avoid extraneous interventions and promote health care cost containment

In some cases, patient independence is not possible, but therapeutic exercise intervention is necessary to improve or maintain health status or prevent complications. In these situations, training and educating family, friends, significant others, or caregivers to deliver appropriate therapeutic exercise intervention in the home can greatly reduce health care costs by limiting in-house physical therapist intervention.

THE LANGUAGE OF HEALTH: ABILITIES AND DISABILITIES

The purpose of defining a model of functioning and disability in a text on therapeutic exercise is to provide the reader with an understanding of the complex relationships of health conditions (i.e., pathology, disease, genetic anomalies), impairments, activity limitations, and participation restrictions and to provide a conceptual basis for organizing elements of patient/client management that are provided by physical therapists. This text will use a biopsychosocial model that provides both the theoretical framework for understanding physical therapist practice and the classification scheme by which physical therapists make diagnoses.

Historically, traditional "medical models" viewed disability as an individual problem caused by disease, genetics, or injury, to be treated by individualized medical care. As a patient-centered perspective with the individual as the focus of intervention, little regard is given to the societal aspects of disability beyond public policy health care guidelines (i.e., vaccinations). This contrasts with "social models" that view disability as a socially created problem where disability is created primarily by the social environment and is *not* an attribute of the individual. Therefore, policies and interventions are directed toward society at large, making environmental modifications necessary to allow persons with disabilities to fully participate in all aspects of social life. The ICF is a "biopsychosocial" model embracing both of these perspectives, addressing factors at both the individual and the social level[10] (**Fig. 1-1**).

Terminology of the Biopsychosocial Model of Functioning and Disability

Although previous models of functioning and disability have focused on disability, ICF model focuses on both the positive and negative aspects of health, viewing health as a continuum. Rather than including only people with "disability," the ICF includes *all* people in its model. The ICF is a model of **both** *functioning* and *disability*.[11,12] The following sections define and describe the components of the ICF model.

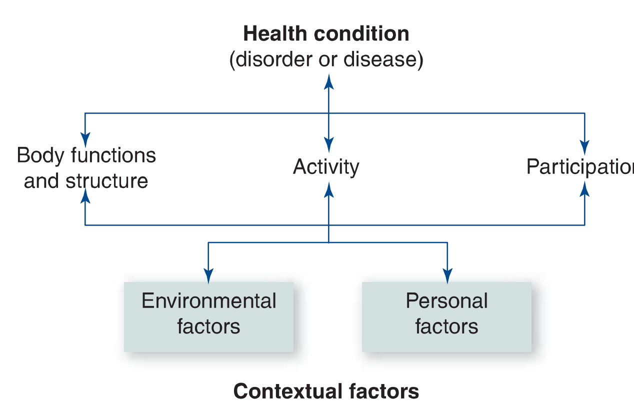


FIGURE 1-1 The WHO model of function and disability.

- **Functioning** is an umbrella term for body structures and function, and activities and participation (Part 1 of the ICF). It represents the *positive* aspects of the interaction between the individual with a health condition and that person's environmental and personal factors (Part 2 of the ICF, "Contextual Factors").
- **Disability** is a parallel umbrella term describing the negative aspects of this same interaction. It is described by terms such as *impairment*, *activity limitation*, and *participation restriction*.

Health Condition

In the medical model, health conditions focused on the negative aspects of health such as infection, trauma, metabolic imbalance, degenerative disease process, or diseases.[13,14] The ICF uses the term *health condition* as an umbrella term for disease, disorder, injury, or trauma, as well as states such as pregnancy, aging, congenital anomalies, or genetic predispositions.[10(p.212)]

Impairment

Impairment refers to a loss or abnormality in a body structure or in a physiologic function at the tissue, organ, or body system level. Impairments frequently treated by physical therapists include impaired range of motion, joint mobility and integrity, or muscle performance. Body function impairments might include pain, mobility or stability of joints, muscle power or endurance functions or gait pattern functions (**Table 1-1**).

Activity Limitation

The ICF uses the term *activity limitation* to describe difficulties an individual may have in executing activities. These limitations range from mild to severe and are measured against a population standard. Examples of activity limitations delineated in the ICF model include changing and maintaining body position, carrying, moving and handling objects, walking and moving, moving around using transportation, and self-care.

Participation Restriction

The ICF uses the term *participation restriction* to describe problems an individual may experience in involvement in life situations. Deficits are determined by measuring against societal standards.

Participation restrictions are reserved for social rather than individual functioning and people with similar activity limitations may have very different participation restrictions. For example, two persons with similar levels of impairment and activity limitation may have two different levels of participation restriction. One person may remain very active in all aspects of life (i.e., personal care and social roles), have support from family members in the home, and seek adaptive methods of continuing with occupational tasks, whereas the other individual may choose to limit social contact, depend on others for personal care and household responsibilities, and have a job where no modifications to support ongoing participation are possible. Contextual factors play an important role in these differences.

TABLE 1-1

Two-Level Classification of Body Functions Related to the Motor System

NEUROMUSCULOSKELETAL AND MOVEMENT-RELATED FUNCTIONS

Functions of the joints and bones (b710–b729)[a]
- b710 Mobility of joint functions
- b715 Stability of joint functions
- b720 Mobility of bone functions
- b729 Functions of the joints and bones, other specified and unspecified

Muscle functions (b730–b749)
- b730 Muscle power functions
- b735 Muscle tone functions
- b740 Muscle endurance functions
- b749 Muscle functions, other specified and unspecified

Movement functions (b750–b799)
- b750 Motor reflex functions
- b755 Involuntary movement reaction functions
- b760 Control of voluntary movement functions
- b765 Involuntary movement functions
- b770 Gait functions
- b780 Sensations related to muscles and movement functions
- b789 Movement functions, other specified and unspecified
- b798 Neuromusculoskeletal and movement-related functions, other specified
- b799 Neuromusculoskeletal and movement-related functions, unspecified

[a]The letter "b" denotes Body Functions.
From World Health Organization. International Classification of Functioning, Disability and Health. Geneva, Switzerland: World Health Organization, 2001.

The distinction between activity limitation and participation restriction is the difference between viewing the individual in isolation (activity limitation) and viewing the individual in relation to the larger world (participation restriction). An activity limitation is primarily a reflection of the characteristics of the individual person. An activity limitation is measured at the level of the individual and compared against a population standard. Participation restriction, however, has a relational characteristic in that it describes the individual's limitation in relation to society and the environment. Persons with similar individual profiles (e.g., disease, impairments, activity limitations) can present with different participation profiles. Factors such as age, general health status, personal goals, motivation, social support, and physical environment influence the level of disability the person experiences (**Evidence and Research 1-1**).

EVIDENCE and RESEARCH 1-1

A total of 100 patients rated as high risk for low back pain because of structural and psychosocial variables were prospectively followed for 4 to 6 years to determine the impact of these variables on disability. Psychosocial variables strongly predicted future disability, whereas the structural variables had no association with future disability and medical care.[15]

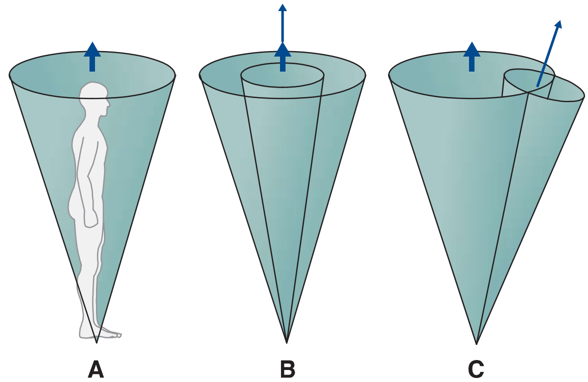


FIGURE 8-1 Relationships of the LOS, the sway envelope, and the COG alignment. **(A)** The LOS are described by a cone-shaped sway envelope. **(B)** When the COG is aligned in the center, the sway envelope remains within the LOS. **(C)** When the COG is offset, as in a forward leaning posture, the sway envelope exceeds the LOS, and a balance restoration strategy must be implemented to regain balance.

characterized by proper sequencing and timing of synergistic and reciprocal muscle activity. In fact, skilled activities, such as throwing, kicking, hopping, and running, are not possible without appropriate balance function.[10] Thus, the concepts of coordination and balance are highly interrelated. However, despite their integrated relationship, balance and coordinated movements are felt to be controlled separately.[11] Observations of reprogramming of postural responses before measured changes in focal movement during a changing task or environmental context provide evidence of the integration of balance and coordination.[12]

Maintenance of postural balance requires that individuals have the ability to maintain a position of stability before, during, and immediately after voluntary activities, as well as the ability to react to external perturbations.[13,14] Balance functions also enable individuals to protect the body in the event of a fall[12] and allow for clear vision during head and/or body movements.

Postural balance is far more complex than a simple relationship between the COM and the BOS. Effective and efficient performance and integration of multiple body systems are required for postural balance.[15] Specifically, stability is accomplished through the interaction of biomechanical (articular and muscular), sensory feedback (somatosensory, visual, and vestibular), self-perception (orientation in space, subjective postural and visual vertical), dynamic control (control of walking and navigation), neuromuscular integration (neuromuscular synergies, and adaptive and anticipatory action), cognitive processing (multitasking, information processing), affective (motivation, preferences), and cardiopulmonary (activity tolerance) systems. **Figure 8-2** describes postural control and orientation from this perspective. Impairment in any of these systems can lead to altered balance and mobility function. A detailed examination enables the clinician to determine the system(s) at fault and to develop targeted treatment for impaired balance. Successful interventions also depend on the clinician's ability to prioritize interventions based on the relative impact of each underlying impairment in relationship to each other and the resulting activity limitations, participation restrictions, and mobility-related disability (see **Building Block 8-1**).

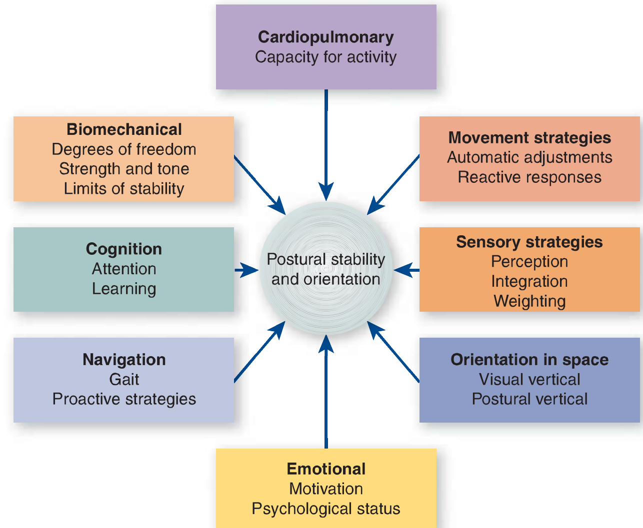


FIGURE 8-2 Systems model of postural stability and orientation.

BUILDING BLOCK 8-1

A 75-year-old woman with multiple sclerosis (MS) presents to your clinic for evaluation and treatment of her gait instability following a recent fall. The patient fractured her right wrist as a result of the fall. The fracture was surgically repaired, and she has recently been cleared for full weight bearing through her right hand. Before the fall, the patient had been using a front-wheeled walker for several years because of decreased stability while walking. In fact, she has fallen four times in the past year. You note that she stops walking whenever she tries to converse with you on the way to the exam room. Her past medical history is significant for the additional problems of depression, an anal cyst, and hypertension. She is taking multiple medications, including disease-modifying agents, a benzodiazepine, prescription pain medication, a selective serotonin uptake inhibitor, and a calcium-channel blocker. She lives alone in the home that she bought with her husband 40 years ago. There are three steps to enter the home, which have a railing on the right side for ascending. Her three adult children live more than 2 hours away. The patient relies on volunteers for transportation because she is unable to drive. In fact, she rarely leaves her home. One of her regular companions spends 3 hours a day helping her with household chores and with completing her home exercise program for residual muscle weakness and adaptive shortening in her right wrist and hand.

Hypothesize impairments from each of the domains just discussed that you might find upon examination.

PHYSIOLOGY OF BALANCE

Identifying causes of and prescribing treatment for balance impairment requires an understanding of the various influences on balance control and their normal interactions. Again, biomechanical, sensory, self-perception, neural integrative, cognitive, and affective systems each directly influence postural balance. The individual must effectively and efficiently process contributions from these systems within the central nervous system (CNS), then choose, and execute an appropriate and integrated balance strategy. The actual movement or task performance, as well as the interaction with the environment, must then be evaluated for accuracy, and corrective action must be taken when necessary. An ecological model (**Fig. 8-3**) describes these interactions among the individual, the environment, and the functional task, with a circular network of domains demonstrating the integration of balance functions.[5,16] Any of these domains may dominate depending on the particular context.

Additionally, other individual body systems, such as the circulatory, respiratory, and integumentary systems, indirectly influence balance and mobility via the effects of disease, damage, or suboptimal function. For example, consider a patient with peripheral vascular disease who has swelling in the lower extremities and the subsequent impact of limitations in ROM on balance reactions. Alternatively, consider the impact a venous stasis ulcer on the plantar surface of the foot has on weight acceptance in a patient with diabetes mellitus. Both of these conditions will affect balance reactions.

The primary systems that influence balance and mobility are depicted in Figure 8-2. Each of these systems is considered to be within the *individual* domain. The role of the integumentary system in balance typically occurs in select situations, such as a case of a person with a burn that limits ROM or affects weight bearing. Thus, this system will not be addressed further herein. Additionally, the influence of the cardiopulmonary system will not be considered further in this chapter. Refer to Chapter 6 for further information regarding examination and treatment of impaired aerobic capacity and endurance.

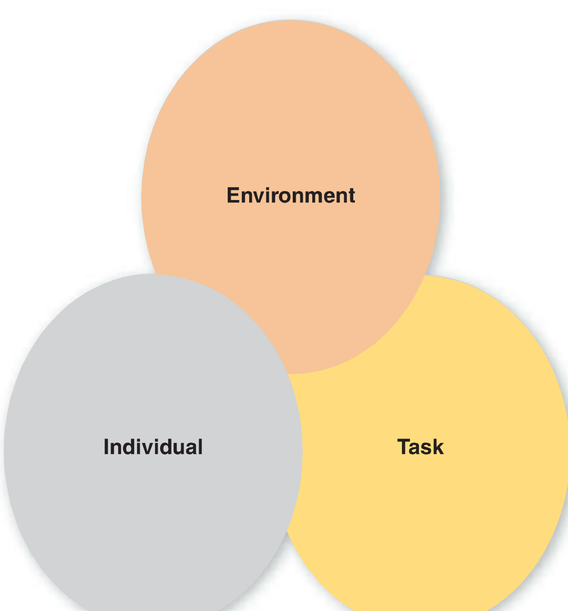


FIGURE 8-3 Ecological model of motor behavior.

Biomechanical Contributions

An individual's LOS is largely a function of the size of the BOS and any impairments in biomechanical, sensory, or neural structure or function in the lower extremities. Individuals who are prone to falling tend to have smaller LOS.[6] The most important biomechanical constraint on balance is the size and quality of the BOS, the feet.[15] Any limitation in size, strength, ROM, pain, or control of the feet will result in impaired balance.[17] Additionally, changes in lower-extremity strength, ROM, and flexibility can cause restrictions in moving the body on the BOS, which will ultimately effect balance control. As previously stated, suboptimal postural alignment also affects balance control. In addition to primary biomechanical impairments, impairments in biomechanics may develop secondary to impairments in other systems. Consider a patient with vestibular dysfunction who presents with complaints of pain and stiffness in the cervical region as a result of self-restricted head movement.

Contributions of the Sensory Systems

Three sensory systems contribute to the maintenance of upright posture and orientation: somatosensory, visual, and vestibular. These are considered to be the sensory triad of postural control (**Fig. 8-4**). No single sense directly determines the position of the body's COM; the combined feedback from each system must be integrated. The somatosensory system gathers information from the individual (e.g., position of one body segment vs. another or the position of the COM relative to the BOS), as well as the environment (e.g., various surface characteristics). The visual system provides information about task performance (e.g., orientation of the body relative to the task) and environmental cues (e.g., position relative to other objects, orientation to vertical, and environmental motion). The vestibular system provides an internal reference and final pathway, providing information about orientation of the head relative to gravity and movement of the head through space.[18]

Somatosensory Neurophysiology

The somatosensory system plays an important role in regulating posture and orientation. Information must be detected peripherally and transmitted centrally for processing. The peripheral receptors are an important source of that information. When a person steps onto a rug that slips beneath his/her foot, the

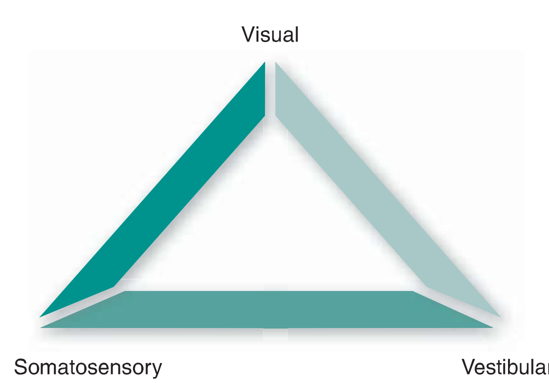


FIGURE 8-4 The triad of balance control.

DISPLAY 7-6

Knee Joint Mobilization

Tibiofemoral Anterior Glide

Purpose: Increase extension
Position: Patient is prone with the knee at the edge of the table; mobilizing hand is just distal to knee joint and stabilizing hand supports anterior ankle
Mobilization: Anteriorly directed force downward through mobilizing hand while stabilizing hand applies gentle distal traction

Tibiofemoral Posterior Glide

Purpose: Increase flexion
Position: Patient is supine or sitting with the knee at the edge of the table; mobilizing hand is just distal to the knee joint and stabilizing hand supports posterior ankle
Mobilization: A posteriorly directed force through mobilizing hand while the stabilizing hand applies gentle distal traction

Patellofemoral Joint Mobilization

Purpose: Increased general patellar mobility; and superior glide for increased extension, inferior glide for increased flexion
Position: Supine with knee supported by table, wedge, or towel roll; mobilizing thumb and index finger placed along patellar border oriented to direction of mobilization
Mobilization: Apply a medially, laterally, superiorly, or inferiorly directed force to the patella

DISPLAY 7-7

Foot and Ankle Mobilization

Ankle Anterior Glide

Purpose: Increase plantarflexion
Position: Prone with foot hanging just over the edge of the table; stabilizing hand under the anterior distal tibiofibular joint; mobilizing hand on the posterior calcaneus, just distal to joint line
Mobilization: Apply a downward, anteriorly directed force to the calcaneus while applying gentle traction

Ankle Posterior Glide

Purpose: Increase dorsiflexion
Position: Supine with foot just over the edge of the table; stabilizing hand under the posterior distal tibiofibular joint; mobilizing hand grasps anterior ankle just distal to joint line
Mobilization: Apply a downward, posteriorly directed force to the ankle while applying gentle traction

Ankle Traction

Purpose: Pain relief and general mobility
Position: Supine with leg stabilized by a strap and foot just over the edge of the table; both hands grasp the foot, one posterior on the calcaneus and the other anteriorly over the midfoot
Mobilization: Lean backward to produce a distal traction to the talocrural joint

Metatarsal and Phalanges Glide

Purpose: Increase mobility of toes
Position: Supine with foot over the edge of the table; stabilizing hand grasps metatarsal while mobilizing hand grasps phalanges
Mobilization: Apply dorsal and ventral mobilizations while applying gentle traction

DISPLAY 7-8

Spine Mobilization

Cervical and Thoracic Spine Posterior to Anterior Glide

Purpose: Increase segmental mobility and pain relief
Position: Patient is prone with towel under forehead or on mobilization table; therapist's thumbs placed one on top of the other, directly over the spinous process to be treated; spread hands over the adjacent neck or back area, keeping shoulders directly above treatment area
Mobilization: Apply a direct posterior to anterior force to the spinous process; this technique can also be performed with thumbs on the transverse processes unilaterally or bilaterally

Cervical and Thoracic Spine Lateral Glide

Purpose: Increase general mobility and unilateral pain relief
Position: Patient is prone; therapist's thumbs placed one on top of the other, directly over the lateral side (right or left) of the transverse. Process to be treated; spread hands over the adjacent neck or back area
Mobilization: Apply gentle pressure to lateral border of transverse process

Lumbar Spine Posterior to Anterior Glide

Purpose: Increase segmental mobility and pain relief
Position: Patient is prone; therapist's ulnar border of the hand over the spinous process to be treated; the other hand reinforces the mobilizing hand by resting on top of it and grasping the radial border of the wrist with the fingers; keep your shoulders directly over your hands; this technique can be modified to provide unilateral pressure to the transverse process using your thumbs adjacent to one another
Mobilization: A gentle rocking motion provides an anteriorly directed force over the spinous process

Lumbar Lateral Glide

Purpose: Increase segmental mobility and pain relief
Position: Patient is prone with the therapist's thumbs (one on top of the other) on the lateral side of the transverse process to be mobilized
Mobilization: Apply a horizontal pressure to the lateral border of the transverse process

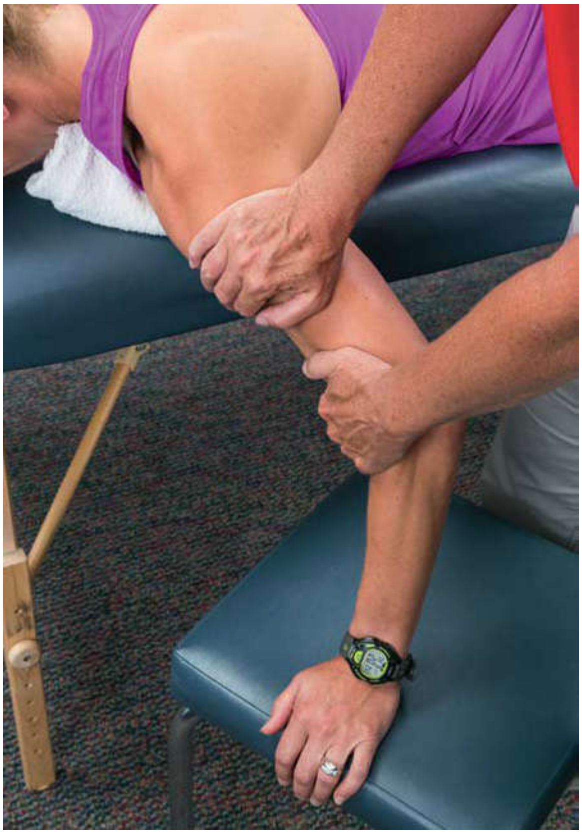


FIGURE 7-27 Glenohumeral anterior glide.

FIGURE 7-28 Glenohumeral posterior glide.

FIGURE 7-29 Scapular mobilization.

FIGURE 7-30 Humeroradial anterior glide.

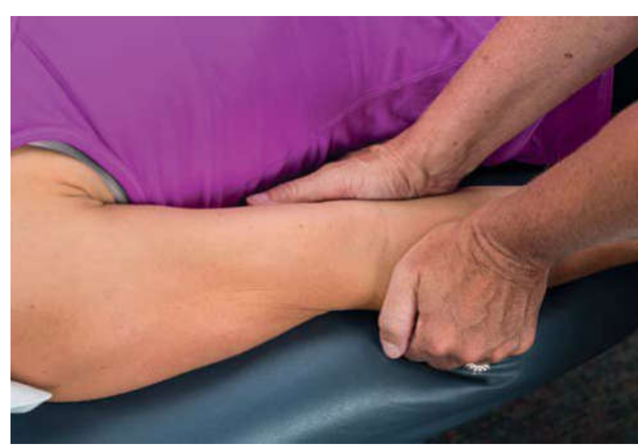


FIGURE 7-31 Radioulnar posterior glide.

FIGURE 7-32 Interphalangeal palmar glide.

FIGURE 7-33 Thumb metacarpal–carpal dorsal glide.

FIGURE 7-34 Wrist dorsal glide.

FIGURE 7-35 Hip distraction.

FIGURE 7-36 Hip anterior glide.

FIGURE 7-37 Tibiofemoral anterior glide.

A B

FIGURE 8-16 Hop and stop for dynamic balance. **(A)** The patient starts from a small stool, hops down, and **(B)** "sticks" the landing.

SELF-MANAGEMENT 8-5
Shoulder Level Claps in the Pool

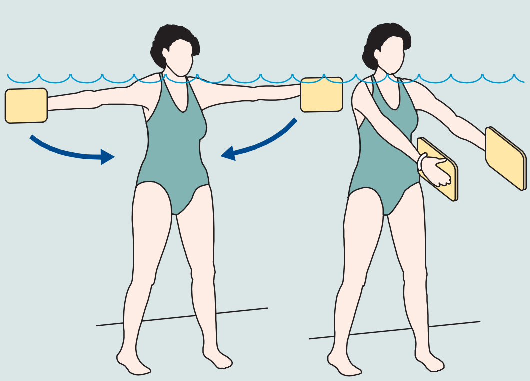
Purpose: To increase upper back and chest strength and to challenge balance.

Movement Technique: Level I: While standing in good postural alignment with your arms to the side at shoulder level, bring them forward and back to the starting position.
Level II: Bring your feet closer together.
Level III: Stand on a single leg.
Level IV: Close your eyes.
Level V: Add resistance to the hands.

Dosage:

Repetitions: ____________________

Frequency: ____________________



BUILDING BLOCK 8-7

List several ADL that require use of an ankle strategy that could be used as functional task practice in rehabilitation for a 52-year-old man who is in the chronic phase of recovery following an acute ankle sprain sustained while playing in a weekend basketball league. The patient is ferry boat operator and must stand for long periods of time. Choose the ideal mode of exercise and several exercises for retraining the hip strategy for a 60-year-old, morbidly obese woman, status post right total hip replacement. Explain your rationale. She is 2 months post-op and has minimal discomfort in the right hip. Her gait is antalgic, and she continues to use cane, and rates her osteoarthritic pain in the left hip and knee at 8/10 while walking.

Facilitating Sensory Strategies

Awareness of posture and the position of the body in space are fundamental to balance training. Jeka[117] demonstrated that the use of light touch through a cane or balance aid enhances the use of somatosensory and can reduce postural sway. Compensatory strategies such as this can be used to increase spatial awareness, as well as facilitate performance and minimize the fear and anxiety sometimes associated with balance retraining.

There are many ways to facilitate relearning sensory strategies. As noted above, the environmental characteristics, such as the support surface, can be altered to change the mode of balance exercise. Understanding how to manipulate the surface or other environmental cues is critical to providing the appropriate sensory context in which patients practice. To that end, patients should be trained in situations that enhance the nervous system's ability to attend to specific types of feedback.

Patients who need to develop effective use of somatosensory feedback for balance control begin activities with the eyes closed on a stable surface. Attention to surface cues can be enhanced by having the individual perform exercises with her shoes off, while standing on a textured surface, or by using knobby insoles in the shoes. If the ability to use existing visual cues effectively for maintaining stability is compromised, training the patient on a compliant or unstable surface with the eyes open and fixed on or attending to visual references in the environment is appropriate. Attention to visual cues can be enhanced by asking the individual to fixate gaze on a stationary target less than 5 feet away or by performing the task near a doorway or other distinct cues of vertical alignment. Alternatively, patients with difficulty using vestibular feedback about head position and acceleration should be trained on compliant or unstable surfaces with their eyes closed in order to force the nervous system to attend to vestibular inputs. The challenge to use vestibular cues for balance is increased by adding varied static head positions, active rotations, or tilts. Use caution with these activities for persons with vestibular disorders as these activities may cause dizziness. Real-world environments often present patients with confusing and conflicting sensory information. Thus, patients also need training in how to resolve conflicting inputs. For example, patients may need to learn how to balance when standing still in an environment with overwhelming motion of the crowd, lighting, or displays. Partially distorting or obscuring vision may also help encourage patients to resolve sensory conflicts. Whether or not these specific sensory manipulations are included in the plan of care depends in large part on the underlying impairments and the patient's prognosis for functional recovery. Thus, understanding the expectations for recovery of function as they relate to the patient's health condition and their response to its influence on their life is critical to effective treatment planning (see **Building Block 8-8**).

BUILDING BLOCK 8-8

What parameters or variables would likely manipulate when retraining sensory strategies for a 57-year-old woman with diabetes mellitus and associated peripheral neuropathy (diminished vibratory sensation below the ankles bilaterally) and retinopathy (legally blind in both eyes)?

Sequencing Considerations

Progression of exercise from simple to complex involves creating increasingly more challenging tasks for the individual to practice in meaningful environmental contexts. Variables related to the individual body systems contributing to balance control, characteristics of the environment, and task setup can be sequentially and systematically manipulated to develop and progress a customized intervention program. Remember, there are complex relationships between each of these domains. Thus, manipulation of one variable in any given domain has broad implications.

Task Variables

Appropriate sequencing related to postural demands involves progression from stable postures (e.g., sitting) to more unstable postures (e.g., SLS). Spatial characteristics such as the distance traveled with each step while side stepping or the amplitude of arm movements produced while performing single-limb stance should be considered. Generally, patients are progressed by increasing step length or the amount of reach. Temporal factors such as the velocity of movement and the time allowed to complete a series of movements can be used to influence performance. Patients may progress from slow movement to attempting to control ballistic movements while maintaining a particular posture. Encouraging increased speed is easily accomplished by decreasing the time allowed to complete a block of practice. Whether or not the patient is asked to manage a physical load or simultaneously manipulate an object in the hand while maintaining stability is another consideration. The patient may begin by practicing walking on a level surface and eventually progress to walking while carrying a full glass of water or a large bag of groceries. Other task-related variables include the frequency, intensity, and schedule for practice. Patients progress from less to more frequent practice, fewer to greater repetitions, and blocked to random practice in order to address variables such as managing fatigue, encouraging motor learning, and developing greater motor control.

Individual Variables

The individual body systems that contribute to balance control can also be manipulated to create appropriate challenges and facilitate progress. As stated, base element problems related to the biomechanical system should be addressed early. Cognitive factors should be considered in all cases regardless of age or condition because many real-world activities are frequently performed under dual-task conditions. Training should begin with intense concentration and minimal cognitive distractions. Progression related to cognitive demands may involve having the individual perform a simultaneous cognitive task that requires listening, comprehension, mathematics, problem solving, etc. The patient's emotional engagement in training in terms of self-efficacy and their level of anxiety are additional considerations. Some individuals may need to practice deep breathing or other relaxation strategies in conjunction with task practice. As an indicator of self-efficacy, the patient should be encouraged to perform exercises that he/she is at least 70% to 80% confident in his/her ability to safely exercise at home.

Facilitation of movement strategies as described earlier is often a critical component. The training plan should emphasize mastery of the appropriate use of in-place, automatic postural reactions for control of quiet stance before activities that involve executing change in BOS strategies, such as stepping correction responses. In terms of in-place responses, because the ankle strategy dominates stance control, this strategy should be addressed before impairments in the use of the hip strategy. To accomplish this, start in standing with simple sway activities that elicit an ankle strategy. Reinforce this strategy by verbal or tactile cuing and ensuring proper posture and firing patterns to prepare the patient for larger perturbations. Encourage the patient to gradually increase the stability limits by reaching or swaying farther. Progress the exercise by applying greater disruptions of the COM in order to elicit a hip strategy or a stepping strategy. After these responses are established, progress to more dynamic activities, unstable surfaces, and complex movement patterns. Additional critical variables involve the

BUILDING BLOCK 14-8

Consider the patients in Case Studies No. 2 and No. 3 to answer the following questions.

1. What are the common examination findings between both case studies?
2. What examination findings are different and significant to abnormal gait?
3. Using the principles of CKC function, how does the influence of the weak hip musculature in Case Study No. 2 contribute to her pathology? Does the pathology match her abnormal closed chain mechanics?
4. Using the principles of CKC function, how does the influence of the forefoot varus alignment in Case Study No. 3 contribute to her pathology? Does the pathology match her abnormal closed chain mechanics?
5. Describe two hip CKC exercises in the frontal plane to improve the valgus position at the knee.

SELF-MANAGEMENT 14-1
Hip Hinge to Squat

Purpose: To promote good alignment and neuromuscular control of the spine by using the hips to initiate movement. As the exercise progresses to a squat, it also serves to strengthen the legs.

Precautions and Contraindications: Limited weight-bearing status; pain on exertion.

Position: Stand in a tall posture with the feet wide enough to allow comfortable squatting. The feet may be directed straight ahead or rotated out for comfort. Initially, the buttocks are a few inches from the wall, trunk muscles are lightly engaged, the pelvis is in neutral, and the knees are straight but not locked backward.

Movement Technique:

- Direct the buttocks backward to lightly touch the wall, allowing the trunk to angle slightly forward.
  - To keep the trunk straight, pretend there is a stick connecting the back of the head, spine, and tailbone.
- Return to the starting position and repeat. Gradually step further from the wall.
- Progress to a squatting movement that includes flexing of the knees. You may use a chair to serve as a target for the squat depth.
- Alternately, you may use weights in the hands to simulate lifting of an object from the floor.
  - During the squat, pretend the knee caps are flashlights and your control of the movement keeps them shining in line with the direction the feet are pointing.
- Maintain rhythmic breathing and fluid movements.

Dosage:

Repetitions: ______________________________

Frequency: ______________________________

following the quick stretch to heighten the response. Quick stretch is a key component to PNF; however, it can be a difficult skill to master. The clinician should know the integrity of the joint capsule, ligaments, and nervous system prior to performing a quick stretch at the end ROM. If the practitioner performs quick stretch incorrectly, it may cause damage to other structures that are also on tension. As such, the clinician should only perform a quick stretch at end range once the skill is mastered as a mid-range intervention.

EVALUATION AND TREATMENT IMPLEMENTATION

Working within the PNF philosophy, the first emphasis is on what the patient *can do* in order to facilitate the functional goals. In other words, for a patient with a right hemiparesis, the clinician can utilize the strength and movement available in the left upper and lower extremity to facilitate movement, such as rolling to the right.

Be sure to note whether the patient's functional problem is *static* (inability to maintain position) or *dynamic* (loss of ability to initiate or control motion). Finally, identify the specific reason for the functional loss; that is, pain, immobility, weakness, loss of sensation, or lack of motor control. After identifying the patient's goals, determine whether treatment sessions should emphasize direct treatment or indirect treatment.

Direct Treatment

Direct treatment utilizes techniques on the affected limb, muscle, or motion (e.g., to increase right hip flexion strength the therapist may apply resistance directly on the right thigh, resisting hip flexion).

Indirect Treatment

Indirect treatment consists of the use of techniques on the unaffected limbs and muscles to facilitate the affected limbs and muscles (refer to the concept of irradiation). The literature has confirmed the effectiveness of indirect treatment initiated on the strong and pain-free part of the body to increase muscle tension and electromyographic activity on the affected parts of the body.[1,5,21–22,112] Therefore, the clinician can use techniques on the unaffected parts of the body to guide irradiation to the affected parts of the body (e.g., the patient with right hip flexor weakness, the therapist may involve the left lower extremity and resist bilateral hip flexion thereby facilitating right hip flexor activity).

MANUAL THERAPEUTIC EXERCISE USING PNF TECHNIQUES

The goals of the PNF techniques are to promote movement, facilitate stability, or to gain joint ROM and muscle flexibility. These techniques are grouped into movement, stability, and flexibility.

FIGURE 15-2 Replication (repeated contractions)—end range: elbow flexion. Command: "Hold." The elbow is then moved to mid-range (actively or passively). The patient then actively flexes the elbow to the start position.

Movement

Replication (Repeated Contractions)

The intent of replication (repeated contractions) is to teach the patient the expected outcome of the activity or movement; this technique may be helpful as part of a patient's reeducation after an injury (e.g., hemiparesis). It is also utilized as an excellent assessment tool for the clinician to "feel" the patient's ability to isometrically "hold" at the end ROM. The patient is placed in the end position (agonist muscle in its shortened length) and asked to hold while the therapist applies "demand" to all the components of desired direction resulting in simultaneous joint stimulation (see **Fig. 15-2**). The joint or extremity is then moved (either passively or actively) closer to mid-range of the diagonal and asked to actively return to the end position. This technique is repeated with the movement starting progressively closer toward the beginning of the pattern of movement to challenge the patient through a larger range of movement (see **Building Block 15-1**).

BUILDING BLOCK 15-1

Replication (Repeated Contractions)

Mr. Jones suffered a cerebral vascular accident and is having difficulty with eating using his right hand secondary to weakness in the right upper extremity, especially the hand. He often drops his eating utensils. Note his strength for performing the activity: shoulder flexion = 3-/5; elbow flexion = 3-/5; wrist flexion = 2+/5; he is able to close his grip and make a fist, but it is very weak. Create a strategy to improve this functional activity using replication.

Rhythmic Initiation

The purpose of rhythmic initiation is to teach the patient a movement pattern using passive, active-assistive, active, and resistive ROM. This is primarily used to enhance the patient's ability to initiate movement; it is also used during complex multi-joint movement patterns. In addition, it can be a useful tool when motor learning or communication problems exist by allowing the patient to visually observe as well as receive sensory input regarding the desired movement, thereby increasing understanding of the movement technique. This technique is also beneficial for patients who have a fear of moving because of pain. Rhythmic initiation allows the clinician to evaluate the patient's ability and willingness to be moved. This technique was originally developed to focus on the agonist muscle group only during unidirectional movement (see **Building Block 15-2**), but can be modified to use in teaching complex multi-joint diagonal movement patterns. Commands may progress as follows; "Let me move you," (PROM) "Help me move you," (AAROM) "Now, you do it" (AROM), "Now move against resistance" (RROM) (see **Fig. 15-3**).

BUILDING BLOCK 15-2

Rhythmic Initiation

Mr. Jones has right upper quadrant hemiparesis and is having difficulty rolling to his left. In assessing his rolling movement, the therapist noted that he is able to use his pelvis and lower body efficiently. However, his right upper extremity and his upper quadrant are lagging behind and his trunk is unable to engage in flexion. Describe how rhythmic initiation can be used to facilitate rolling in this case.

Combination of Isotonics

The intent of isotonic contractions is to emphasize control and quality of movement of the agonists by changing the muscle dynamic contraction intent (see **Display 15-1**). The intention of isotonic contractions is to employ combinations of concentric and eccentric muscle actions, without any relaxation, to promote smooth, coordinated functional movement (see **Fig. 15-4**).

Slow Reversals

The intent of a slow reversal is to facilitate dynamic movement by alternating between agonist and antagonist muscle contractions through a full ROM, thereby improving muscular strength and endurance. These reversals may or may not involve an initial "quick stretch" from elongated muscle tissue at beginning range. The patient is asked to dynamically move through a pattern to end range through a concentric muscle action from the agonist muscle group and then reverse and move in the opposite direction to end range through a concentric muscle action from the antagonist muscle group. The end of one pattern is the beginning of the other pattern (see **Fig. 15-5**). The movement can also be performed utilizing eccentric contractions in both directions. Each directional movement can be initiated by the clinician's command or "quick stretch" (see **Display 15-2**).

A

B

C

FIGURE 15-3 Rhythmic initiation: **(A)** "Let me move you." Therapist performs the movement passively (*bidirectional arrow*). **(B)** "Help me move you." The patient/therapist performs AAROM (*bidirectional arrow*). **(C)** "Pull up." The patient concentrically contracts against resistance (*unidirectional arrow*).