ADULTS
INTRODUCTION
The purpose of this chapter is to present one of the most frequently used treatment interventions in neurologic rehabilitation, proprioceptive neuromuscular facilitation (PNF). PNF can be used to improve performance of functional tasks by increasing strength, flexibility, and range of motion. Integration of these gains assists the patient to: (1) establish head and trunk control, (2) initiate and sustain movement, (3) control shifts in the center of gravity, and (4) control the pelvis and trunk in the midline while the extremities move. Utilizing the developmental sequence as a guide, the goal of these techniques is to promote achievement of progressively higher levels of functional independence in bed mobility, transitional movements, sitting, standing, and walking.

HISTORY OF PNF
Dr. Herman Kabat, a medical physician, applied his background in neurophysiology to conceptualize the PNF therapeutic approach in the early 1940s. He was joined by two physical therapists, Margaret Knott in 1947 and Dorothy Voss in 1953. The team collaborated in expanding and refining treatment techniques and procedures to improve motor function. Knott and Voss authored the first book introducing this treatment approach in 1956.

During PNF’s inception, focus was on the key concepts of using resistance, stretch reflexes, approximation, traction, and manual contacts to facilitate movement. The goal was to allow the patient to be more efficient in motor function and independent in activities of daily living (Kabat, 1961). PNF was based on the understanding of the central nervous system at the time and grew to become a viable treatment method. Kabat, Knott, and Voss continued to treat patients, review the literature, and refine their approach during the ensuing years. Today, clinicians and researchers continue to provide input that allows PNF to grow and evolve. This chapter presents a combination of the traditional interventions used by clinical practitioners and the tenets of the International PNF Association’s program.

BASIC PRINCIPLES OF PNF
Motor learning is enhanced through skilled application of the ten identified essential components of PNF (Knott and Voss, 1968). These elements or concepts are listed in Table 9-1.

Manual Contacts
Placing the hands on the skin stimulates pressure receptors and provides information to the patient about the desired direction of movement. Optimally, manual contacts are placed on the skin overlying the target muscle groups and in the direction of the desired movement (Adler, Beckers, Buck, 2000). For example, to facilitate shoulder flexion, one or both of the clinician’s hands are placed on the anterior and superior surface of the upper extremity; to facilitate
trunk flexion, the hands contact the anterior surface of the trunk. A lumbrical grip is preferred to control movement and provide optimal resistance, especially regarding rotation, while avoiding excessive pressure or producing discomfort (Fig. 9-1).

**Body Position and Body Mechanics**
Dynamic clinician movement that mirrors the patient’s direction of movement is essential to effective facilitation. The pelvis, shoulders, arms, and hands of the clinician should be placed in line with the movement. When this is not possible, the arms and hands of the clinician should be in alignment with the movement. Resistance is created through use of the clinician’s body weight while the hands and arms remain relatively relaxed (Adler, Beckers, Buck, 2000).

**Stretch**
Kabat proposed that the stretch reflex could be utilized to facilitate muscle activity. He hypothesized that if the muscle is placed in an elongated position, a stretch reflex could be elicited by producing slight movement farther into the elongated range. A stretch facilitates the muscle that is elongated, synergistic muscles at the same joint, and other associated muscles (Loobbourouw and Gellhorn, 1948). While quick stretch tends to increase motor response, prolonged stretch can potentially decrease muscle activity; therefore, patient response should be closely monitored. The presence of joint hypermobility, fracture or pain contraindicates the use of facilitatory stretch. Stretch, especially quick stretch, should be applied with caution in the presence of spasticity. In this clinical situation, individual responses vary and undesired motor activity may result.

**Manual Resistance**
Resistance is defined by Sullivan and Markos (1995) as “an internal or external force that alters the difficulty of moving.” The status of the involved tissue regarding stiffness, length, and neurologic influences dictates the internal resistance that the patient encounters during movement. Manual, mechanical, or gravitational forces can be utilized to apply resistance external to the body surface. Some PNF procedures focus on reducing internal resistance by altering neural firing patterns; other activities or techniques provide external resistance. Therefore, in the context of PNF, resistance may be considered either a means of facilitation, through reduction of internal resistance, or a way to strengthen or train the target muscles, by providing an outside force. Through complex interactions among neural and contractile components, resistance may influence movement initiation, postural stability, timing of functional movement patterns, motor learning, endurance, and muscle mass (Sullivan and Markos, 1995).

**TABLE 9-1 Essential Components of PNF**

| 1. Manual contacts            |
| 2. Body position and body mechanics |
| 3. Stretch                  |
| 4. Manual resistance        |
| 5. Irradiation              |
| 6. Joint facilitation       |
| 7. Timing of movement       |
| 8. Patterns of movement     |
| 9. Visual cues              |
| 10. Verbal input            |

**FIGURE 9-1.** Lumbrical Grip. A lumbrical grip is one in which the metacarpophalangeal joints are flexed and adducted while the fingers are in relaxed extension. This position allows flexion forces to be generated through the clinician’s hand without squeezing or exerting excessive pressure. This grip provides optimal control of the three-dimensional movements that occur in PNF patterns.
Appropriate resistance facilitates the maximum motor response that allows proper completion of the defined task (Knott and Voss, 1968). If the goal of intervention is mobility, appropriate resistance is the greatest amount of resistance that allows the patient to move smoothly and without pain through the available range of motion (Kisner and Colby, 2002). The amount and direction of the applied force must adapt to the changes in muscle function and patient ability that may occur throughout the range. If the goal of intervention is stability, appropriate resistance is the greatest amount that allows the patient to isometrically maintain the designated position.

Irradiation

Irradiation is a neurophysiologic phenomenon defined as the spread of muscle activity in response to resistance. This term is often used synonymously with overflow and reinforcement (Adler et al.; Sullivan et al., 1982). The magnitude of the response increases as the stimulus increases in intensity and duration (Sherrington, 1947). PNF utilizes the process of irradiation to increase muscular activity in the agonist muscle(s) or to inhibit opposing antagonist muscle groups. Each person’s response to resistance varies; therefore, different patterns of overflow occur among individuals. By watching the patient’s response, the clinician can identify the manual contacts and amount of resistance that maximize a patient’s ability to generate the desired movement. Examples of activities and typical patterns of response include the following:

1. Resistance to trunk flexion produces overflow into the hip flexors and ankle dorsiflexors.
2. Resistance to trunk extension produces overflow into the hip and knee extensors.
3. Resistance to upper-extremity extension and adduction produces overflow into the trunk flexors.
4. Resistance to hip flexion, adduction, and external rotation produces overflow into the dorsiflexors.

Joint Facilitation

Traction and approximation stimulate receptors within the joint and periarticular structures. Traction creates elongation of a body segment, which can be used to facilitate motion and decrease pain (Sullivan et al., 1982). Approximation produces compression of body segments, which can be used to promote stability and weight bearing (Adler et al., 2000). Individual responses to traction and approximation vary. These forces may be applied during performance of extremity patterns or superimposed upon body positions.

Timing of Movement

Normal movement requires smooth sequencing of muscle activation. Timing of most functional movements occurs in a distal to proximal direction, as in picking up a pencil. The pencil is grasped in the hand and then positioned for use by actions of the elbow and shoulder. A related consideration is that development of postural control proceeds from cephalad to caudal and from proximal to distal (Shumway-Cook and Woollacott, 2001). These issues must be considered when assessing, facilitating, and teaching movement strategies in the neurologically impaired individual (Carr and Shepherd, 1998). Adequate muscle strength and joint range of motion may be present to allow execution of a specified functional task; however, sequencing of the components within a movement pattern may be faulty. Also, sufficient control of the trunk and proximal extremity joints must be attained before mastery of tasks that require precise movements of the distal joints.

Patterns of Movement

PNF is characterized by its unique diagonal patterns of movement. Kabat and Knott recognized that groups of muscles work together synergistically in functional contexts. They combined these related movements to create PNF patterns. Furthermore, because muscles are spiral and diagonal in both structure and function, most functional movements do not occur in cardinal planes. For example, reaching with an upper extremity and walking are two common activities that occur as triplanar versus uniplanar movements. PNF patterns, therefore, more closely simulate the demands incurred during functional movements.

Visual Cues

Visual cues can help a patient control and correct body position and motion. Eye movement influences both head and body position. Feedback from the visual system may be used to promote a stronger muscle contraction (Adler et al., 2000) and to facilitate proper alignment of body parts, such as the head and trunk, through use of postural reactions.

Verbal Input

A verbal command is utilized to provide information to the patient. The command should be concise and provide a directional cue. The verbal command consists of three phases: preparation, action, and correction. The preparatory phase readsies the patient for action. The action phase provides information about the desired action and signals the patient to initiate the movement. The correction phase tells the patient how to modify the action if necessary. PNF uses the knowledge of the effects of voice volume and intonation to promote the desired response, such as relaxation or greater effort (Adler et al., 2000).

Application of PNF Principles

When considered as a group, the preceding principles provide a template for clinical application of PNF techniques. The clinician’s hands are placed on the surface of the patient’s body in the direction of the desired diagonal movement utilizing a lumbrical grip (see Fig. 9-1). The clinician positions herself to allow for dynamic movement.
by aligning her body with the diagonal movement pattern. The body segment is elongated prior to requesting the patient to move, and a quick stretch is applied if appropriate. A concise verbal command is given and timed to coincide with the initiation of the desired movement. The amount of resistance is graded (increased or decreased to match the patient’s ability to generate force) to allow for the desired response. Normal timing is considered and reinforced during the movement pattern. The clinician monitors the patient’s response and may add a visual cue to enhance the response. Table 9-2 lists key points to use as a backup tool for clinical application. This checklist may help the clinician select specific PNF techniques to address individual patient needs.

**BIOMECHANICAL CONSIDERATIONS**

Other considerations that affect relative ease or difficulty of movement include biomechanical factors such as the base of support (BOS), center of gravity (COG), number of weight-bearing joints, and length of the lever arm. The BOS involves both the body surface in contact with the supporting surface and the area enclosed by the contacting body segments. COG refers to the distance of the center of mass of the patient’s body to the supporting surface. The number of weight-bearing joints involved indicates the complexity and degree of control inherent in the activity. The lever arm is affected by gravity, body weight, and the location of the resistive force. The resultant force on the moving segment increases as the distance between the applied force and the target muscles increases. All of these factors must be considered when selecting and progressing activities and techniques within a therapeutic exercise program. A relative increase in difficulty is experienced by the patient when the height of the COG, number of weight-bearing joints, and length of lever arm are increased or the BOS is decreased. Within the developmental sequence, the natural progression of postures is that of increasing challenge to the stabilizing muscles. A quadruped is understandably a more demanding position than the prone-on-elbows position because of differences in base of support and location of the center of gravity relative to the support surface.

**PATTERNS**

Early development of PNF techniques included analysis of typical movement strategies (Knott and Voss, 1968). The results of these observations were integrated into specific combinations of joint movements called patterns. Although often combined in clinical practice, patterns focus on either the extremities or the trunk. All PNF patterns consist of a combination of motions occurring in three planes. The rotation component is especially important and should be recruited during the beginning range of the pattern. Early rotation reinforces normal distal to proximal timing of extremity movements while recruiting greater participation of the trunk musculature.

**Extremity Patterns**

The two major extremity diagonal patterns are diagrammed in Figure 9-2. These are named diagonal 1 (D1) and diagonal 2 (D2). Extremity patterns are named for the direction of movement occurring in the proximal joint and represent the movement that results from performing the pattern. Each diagonal is further subdivided into flexion and extension directions. For example, in D1 flexion in the upper extremity (UE) the shoulder moves into flexion and in D1 extension, the shoulder moves into extension. The middle or intermediate joint may be flexed or extended. Straight arm and leg patterns are used to emphasize the proximal component of the pattern and recruit greater trunk activity. When the intermediate joints are flexed, more emphasis can be placed on the intermediate or distal components. The UE patterns will be described in a supine position. Figure 9-2 illustrates the components of the UE patterns.

**Upper-Extremity Patterns**

The UE D1 Flexion pattern consists of shoulder Flexion/Adduction/Internal Rotation. The arm begins in an extended position slightly out to the side, about one fist width from the hip. The shoulder is extended/abducted/externally rotated with the forearm pronated, and the wrist ulnarily deviated. The clinician requests that the patient “squeeze my hand and pull up.” It is helpful for the clinician to suggest that the patient think about reaching up to bring a scarf over the opposite shoulder.

The UE D1 Extension pattern is the reverse of the flexion pattern and consists of Extension/Abduction/Internal Rotation. The patient starts with the arm flexed with the elbow across the midline of the body at about nose level. The forearm is supinated with the wrist and fingers flexed and the wrist radially deviated. The clinician requests that the patient “open your hand and push down.” The UE D1 Flexion diagonal pattern is often thought of as functional for feeding and the UE D1 Extension pattern as functional for performing a protective reaction when in a sitting position. Detailed descriptions of the UE D1 Flexion and UE D1 Extension patterns are found in Tables 9-3 and 9-4, respectively. Performance of the UE D1 Flexion and UE D1 Extension patterns is depicted in Interventions 9-1 and 9-2, respectively.

The second UE diagonal (D2) pattern comprises shoulder Flexion/Abduction/External Rotation. The arm begins extended across the body with the elbow crossing the midline.
FIGURE 9-2. Upper-extremity Diagonal Patterns. The two major diagonal patterns (D1 and D2) of the upper extremity are depicted in this diagram. The reader should orient herself to the illustration as if she is the person moving her left arm with her head at the top of the diagram. The posture of the hands is used to help the reader guide her movements in the correct combinations. The shaded areas represent the components of the highlighted pattern: A is D1 Flexion, B is D1 Extension, C is D2 Flexion, and D is D2 Extension. For example, to perform D1 Flexion, the reader places her hand in the D1 Extension hand position in which the left hand is thrust slightly out from the left side of the body as if in preparation to stop a fall and performs the shaded movements depicted in view A so that her hand ends up in the D1 hand position (the left hand now curls in a fist as if grabbing a scarf and bringing it across the body and up over the right shoulder). To perform D1 Extension, the reader looks at Figure 9-2, B and starts in the D1 Flexion hand position, performing the shaded movements in a reverse sequence. To perform D2 Flexion, the reader starts with her left hand in a curled fist next to her right hip with her arm across the body and then moves the arm up and across the body as if in preparation to throw a bouquet over her left shoulder. D2 Extension is performed in a reverse sequence.
forearm pronated, wrist and fingers flexed, and wrist ulnarly deviated. The clinician asks the patient to “lift your wrist and arm up.” The UE D2 Extension pattern is the reverse of the flexion pattern and consists of shoulder Extension/Adduction/Internal Rotation. The arm begins in flexion about one fist width from the ipsilateral ear. The shoulder is externally rotated with the forearm supinated, wrist and fingers extended and wrist radially deviated. The clinician requests that the patient “squeeze my hand and pull across.”

Students can remember these diagonals functionally by thinking of D2 Flexion as throwing a wedding bouquet over the same shoulder and D2 Extension as placing a sword in its sheath. Detailed descriptions of the UE D2 Flexion and UE D2 Extension patterns are found in Tables 9-5 and 9-6, respectively. Performance of the UE D2 Flexion and UE D2 Extension patterns is depicted in Interventions 9-3 and 9-4, respectively.

The following associations may help students remember the movement combinations in the upper extremity. Flexion patterns are always paired with shoulder external rotation, forearm supination, and radial deviation of the wrist. Conversely, UE extension patterns are always paired with shoulder internal rotation, forearm pronation, and ulnar deviation of the wrist.
The pattern begins in the lengthened position of the primary muscles involved (extension) and ends in the shortened position of the same muscle groups (flexion). The patient’s left upper extremity is being treated. The clinician’s right hand is placed distally, her left hand proximally.

A. Beginning—The clinician stands in the diagonal position and faces the patient’s feet. The clinician’s right hand contacts the patient’s left palm, similar to holding hands as if going for a walk. The palmar surface of the clinician’s left hand is placed on the anterior aspect of the patient’s arm just proximal to the elbow. The verbal command is given to “turn your hand up and pull up and across your body.”

B. Midrange—As the patient pulls her left upper extremity across her body, the clinician remains in the diagonal position while pivoting to face the patient. Manual contacts may shift slightly to accommodate patient effort.

C. End range—The patient completes the range with hand placements consistent with the previous description of midrange.
The pattern begins in the lengthened range of the involved muscle groups (flexion) and ends in the shortened range (extension). The patient’s left upper extremity is treated. The clinician’s left hand contacts the dorsal aspect of the patient’s hand, including the fingers. Her right palm contacts the patient’s dorsal arm, just proximal to the elbow.

A. Beginning—The clinician stands in the diagonal position and faces the patient. The verbal command is given to “turn your hand down and push down and out to the side.” The patient extends her wrist and fingers and pronates her forearm, as if pushing the clinician away. Note that some clinicians prefer to face the patient’s feet in the starting position of this pattern.

B. Midrange—The clinician shifts her body weight and position to accommodate movement through the range. Manual contacts continue on the dorsal hand/fingers and the dorsal and distal aspect of the patient’s humerus.

C. End range—The clinician pivots toward the patient’s feet, remaining in the diagonal position. Manual contacts remain as previously. It is important that during the latter part of this pattern that as the clinician facilitates or resists wrist extension that the force is parallel to the patient’s forearm. **CAUTION:** Care must be taken to avoid application of force perpendicular to the forearm, which can result in resistance to the shoulder flexors. This input disrupts the flows of the pattern and often confuses the patient as to the intent of the movement.

### TABLE 9-5
**Upper Extremity D2 Flexion—Flexion/Abduction/External Rotation—Straight Arm**

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scapula</td>
<td>Anterior depression</td>
<td>Posterior elevation</td>
</tr>
<tr>
<td></td>
<td>Extension/adduction/external rotation</td>
<td>Flexion/abduction/external rotation</td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td>Extension</td>
<td>Extension</td>
</tr>
<tr>
<td>Forearm</td>
<td>Supination</td>
<td>Pronation</td>
</tr>
<tr>
<td>Wrist</td>
<td>Flexion/ulnar deviation</td>
<td>Extension/radial deviation</td>
</tr>
<tr>
<td>Fingers</td>
<td>Flexion</td>
<td>Extension</td>
</tr>
</tbody>
</table>

### TABLE 9-6
**Upper-Extremity D2 Extension—Extension/Adduction/Internal Rotation—Straight Arm**

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scapula</td>
<td>Posterior elevation</td>
<td>Anterior depression</td>
</tr>
<tr>
<td></td>
<td>Extension/adduction/external rotation</td>
<td>Extension/adduction/external rotation</td>
</tr>
<tr>
<td>Shoulder</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elbow</td>
<td>Extension</td>
<td>Extension</td>
</tr>
<tr>
<td>Forearm</td>
<td>Pronation</td>
<td>Supination</td>
</tr>
<tr>
<td>Wrist</td>
<td>Extension/radial deviation</td>
<td>Flexion/ulnar deviation</td>
</tr>
<tr>
<td>Fingers</td>
<td>Extension</td>
<td>Flexion</td>
</tr>
</tbody>
</table>

### Scapular Patterns

The scapula moves in diagonal patterns in keeping with scapulohumeral biomechanics. The scapular pattern associated with D1 Flexion is **anterior elevation**. The scapula elevates and protracts as the arm comes across the body. The scapular pattern associated with D1 Extension is the opposite of anterior elevation or **posterior depression**. The scapula is depressed and retracted. To help visualize these movements, consider shrugging your shoulder forward toward your ear as being associated with the UE D1 Flexion pattern and putting the inferior angle of your right scapula in the left hip pocket as related to D1 extension. These patterns are pictured in Intervention 9-5 and 9-6, respectively.

The scapular pattern associated with D2 Flexion is **posterior elevation**. As the arm is lifted up and outwardly rotated, the scapula is posteriorly elevated. Shrugging with the shoulder held back is approximately the same motion as the scapula is elevated and retracted. Scapular **anterior depression** is part of the D2 Extension pattern and is the opposite of posterior elevation. The scapula is depressed and protracted as when pushing up to sitting from side lying. These patterns are shown in Intervention 9-7 and 9-8, respectively.
The pattern is pictured as applied to the patient’s left upper extremity. The clinician’s right hand contacts the dorsal aspect of patient’s hand, with her left hand on the dorsal humeral region.

A. Beginning—The clinician stands in the diagonal position and faces the patient’s left hip. Her right palm contacts the patient’s dorsal hand. She places the dorsal aspect of her left hand against the patient’s dorsal humerus, just proximal to the elbow. The command is given to “open your hand and lift your thumb up and out.”

B. Midrange—As the patient moves into midrange, the clinician shifts backward. The clinician’s left hand naturally supinates with the movement, allowing her palm to now contact the patient’s dorsal arm. The clinician’s right thumb may be utilized to facilitate or resist thumb abduction.

C. End range—Movement continues through range with manual contacts remaining similar to those at midrange. The clinician shifts farther backward as needed to accommodate patient movement.
The patient’s left upper extremity participates, starting with the shoulder in a flexed position overhead.

A. Beginning—The clinician stands in the diagonal position and faces the patient. She places her left hand in the patient’s palm and the dorsal aspect of her right hand on the anterior surface of the patient’s arm, just proximal to the elbow. The pattern commences upon the command to “squeeze my hand, turn your thumb down and toward your opposite hip.” The patient then flexes her fingers to grasp the clinician’s hand, flexes her wrist, and pronates her forearm.

B. Midrange—As the patient extends and adducts, the clinician pivots to face the patient’s feet and supinates her forearm such that the patient’s dorsal arm now lies within the clinician’s open hand.

C. End range—The patient completes the motion as the clinician shifts her weight backward to resist the patient’s efforts as appropriate. The clinician maintains similar manual contacts as described for midrange.
INTERVENTION 9-5 Scapular Anterior Elevation

The patient is pictured in left side lying with the cervical spine in neutral position. The right scapular region is addressed. The clinician stands behind the patient, approximately level with the patient’s pelvis. The clinician stands in the diagonal position and faces the patient’s head.

A. Beginning—The clinician’s right hand contacts the patient’s right acromial region. Her left hand is placed on top of and reinforces her right. The patient is asked to “shrug your shoulder forward toward your ear.”

B. End—The patient completes the motion while the clinician shifts her body weight onto her forward foot, mirroring patient movement.

INTERVENTION 9-6 Scapular Posterior Depression

The patient is lying on her left side and the right shoulder region is treated. The clinician stands in the diagonal position, behind the patient and facing her head.

A. Beginning—The clinician’s right hand is placed on the patient’s right acromion with her left hand contacting the inferior and medial border of the scapula. The pattern begins upon the command to “pull your shoulder blade down and back.”

B. End—As the patient continues through the range, the clinician shifts her body weight onto her back leg to counter patient effort.

A clock is a useful way to visualize the scapula moving on the thorax. The patient is positioned in left side lying. Twelve o’clock is toward the patient’s head, and six o’clock is toward the feet. Figure 9-3 depicts the placement of the scapular diagonals on a clock face. Posterior elevation is at eleven o’clock, and diagonally opposite at five o’clock is anterior depression. Anterior elevation is at one o’clock, and diagonally opposite at seven o’clock is posterior depression.
**INTERVENTION 9-7  Scapular Posterior Elevation**

The pattern is performed with the right scapula with the patient lying on her left side. The clinician stands in the diagonal position at the end of the table adjacent to the top of the patient’s head.

A. **Beginning**—The clinician’s left hand is placed slightly posterior to the patient’s right acromion; her right hand covers her left hand. The patient is asked to “shrug your shoulder up and back.”

B. **End**—As the patient elevates and adducts her scapula, the clinician shifts her body weight backward.

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**INTERVENTION 9-8  Scapular Anterior Depression**

The pattern is applied to the patient’s right scapula while the patient is left side lying. The clinician stands at the head of the table and faces the patient.

A. **Beginning**—Manual contacts are positioned slightly anterior to the patient’s right acromion with the left hand under the right. The verbal command to “push your shoulder blade down and forward” is given.

B. **End**—The clinician shifts her weight forward as the patient depresses and adducts the scapula.

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**Lower-Extremity Patterns**

The lower extremity (LE) patterns will be described in supine position but will be related to functional movements in sitting and standing (Fig. 9-4). The first LE diagonal (D1) pattern consists of hip Flexion/Adduction/External Rotation. The leg begins extended at the side with the heel in line with the shoulder of that same side. The leg is abducted and internally rotated. The foot is plantar flexed...
and everted. The patient is requested to “pull your foot up and in and pull your leg across.” Knee flexion frequently accompanies associated functional movements and is, therefore, the most common direction of movement for the intermediate joint during this pattern. This is the motion used to cross one leg over the other in sitting or to bring the foot up to the opposite hand to take off a shoe. If the person is supine, the lower extremity is up in the air.

The reverse pattern, D1 Extension, is comprised of hip Extension/Adduction/External Rotation. The leg begins in hip and knee flexion with external rotation of the hip. The foot is dorsiflexed and inverted. The patient is requested to “push your foot down and out.” This motion is similar to the stance phase of gait and coming to stand from a seated position. The leg is extended at the hip and knee with the ankle in plantar flexion and eversion. Detailed descriptions of LE D1 Flexion and LE D1 Extension patterns are found in Tables 9-7 and 9-8, respectively. Performance of the LE D1 Flexion and LE D1 Extension patterns is depicted in Interventions 9-9 and 9-10, respectively.

The second LE diagonal (D2) pattern consists of hip Flexion/Abduction/Internal Rotation. The leg begins in hip and knee extension with external rotation of the hip. In order to position the knee past the midline of the body, the leg not involved in the pattern is abducted. The foot is plantar flexed and inverted. The patient is requested to “pull your foot up and out.” This pattern has euphemistically been called the fire hydrant as the end position resembles the movement used by an animal to relieve itself. D2 Flexion is not used as frequently as the other LE patterns but does provide a means to elicit eversion with dorsiflexion, a movement combination that is often difficult for patients who have had a stroke. The reverse of the LE D2 Flexion pattern is the LE D2 Extension pattern. The LE D2 Extension pattern consists of hip Extension/Adduction/Internal Rotation. To start, the hip and knee are flexed with the hip abducted. The hip is internally rotated with care taken to avoid excessive stress on the medial aspect of the knee. The patient is asked to “push your foot down and in.” In standing, this movement resembles a soccer kick. Detailed descriptions of the LE D2 Flexion and LE D2 Extension patterns are found in Tables 9-9 and 9-10, respectively. Performance of the LE D2 Flexion and LE D2 Extension patterns is depicted in Interventions 9-11 and 9-12, respectively.

Pelvic Patterns

Just as scapular patterns are related to UE diagonal patterns, pelvic patterns are related to LE patterns. There is considerably less motion available in the pelvis than at the scapula resulting in extremely narrow ranges of movement. All four pelvic diagonals can be visualized on the same clock as the scapular diagonals because they have the same names. Figure 9-3 pictures this clock. Intervention 9-13 features the Anterior Elevation pattern and Intervention 9-14 illustrates the Posterior Depression Pelvic pattern. These are the most functionally relevant pelvic patterns.

Patterns may be modified using the PNF philosophy and basic principles in order to address the particular needs of the patient or demands of the desired activity. Specific muscle groups or components of functional movements may be targeted with the patient supine. For example, the UE D2 Flexion/Abduction/Internal Rotation pattern may
FIGURE 9-4. Lower-Extremity Diagonal Patterns. The two major diagonal patterns (D₁ and D₂) of the lower extremity are depicted in this diagram. The reader should orient himself to the illustration as if he is the person moving his left leg with his head at the top of the diagram. The posture of the feet is used to help the reader guide his movements in the correct combinations. Unlike the upper extremity, hip internal rotation is always paired with ABDUCTION, and hip external rotation is always paired with ADDUCTION. The shaded areas represent the components of the highlighted pattern: A is D₁ Flexion, B is D₁ Extension, C is D₂ Flexion, and D is D₂ Extension. For example to perform D₁ Flexion, the reader places his foot in the D₁ Extension position (which is out to the side as if taking a protective step) and performs the shaded movement depicted in Figure 9-4, A so that the foot ends up in the D₁ Flexion position with the bottom of the foot turned up (as if about to cross the left leg over the right). To perform D₁ Extension, the reader looks at Figure 9-4, B and places the foot in the D₁ foot position. He then performs the shaded movements in a reverse sequence. To perform D₂ Flexion, the reader places his left foot in the D₂ Extension position. To get to the D₂ foot position, the reader moves the right leg out to the side allowing the left foot to cross the midline of the body. The reader performs the shaded movements in Figure 9-4, C so the foot ends up in the D₂ Flexion foot position much like a dog lifting its leg at a fire hydrant. D₂ extension is performed in a reverse sequence as in a soccer kick.
be used to strengthen the deltoids in supine. This position is inherently stable; therefore, patient and clinician can concentrate on the focal movement. Extremity patterns may also be performed in more challenging postures such as quadruped to incorporate dynamic total body control into the activity. Progression and functional integration may include performance of the UE D2 Flexion/Abduction/External Rotation pattern in quadruped, sitting or standing. Each respective posture creates different demands on the target muscles and imposes increasingly greater challenge to the trunk stabilizers.

**Trunk Patterns**

The PNF approach recognizes the patient’s trunk as the foundation of controlled movement. To maximize recruitment of the trunk musculature, patterns are utilized that emphasize either the shoulder or pelvic girdles, or bilateral extremity patterns. The scapula and pelvis are the connecting segments between the trunk and the respective extremities. Thus scapular and pelvic patterns are utilized to improve the quality, sequence, strength, range of motion, and coordination of both trunk and extremity movements. Scapular patterns directly influence upper-extremity function

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**TABLE 9-7** Lower-Extremity D1 Flexion—Flexion/Adduction/External Rotation—with Knee Flexion

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>Posterior depression</td>
<td>Anterior elevation</td>
</tr>
<tr>
<td>Hip</td>
<td>Extension/abduction/ internal rotation</td>
<td>Flexion/adduction/ external rotation</td>
</tr>
<tr>
<td>Knee</td>
<td>Extension</td>
<td>Flexion</td>
</tr>
<tr>
<td>Ankle</td>
<td>Plantarflexion/eversion</td>
<td>Dorsiflexion/inversion</td>
</tr>
</tbody>
</table>

**TABLE 9-8** Lower-Extremity D1 Extension—Extension/Abduction/Internal Rotation—with Knee Extension

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>Anterior elevation</td>
<td>Posterior depression</td>
</tr>
<tr>
<td>Hip</td>
<td>Flexion/abduction/ external rotation</td>
<td>Extension/abduction/ internal rotation</td>
</tr>
<tr>
<td>Knee</td>
<td>Flexion</td>
<td>Extension</td>
</tr>
<tr>
<td>Ankle</td>
<td>Dorsiflexion/inversion</td>
<td>Plantarflexion/eversion</td>
</tr>
</tbody>
</table>
The pattern is applied to the patient’s left lower extremity, beginning with the primary muscles in a lengthened position (extension). The patient may be requested to maintain isometric knee extension throughout the pattern, or as pictured here, to flex the knee as the hip flexes.

A. Beginning—The clinician stands in the diagonal position and faces the patient’s feet. Alternatively, the clinician may begin facing the patient. She places her left hand on the patient’s dorsomedial foot and her right hand on the anteromedial thigh. The patient is requested to “pull your foot up and in, and lift your leg across the other leg.” The clinician facilitates ankle dorsiflexion and inversion, then hip flexion with adduction and medial rotation. The knee is pictured as flexing but may remain extended, depending upon the goals for this patient.

B. Midrange—As the patient moves toward midrange of the pattern, the clinician pivots to face the patient. The distal hand placement remains consistent. The proximal hand shifts as appropriate to facilitate or resist as needed to address the individual patient’s needs.

C. End range—As the patient completes the pattern, the clinician remains in the diagonal position and shifts her body weight onto her back foot. This allows for more efficient application of resistance, if needed. Manual contacts continue as previously described; however, the proximal hand may be shifted to promote the optimal combination of hip flexion, adduction, and medial rotation for this patient.
and alignment of the cervical and thoracic spine, while pelvic patterns influence lower-extremity function and alignment of the lumbar spine. Scapular and pelvic movements may be targeted as components of related extremity patterns or performed in a more isolated manner.

Side lying is an excellent position for performing scapular and pelvic patterns because it provides ease of access for the clinician and unrestricted movement for the patient. The scapular and pelvic PNF patterns are components of functional activities such as rolling, reciprocal arm movements, scooting in supine and sitting, and gait. As previously described, there are two diagonal patterns for both the scapula and pelvis. These diagonals are narrow, and excessive spinal rotation should be avoided.

### Lifts and Chops

Combining UE PNF patterns can promote activation of the trunk musculature, especially the rotators. The two extremities are in contact with each other. One hand holds the other extremity at the wrist; the other hand is free. The extremity in which the hand is free may also be referred to as the lead arm (Sullivan et al., 1982; Adler et al., 2000). The movement of the lead arm determines the name of the trunk pattern. If the lead arm follows the D2 Flexion Flexion/Abduction/External Rotation, the movement is termed a lifting pattern. This pattern is depicted in Intervention 9-15.

Facilitatory manual contacts may be used and vary according to the patient situation. The combination of two extremities working together increases the irradiation or overflow into the trunk musculature. Resistance may be used to promote isotonic movement throughout the entire range or to

### TABLE 9-9

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>Posterior elevation</td>
<td>Anterior depression</td>
</tr>
<tr>
<td>Hip</td>
<td>Extension/adduction/</td>
<td>Flexion/abduction/internal</td>
</tr>
<tr>
<td></td>
<td>external rotation</td>
<td>rotation</td>
</tr>
<tr>
<td>Knee</td>
<td>Extension</td>
<td>Flexion</td>
</tr>
<tr>
<td>Ankle</td>
<td>Plantarflexion/inversion</td>
<td>Dorsiflexion/eversion</td>
</tr>
</tbody>
</table>

### TABLE 9-10

<table>
<thead>
<tr>
<th>Joint</th>
<th>Starting Position</th>
<th>Ending Position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pelvis</td>
<td>Anterior depression</td>
<td>Posterior elevation</td>
</tr>
<tr>
<td>Hip</td>
<td>Flexion/abduction/</td>
<td>Extension/abduction/</td>
</tr>
<tr>
<td></td>
<td>internal rotation</td>
<td>external rotation</td>
</tr>
<tr>
<td>Knee</td>
<td>Flexion</td>
<td>Extension</td>
</tr>
<tr>
<td>Ankle</td>
<td>Dorsiflexion/eversion</td>
<td>Plantarflexion/inversion</td>
</tr>
</tbody>
</table>
The pattern is presented on the left lower extremity. The clinician stands in the diagonal position and faces the patient's feet, with her left hand on the patient's foot and her right hand on the thigh.

A. Beginning—The clinician contacts the patient's dorsolateral foot with her left hand and the patient's anterolateral thigh with her right hand. The patient is requested to "pull your foot up and out and lift your leg out to the side." Near-full-range ankle dorsiflexion and eversion should be achieved early in the range to promote normal timing of the movement pattern. This also provides a "handle" for the clinician that improves her ability to control the patient's limb.

B. Midrange—The clinician remains in the diagonal position and shifts her body weight to optimize patient effort. The proximal contact (right hand) may shift in position to enhance the quality of the movement. For example, if inadequate hip medial rotation is produced, the clinician may move her hand to the medial thigh.

C. End range—As the patient completes the pattern, the clinician may continue to make subtle adjustments in her body and hand positions to enhance the patient's motor response.
The pattern begins in the lengthened position of the pattern (flexion). The clinician stands in the diagonal position and faces the patient’s feet. Her left hand is placed distally and her right hand proximally on the patient’s lower extremity. To allow for greater hip adduction at the end of the pattern, the patient’s stationary limb may be pre-positioned in abduction. The patient may also lie close to the edge of the plinth or in side-lying position to allow a greater range of hip extension.

A. Beginning—Manual contacts are such that the clinician’s left hand is placed on the medial and plantar aspect of the patient’s foot and her right hand is placed on the posterior thigh. In this example, the clinician’s hand is shown posteromedial, which helps to facilitate hip adduction and the general direction of the pattern. If the patient has difficulty producing hip lateral rotation, a posterolateral contact may enhance the patient’s effort. The verbal command to “step down into my hand” initiates the movement pattern.

B. Midrange—Full or nearly full ankle motion and hip rotation should be attained by midrange of the pattern. The clinician may pivot her left hand and shift her body weight to accommodate patient movement and effort.

C. End range—The pattern ends as the moving limb contacts the stationary limb. Alternatively, the patient may be pre-positioned to allow for greater range of movement into hip extension and adduction, as previously described.
enhance isometric contraction in a desired position. Holding the end range position of a lift can facilitate trunk extension, elongation on one side of the trunk, and a weight shift. The downward motion from the lift position is called a reverse lift. In a reverse lift, the lead arm performs a D2 extension pattern. This trunk pattern is pictured in Intervention 9-16.

The other trunk pattern created by concurrent movement of the upper extremities is called a chopping pattern. The extremities are in contact as previously described. The extremity with the free hand, or the lead arm, is again utilized for naming the pattern. In a chop, the lead arm follows moves through the D1 Extension-Extension/Abduction/Internal Rotation pattern as seen in Intervention 9-17. This combination of UE patterns facilitates trunk flexion, shortening of the trunk on one side, and a weight shift. The upward motion returning from the
A left lifting pattern is shown, which involves movement of the left lead arm through the D2 Flexion pattern. Many options exist for appropriate manual contacts. Both the clinician and patient sit and face each other; however, the activity may be performed in various positions, including supine, kneeling, and standing. Hand placements on the patient’s distal upper extremities are shown. The patient is encouraged to watch her hands as she moves through all trunk patterns.

**A.** Beginning—The clinician facilitates the D2 Flexion pattern in the left lead arm through manual contact on the dorsal forearm; she also promotes the D1 Flexion pattern in the right upper extremity through contact with the anterior forearm. The command is given to “turn your left hand up and lift your arms over your left shoulder.”

**B.** Midrange—The clinician actively maintains an upright trunk as she observes the patient’s trunk position throughout the range of the pattern. Additional verbal cues or changes in manual contacts may be used to enhance trunk extension and rotation.

**C.** End range—The patient completes the range of the pattern including trunk extension rotation while the clinician mirrors the movement and applies resistance as indicated to promote the optimal patient response.
A left Reverse Lift is pictured involving movement of the left lead arm through the D2 Extension pattern. Both the clinician and patient are shown in sitting. Manual contacts at the distal upper extremities are utilized in this example.

A. Beginning—The clinician places one hand on the right dorsal forearm and the other on the left anterior forearm/wrist. The request is made for the patient to "make a fist with your left hand, turn your thumb down, and bring your arms down toward your right hip."

B. Midrange—The clinician shifts her body weight to accommodate patient movement. Manual contacts may also shift slightly to adjust to changes in the patient’s upper-extremity position. The clinician monitors the patient’s trunk and provides verbal or manual cues to promote the desired amounts of flexion and rotation.

C. End range—The patient completes the appropriate range of upper-extremity and trunk movement, shifting her body weight and hand positions to evoke the optimal patient response.
chop is a reverse chop (Adler et al., 2000; Sullivan et al., 1982), which is shown in Intervention 9-18. The direction of the weight shift during both chopping and lifting differs from patient to patient. The clinician is encouraged to vary the position of the arms and to try both traction and approximation forces to determine the optimal response for each individual.

**PNF TECHNIQUES**

The goal of PNF techniques is to promote functional movement through facilitation, inhibition, strengthening, or relaxation of muscle groups (Adler et al., 2000). These techniques are designed to promote or enhance specific types of muscle activity associated with a target pattern, posture, or task. Some techniques focus on isometric contractions to increase stability in a chosen position; others promote movement through a functional range utilizing isotonic contractions. Techniques can be used to alleviate impairments in motor-control characteristic of specific stages such as mobility, stability, controlled mobility, and skill (Table 9-11).

Some techniques address tissue shortness, which limits joint range of motion; others enhance movement initiation. Names assigned to the techniques indicate the focus of that technique. These names have evolved over the last several decades. This process has caused confusion as a specific technique may be referred to by more than one name. The
The left Reverse Chopping pattern involves movement of the left lead arm through the D1 Flexion pattern. The clinician and patient sit and face each other. Manual contacts at the distal forearms are shown.

A. Beginning—The clinician places one hand on the anterior surface of the patient’s left forearm and the other hand on the dorsal surface of the right forearm. The patient is asked to “make a fist with your left hand, turn your thumb up, and pull your arms toward your right shoulder.” SPECIAL NOTE: The patient’s wrist and fingers should be extended when initiating the pattern, which is not shown here.

B. Midrange—The clinician observes the patient’s trunk and provides manual or verbal cues as needed. The clinician shifts her body weight to adapt to patient movements.

C. End range—The patient completes the desired range of movement of the trunk and upper extremities. The clinician mirrors patient movement and alters her body and hand positions to optimize patient efforts.
names of techniques presented in this chapter are those most commonly used by clinicians. If the International PNF Association uses a different term, it is given in parentheses (still need reference). The techniques will be presented according to the primary stage of motor control that each promotes, beginning with the mobility stage.

### Rhythmic Initiation

Rhythmic Initiation is a technique that focuses on improving mobility that is impaired by deficits in movement initiation, coordination, or relaxation. This technique involves sequential application of first passive, then active assisted, then active or slightly resisted motion. Passive movement is used to encourage relaxation and teach the movement or task. Once relaxation is achieved, the patient is asked to assist. The clinician constantly monitors the patient’s movement strategies. If appropriate recruitment patterns are noted, the progression continues such that manual contacts remain in place but no assistance is provided by the clinician. Slight resistance may then be added to promote further muscle contraction and reinforce the movement pattern. This technique can be used successfully with any pattern or activity, particularly as a teaching tool. It is frequently utilized with lower-level functional tasks such as rolling. Patients with hypertonicity who have difficulty initiating functional movements are especially appropriate candidates for this technique.

Rolling is an example of Rhythmic Initiation. The patient begins supine with the head turned toward the side to which she is rolling. The upper extremity on that side is prepositioned so that it is away from the body. The patient is passively moved into a side-lying position using manual contacts on the trunk and extremities while being asked to feel the movement. The clinician then asks the patient to assist with the motion. This continues until the patient can demonstrate the ability to do more of the movement independently. Facilitatory manual contacts remain in place, but assistance is gradually withdrawn. When appropriate, the clinician may apply slight resistance to the rolling movement through manual contacts on the trunk or extremities.

### Rhythmic Rotation

Rhythmic rotation is characterized by application of passive movement in a rotational pattern. The movement is slow and rhythmical in an attempt to promote total body relaxation or tone reduction. The goal is to lessen spasticity to allow further active or passive joint mobility. The clinician applies slow rotary movements about the longitudinal axis of the part. The patient is instructed to relax and allow the clinician to perform these movements without assistance. The technique can affect both resting muscle tone and hypertonicity that presents during attempts at active movement. (Sullivan et al., 1982).

Lower trunk rotation in hook lying is an example of Rhythmic Rotation. The patient is positioned supine with the hips and knees flexed and feet flat on the surface. The clinician kneels on either side of the patient’s feet to help stabilize the lower extremities. Manual contacts are placed on the lateral aspect of the knees or another suitable position on the thighs to allow adequate control. With the clinician’s trunk moving as a unit with the patient’s lower body, the patient’s knees are moved side to side, producing lower trunk rotation.

### Hold Relax Active Movement

The hold relax active movement (replication) technique enhances functional mobility by facilitating recruitment of muscle contraction in the lengthened range of the agonist. Only one direction of a movement pattern is emphasized. A resisted isometric contraction of the agonist pattern in a shortened range is used to increase muscle spindle sensitivity. Once an optimal contraction is achieved, the patient is asked to relax. The clinician then passively moves the part toward the lengthened position in increments according to patient response. A quick stretch may be applied concurrently with a command for the patient to move into the agonist pattern. Light resistance is often applied as a facilitatory element, although resistance is not mandatory.

Scapular Anterior Elevation is an example of Hold Relax Active Movement. The patient is side lying with the clinician kneeling behind. The patient’s scapula is passively placed in anterior elevation and she is asked to hold this position. The clinician provides resistance to the isometric contraction. The patient is then told to relax and is moved back slightly toward posterior depression. The patient is told to “pull up” and moves back into anterior elevation. This motion can be performed actively or with resistance. The patient holds the end position of anterior elevation once again, relaxes upon verbal command, and then is moved further back toward posterior depression. This cycle is

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### TABLE 9-11 PNF Techniques Related to Stages of Motor Control

<table>
<thead>
<tr>
<th>Stage/Technique</th>
<th>Mobility</th>
<th>Stability</th>
<th>Controlled Mobility</th>
<th>Skill</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agonistic</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reversal</td>
<td></td>
<td></td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>Alternating</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Isometrics</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contract</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Relax</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hold Relax</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Active Movement</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhythmic Initiation</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhythmic Rotation</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rhythmic Stabilization</td>
<td></td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slow Reversal Hold</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Slow Reversals</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
repeated as the patient moves through a greater range each time until he completes the entire pattern.

**Hold Relax**

The purpose of the hold relax technique is to increase passive joint mobility and decrease movement-related pain. Main components of the technique include resisted isometric contraction, verbal cues, and active or passive stretch. The patient or clinician moves the joint or body segment to the limit of pain-free motion. The patient maintains this position while the therapist resists an isometric contraction of the antagonist muscle group, the muscles restricting the desired direction of movement. A verbal cue of “hold” is given as the clinician gradually increases the amount of applied resistance. A command is given for the patient to slowly relax. When possible, the joint or body segment is moved through a greater range of motion. The clinician may perform the movement passively; however, active patient-controlled movement is preferred, especially when pain is a factor. All steps are repeated until there is no further improvement in range of motion. A variation in the traditional method is to elicit an isometric contraction of the agonist muscle, instead of the antagonist, then proceed with active or passive movement into further range (Prentice, 2001).

Increasing hip flexion with concurrent knee extension as in a straight leg raise is an example of Hold Relax. If hip flexion with knee extension (agonist movement) is limited, the hip extensors, or hamstrings, would be the limiting muscles (antagonist). With the person in hook lying, an active or passive straight leg raise is performed. An isometric contraction of the hip extensors (hamstrings), or alternatively the hip flexors (iliopsoas/rectus femoris), is elicited through a request to “hold” the position. After the contraction is held for a minimum of five seconds, the patient is asked to relax as resistance is slowly withdrawn. Further range of hip flexion is attempted either actively or passively. Intervention 13-3 depicts the patient position and the manual contacts utilized by the clinician.

**Contract Relax**

The contract relax technique provides another method to increase passive joint range. It is most appropriate and effective when addressing decreased length in two-joint muscles and when pain is not a significant factor. Components of the technique are composed of resisted isometric and isometric contractions of the short muscles, verbal cues, and active or passive stretch. Either the clinician or the patient moves the joint or body segment to the end of the available range of motion. A verbal cue to “turn and push or pull” is given. The resistance overcomes all motion except rotation. Thus, the result is a resisted concentric contraction of the rotary component and an isometric contraction of the remaining muscles (Sullivan et al., 1982; Knott and Voss, 1968; Kisner and Colby, 2002). A strong muscle contraction is elicited and held for a minimum of five seconds. After the contraction, the patient relaxes and the joint or body segment is repositioned either actively or passively to the new limit of passive range of motion. As in Hold Relax, the sequence is repeated until no further gains are made. Changes in muscle tension with this technique are relatively abrupt, while those used during Hold Relax are gradual.

Increasing shoulder range of motion into D2 Flexion-Flexion/Adduction/External Rotation is an example of Contract Relax. The arm is placed at the end of the available range of the D2 Flexion-Flexion/Adduction/External Rotation pattern. The shoulder and elbow extensors are identified as the muscles that are short and limiting motion into flexion. The patient is asked to lift the arm up and out to the side into the D2 Flexion pattern. An isometric contraction of the shoulder extensors and adductors is held for a minimum of five seconds while resisted rotation through available range is allowed to occur. Then a command to “relax” is given. The arm is moved into further flexion, abduction, and external rotation by either the patient or the clinician, establishing the new limit to motion. The technique is repeated until there is no further improvement. The arm is then resisted through the UE D2 patterns of Flexion/Adduction/External Rotation and Extension/Adduction/Internal Rotation to help integrate the new range into functional movements.

**Alternating Isometrics**

The alternating isometrics (isotonic stabilizing reversals, alternating holds) technique promotes stability, strength, and endurance in identified muscle groups or in a specific position. Isometric contractions of both agonist and antagonist muscle groups are facilitated in an alternating manner. Manual contacts and verbal cues are the primary facilitatory elements. As proximal extremity joint or trunk stability is a common focus, this technique is often applied in developmental postures; however, it may also be utilized with bilateral or unilateral extremity patterns.

Manual resistance is imparted to encourage isometric contraction of agonist muscles. Once an optimal response is achieved, the clinician changes one hand to a new location over the antagonist muscles and gradually increases resistance in the appropriate direction. The second hand may be moved to the new location or removed from the surface until the next change in direction of resistance is initiated. Manual contacts are smoothly changed to encourage gradual shifting of contractions between agonist and antagonist muscle groups.

Trunk stability is an example of Alternating Isometrics. The clinician resists trunk flexion with manual contacts on the anterior trunk. A verbal cue of “don’t let me pull you forward” is used. Once the trunk flexors contract, input is maintained with one hand and the second hand is moved to the posterior trunk to activate the trunk extensors. The verbal cue then becomes “don’t let me push you backward.” As the patient responds to the initial posterior input, the second hand is moved to the posterior trunk. The hands continue to switch from the anterior to posterior trunk, challenging trunk stability in the sagittal plane. Intervention 9-19 shows this technique being used to increase trunk stability in unsupported sitting.
A. Resistance is provided to trunk flexion through symmetrical manual contacts on the anterior shoulder. The verbal cue of “don’t let me push you backward” is given as the clinician leans forward using her body weight to produce the resistance.

B. The clinician places her hands bilaterally on the superior aspect of the patient’s scapulae. The command to “don’t let me push you backward” is voiced as the clinician shifts her body weight backward.

C. The clinician provides resistance to right trunk lateral flexion through placement of her right hand on the patient’s right lateral trunk. The verbal command “don’t let me push you to the left” is spoken as the clinician shifts her weight to produce the resistance.

D. Resistance is provided to left trunk lateral flexion through placement of the clinician’s left hand on the patient’s left lateral trunk.
Rhythmic Stabilization

Rhythmic stabilization (isometric stabilizing reversals) enhances stability through co-contraction of muscles surrounding the target joint(s). Resistance is applied to promote isometric contraction. Often the goal is to enhance the patient’s ability to maintain a specific developmental position. A rotary force is emphasized to encourage simultaneous contraction of the primary stabilizers about the involved joints. The patient is asked simply to hold the position. Force is increased slowly, emphasizing the rotary component of the motion and matching patient effort. When the patient has built up muscular force in one direction, the clinician changes the position of one hand and begins to slowly apply force in a different direction, again emphasizing rotation. Depending upon the demands of the clinical situation, Rhythmic Stabilization can be used to promote stability and balance, decrease pain upon movement, and increase ROM and strength.

Trunk stability in unsupported sitting is an example of Rhythmic Stabilization. Rotation of the trunk is resisted with the clinician placing one hand on the anterior trunk and one hand on the posterior trunk. The patient is expected to isometrically hold an erect trunk position. A verbal cue of “hold; don’t let me move you” is used. There is no intention of movement on the part of the patient. The patient matches the resistance provided by the clinician and actively holds the position. Once the patient stabilizes adequately in response to the applied force, the relative positions of the right and left hand are sequentially changed so that resistance is applied in the opposite rotational direction. Intervention 9-20 depicts the use of Rhythmic Stabilization to promote trunk stability in sitting.

**INTERVENTION 9-20** Rhythmic Stabilization to Increase Trunk Stability in Sitting

The patient sits on the edge of plinth with feet resting on the floor. The clinician kneels behind the patient. Suggested manual contacts allow the clinician to resist flexion, extension, and rotation simultaneously or sequentially as placements are rhythmically moved between the two options pictured.

A. The clinician places her left hand on the anterior aspect of the patient’s left shoulder and her right hand on the posterior right shoulder.

B. Manual contacts are shifted to vary the forces applied to the patient. The clinician’s left hand is now posterior and her right hand is anterior.
Slow Reversal

The Slow Reversal (Reversal of Antagonists, Dynamic Reversals) is a versatile technique that may be used to address a variety of patient problems such as lack of strength, ROM, and coordination. Concentric contraction of muscles in an agonist pattern is facilitated through manual contacts and verbal cues. At the desired end range, manual contacts of one or both hands are changed to facilitate concentric contraction of the antagonist pattern. Resistance is applied to both directions of movement with force varying from slight to maximal, in accordance with the patient’s abilities and goals. As the amount of force generated by a patient may vary throughout a pattern, resistance must accommodate changes in patient effort. Emphasis is placed on smooth transitions between directions of movement patterns such as when moving from D2 Flexion to D2 Extension. The mobility, controlled mobility, and skill stages of motor control can be addressed through this technique. In the skill stage, smooth reversal of movement from one direction to another is especially emphasized. Fatigue is minimized by rhythmically alternating between agonist and antagonist muscle groups.

Performance of the UE D2 Flexion-Flexion/Abduction/External Rotation pattern as the agonist and D2 Extension/Adduction/Internal Rotation as the antagonist is an example of the Slow Reversal technique. Beginning in the lengthened position of the agonist (D2 Flexion) pattern, appropriate resistance is applied through both proximal and distal manual contacts. The flexion pattern is initiated by the command to “open your hand and lift the arm up and out.” Near the completion of the pattern, the clinician’s proximal hand is moved to resist the distal component of the antagonist (D2 Extension) pattern. The verbal cue to “squeeze my hand and pull down” is timed with the change in direction. As the patient starts to move into extension, the clinician’s other hand moves to resist the remaining components (usually proximal) of the antagonist pattern. This process of reversing directions and altering manual contacts continues. Either full or partial range of motion may be utilized. Although there are personal preferences among clinicians, some specific suggestions regarding hand placements will be offered. When the patient performs a UE flexion (D1 or D2) pattern with her right hand, the clinician places her left hand distally and right hand proximally on the patient’s arm. The placements reverse when D1 or D2 extension patterns are performed. These manual contacts tend to allow more consistent application of appropriate resistance throughout both directions of the pattern. Interventions 9-1 and 9-2 demonstrate the patterns and manual contacts recommended with this technique.

Slow Reversal Hold

Slow Reversal Hold is a variation of the Slow Reversal technique in which a resisted isometric contraction is held at the completion of the range in each direction of the chosen pattern or activity. Movement may proceed through the available joint range or a lesser excursion may be used, depending on the patient situation or goal. Movement occurs as described for the Slow Reversal hold; however, at the desired endpoint in each direction, a resisted isometric contraction of all involved muscles is elicited. This technique aids in the transition from the mobility to stability stages of motor control, by promoting increased strength, balance, and endurance. The Slow Reversal Hold is appropriate for use with single extremity or trunk patterns as well as functional movements.

Performance of the UE D2 Flexion/Abduction/External Rotation as agonist pattern in kneeling is an example of the Slow Reversal Hold technique. Concentric contraction of the muscles involved in the D2 Flexion (agonist) pattern is resisted throughout the desired range. Without changing manual contacts, the patient is requested to hold the chosen end position using all muscles within the flexion pattern. The distal then proximal hand placements are carefully reestablished to facilitate a smooth transition into the D2 Extension-Extension/Adduction/Internal Rotation pattern. Graded resistance is applied throughout the D2 extension pattern. An isometric contraction of the D2 Extension pattern is held at the desired end of range.

Agonistic Reversals

The Agonistic Reversal technique (Combination of Isotonics) is used to facilitate functional movement throughout a pattern or task. Both concentric and eccentric contractions of the agonist musculature are utilized. The focus of the technique is to promote functional stability in a smooth, controlled manner (controlled mobility). Other goals include increasing muscle strength and endurance, improving coordination, and training eccentric control. To implement the technique, a concentric contraction of the agonist muscle group(s) is resisted through a specific direction and range of the chosen pattern or task. At the desired endpoint of the movement, the patient holds isometrically against resistance. The clinician then resists the patient’s slow, controlled return toward the beginning of the movement pattern, promoting an eccentric contraction. The patient holds again at the completion of the eccentric phase to further encourage stability in this range. In summary, the technique begins with resistance to a concentric contraction, followed by a stabilizing hold, resistance to an eccentric contraction, and another stabilizing hold. The agonist groups are targeted throughout this sequence (Saliba et al., 1993).

Bridging is an example of the Agonistic Reversal technique. The patient lifts the pelvis into a bridge against resistance from the clinician (concentric phase). Manual contacts are on the anterolateral pelvis with force directed posteriorly. The patient is requested to hold the pelvis in this position (stabilizing hold) and then asked to slowly lower the pelvis toward the bed while the clinician’s manual contacts and direction of resistance remain consistent (eccentric phase). The clinician instructs the patient to hold the new position (stabilizing hold). Intervention 9-21 depicts this technique as used with bridging.
Resisted Progression

The Resisted Progression technique focuses on the skill level task of locomotion. Resistance is utilized to increase strength or endurance, develop normal timing, or reinforce motor learning. This technique may be applied during crawling, creeping or walking. Manual contacts are selected according to the desired emphasis, including upper or lower trunk, extremities, pelvis, and scapula (Sullivan et al., 1982).

Backward locomotion in quadruped (creeping) is an example of the Resisted Progression technique. Backward progression may occur by moving each extremity by itself or by moving contralateral upper and lower extremities simultaneously. This choice is dependent upon the patient’s motor abilities, coordination, trunk control, strength, and cognitive status. Typical manual contacts include the posterior thigh, posterior humerus, ischial tuberosity, and inferior angle of the scapula. Any combination of contacts may be used, depending on the desired focus. In this technique, the clinician’s hands may be placed on the ischial tuberosities bilaterally, on the right posterior humerus and left posterior thigh, or on the left scapula and right ischial tuberosity. The clinician kneels beside or behind the patient and faces the patient’s head.

Application of PNF Techniques

The physical therapist examines each patient and determines an individualized plan of care. Specific interventions are selected to meet individual patient’s needs; however, there are some typical combinations of PNF basic principles and techniques that are used to address certain impairments. Table 9-12 matches specific impairments with suggested PNF techniques. The use of these techniques in appropriate clinical situations has already been discussed in the sections.
Use of PNF Techniques to Treat Impairments

<table>
<thead>
<tr>
<th>Impairment</th>
<th>Goal</th>
<th>Technique</th>
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</thead>
<tbody>
<tr>
<td>Pain</td>
<td>Decrease pain</td>
<td>Alternating Isometrics, Hold Relax</td>
</tr>
<tr>
<td>Decreased strength</td>
<td>Increase strength</td>
<td>Agonistic Reversal, Rhythmic Stabilization</td>
</tr>
<tr>
<td>Decreased range of motion</td>
<td>Increase range of motion</td>
<td>Alternating Isometrics, Contract Relax, Hold Relax</td>
</tr>
<tr>
<td>Decreased coordination</td>
<td>Increase coordination</td>
<td>Agonistic Reversal, Rhythmic Initiation, Rhythmic Stabilization</td>
</tr>
<tr>
<td>Decreased stability</td>
<td>Increase stability</td>
<td>Agonistic Reversal, Rhythmic Stabilization</td>
</tr>
<tr>
<td>Movement initiation</td>
<td>Initiate movement</td>
<td>Rhythmic Initiation, Hold Relax Active Motion</td>
</tr>
<tr>
<td>Muscle stiffness/ hypertonicity</td>
<td>Promote tone reduction</td>
<td>Rhythmic Rotation, Hold Relax</td>
</tr>
<tr>
<td>Decreased endurance</td>
<td>Increase endurance</td>
<td>Alternating Isometrics, Rhythmic Stabilization, Slow Reversal</td>
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</tbody>
</table>

The developmental sequence provides a means to progress from simple to complex movements and postures (McGraw, 1962). The supine progression and the prone progression comprise the developmental sequence. Supine progression consists of the following positions: supine, hook-lying, side-lying, propping up on one elbow, pushing up to one hand, sitting, and standing. Prone progression consists of the following positions: prone, prone on elbows, quadruped, kneeling, half-kneeling, and standing.

Impairments in strength, flexibility, coordination, balance, and endurance can be addressed using the prone and supine progressions. The patient is familiar with these positions and understands the movements; therefore, the progression is relevant and functional. Within the developmental sequence, the natural progression of postures is that of increasing challenge to the stabilizing muscles. For example, in prone-on-elbows position, a broad surface area is in contact with the supporting base; the COG is very close to the surface; and only the shoulder and cervical spine segments bear significant weight. Therefore, this position is very stable and requires relatively minimal muscular effort to maintain.

In quadruped, however, the demands placed upon the muscles are much greater. The BOS is reduced. The COG is higher. The muscles about the hips, shoulders, and elbows must work in a coordinated fashion to sustain the position, both statically and during superimposed activity. Each posture within the developmental sequence fosters achievement of motor skills that serve as a foundation for more advanced functional activities. The stronger components of a total pattern are used to augment the weaker components (Voss et al., 1985). Greater demands may be placed on the patient within each position by considering the stages of motor control and applying these principles in developmental postures. The following section addresses selected postures as to possible treatment progression strategies.

Supine Progression

Working in a hook-lying position prepares the patient for bridging and scooting, which are essential for bed mobility. Weight-bearing through the feet facilitates co-contraction of the trunk and lower extremity muscles needed to maintain the position. Unilateral and bilateral LE PNF patterns are used to facilitate acquisition of the hook-lying position. Initial focus within any position is on the mobility stage, which is defined as the ability to assume a stated position. Sufficient joint range of motion and muscular strength in the pertinent regions are prerequisite to mastering this stage.

Use of PNF patterns helps the patient gain the ability to pull the legs into a hook-lying position independently. LE D1 Flexion-Flexion/Adduction/External Rotation with knee flexion is an appropriate pattern to utilize. Please refer to Intervention 9-7 for a review of the pattern and manual contacts. Mass flexion of the lower extremity may also be used to aid in assuming hook lying as pictured in Intervention 9-22.
Resisted movement of the uninvolved extremity can enhance muscular activity through irradiation into the trunk and involved lower extremity.

Once the patient has achieved a hook-lying position, stability can be created by applying Alternating Isometrics and Rhythmic Stabilization. Both of these techniques employ facilitation of isometric contractions to sustain a position. Manual contacts may be applied from proximal thigh to ankle as appropriate to vary the lever arm and thus the demand on the patient. The stability stage of motor control is reached when the patient can independently maintain the hook-lying position. The third stage of motor control, controlled mobility, then becomes the focus of treatment. Controlled mobility involves superimposing proximal mobility on a stable position. Activities in the hook-lying position that contribute to functional gains in this stage include hip abduction/adduction and lower trunk rotation.

Slow Reversal, Slow Reversal Hold, and Agonistic Reversals may be applied with either activity. Both Slow Reversal and Slow Reversal Hold include resisted alternating concentric contractions of agonist and antagonist patterns (e.g., hip abduction and adduction, or D1 flexion and D1 extension).

Slow Reversal Hold adds a held isometric contraction in the shortened range of each muscle group or pattern. Agonistic Reversal focuses on one muscle group only, the designated agonist, and concentric then eccentric contractions are facilitated. The medial and lateral femoral condyles provide effective manual contacts for hip abduction/adduction and lower trunk rotation, with care taken to facilitate the desired direction of movement. The clinician positions herself in front of the patient, or off to one side in the diagonal. The diagonal position will produce a different muscular response from the patient and increase recruitment of trunk muscles.

Bridging is a prerequisite to many functional activities including dressing, toileting, scooting in bed, and weight shifting for pressure relief. The motion of bridging also includes hip extension and pelvic rotation, which are both components of the stance phase of gait. Bridging increases weight bearing through the plantar surface of the foot and can reduce extensor tone in a patient with hypertonicity. Bridging addresses balance, coordination, and function while activating multiple muscle groups. Bridging is an example of the third stage of motor control.

Bridging is facilitated by use of manual contacts on the patient’s anterior pelvis near the anterior superior iliac spine (ASIS). Manual contacts and an appropriate level of assistance are provided to teach the proper movement strategy to achieve the mobility stage of motor control. Patients are often able to hold the bridge position (stability stage) prior to being able to actively move into the posture. Once in the position, techniques such as Alternating Isometrics or Rhythmic Stabilization may be applied at the pelvis, then more distally to enhance stability. For patients who are weaker on one side, resistance is given to the stronger side while assistance is offered to the weaker side. Once the patient no longer requires assistance to achieve a bridge position, Agonistic Reversals may be utilized to promote controlled mobility. Eccentric lowering of the pelvis in a smooth coordinated manner is often difficult for patients. The Agonistic Reversal technique is used with bridging to address coordination and strengthening of both the concentric and eccentric components of the movement. The reader is referred to Intervention 9-18 for illustrations of this technique as used with bridging. The clinician can increase the challenge of bridging by changing the base of support, increasing the hold duration, or adding extremity movements. Examples include removing one limb from the surface through hip

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**INTERVENTION 9-22** Mass Flexion Pattern of the Lower Extremity to Assist in Achieving Hook-Lying Position

A. The clinician kneels to one side, approximately level with the knees. Beginning in supine position, manual contacts are placed on the dorsal foot and posterior calf and are used to facilitate flexion throughout the lower extremity.

B. The patient completes the flexion movement of first one LE, then the other to assume the hook-lying position.
flexion or knee extension while the patient holds the bridge position or applying a resistive technique such as Slow Reversal to an extremity pattern.

Scooting in bed is considered a skilled movement associated with the hook-lying and bridging positions. Skill is the fourth stage of motor control. Scooting is often a difficult transitional movement and requires coordination of the head, upper trunk, lower trunk and extremities. Movement may be initiated with either the upper trunk, lower extremities, or lower trunk. Manual contacts facilitate the direction of movement and offer assistance or resistance to the component movements as appropriate. Manual contacts may be used below the clavicles to facilitate upper-trunk flexion while verbal cues can be given for head and neck flexion. Manual contacts on the pelvis similar to those used to facilitate bridging are used to provide input to the lower trunk.

Rolling

Many components of higher-level activities such as gait can be found in movements associated with rolling. Additionally, rolling stimulates cutaneous receptors, the vestibular and reticular systems, and proprioceptors within the joints and muscles. Rolling can positively influence muscle tone, the level of arousal/alertness, and body awareness. Rolling is an excellent total body activity that provides opportunities to improve strength, coordination, and sensation in the trunk and extremities.

There are several key points to consider when incorporating rolling into a therapeutic program. Individuals use different strategies for rolling, including flexion movements, extension movements, or pushing/pulling with one arm or leg (Richter et al., 1989). As with all complex functional activities, individuals utilize various strategies to accomplish this task. Patients need to learn to roll in both directions early in rehabilitation. Rolling to the involved side may be easier in individuals with hemiplegia because the movement is initiated primarily with the uninvolved side of the body. Prepositioning in hook lying or side lying encourages use of certain components or methods of rolling. In hook lying, a shorter lever arm is created for initiation of lower-extremity and trunk movements with emphasis on the lower trunk and hip musculature. Side lying provides an ideal position to focus on trunk rotation or to minimize the effects of gravity on extremity patterns. Specific extremity and trunk patterns and PNF techniques allow the clinician to incorporate the individual’s strengths into rolling. Rolling is also an effective task through which to enhance head control and eye-hand coordination. Basic prepositioning and one example of manual contacts are shown in Intervention 9-23.

Because of the transitional nature of the activity, the stages of motor control are not as useful in providing a clear path of functional treatment progression; therefore, treatment applications will focus on tools to enhance rolling in general. Mass flexion and extension trunk patterns provide an initial means to facilitate rolling supine to side lying and side lying to supine, respectively. Greater trunk rotation can be introduced through use of extremity patterns, such as UE D2 Extension-Extension/Adduction/Internal Rotation pattern or the LE D1 Flexion-Flexion/Adduction/External Rotation pattern with knee flexion. In both examples, the right extremity would be used to encourage rolling from supine to left side lying. The antagonist patterns of the right extremity can be used when focusing on rolling from left

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**Intervention 9-23** Prepositioning and Manual Contacts to Facilitate Rolling Supine to Right Side Lying

A. Beginning position—In preparation to roll to the right, the patient turns her head to the right. The left hip and knee are flexed. The left upper extremity is placed in flexion with the shoulder adducted. The left upper extremity is positioned away from the body in extension and adduction.

B. End position—Through manual contacts at the right anterior shoulder and pelvis, the patient is assisted, facilitated, or resisted, as appropriate, to aid in assumption of right side-lying position.
side lying back to supine. Either the UE D2 Flexion-Flexion/Abduction/External Rotation pattern or the LE D1 Extension-Extension/Adduction/Internal Rotation pattern can be used to accomplish the latter transition. In side lying, both directions of the D1 and D2 patterns of the uppermost extremities may be used in a reciprocal manner to improve trunk and extremity strength and coordination and to reinforce the components necessary for rolling. Use of the D1 pattern with the left lower extremity to promote rolling from supine to right side lying is pictured in Intervention 9-24.

Trunk patterns such as chops, lifts, and lower trunk rotation are also quite helpful in facilitating the movements required to roll. For example, rolling supine to left side lying can be performed by using a left chop in which the left upper extremity moves through the D1 Extension pattern. A left lift in which the left upper extremity moves through the D2 Flexion pattern may also be used to roll from supine to left side lying. Determining which pattern depends upon the patient’s abilities. When a person’s preferred strategy is to initiate rolling with the lower extremities, incorporating lower trunk rotation in hook lying is advantageous. This activity has been described previously in relation to the hook-lying developmental posture.

Rhythmic Initiation is often used when teaching a patient to roll. Movement is progressed from passive to assistive to active or slightly resisted. Supine or hook lying may be used as the starting position. The reader can review the section on Rhythmic Initiation for a more complete description in promoting rolling. The technique Hold Relax Active Movement may also be an effective

**Intervention 9-24 D1 Pattern with the Left Lower Extremity to Promote Rolling Supine to Right Side Lying**

A. The clinician positions herself in half-kneeling just left of the patient’s left lower extremity. She contacts on the patient’s dorsal foot with her right hand and the posterior tibia with her left hand.

B. The clinician shifts her body weight forward as the patient completes the left LE D1 Flexion pattern to assist in rolling to right side lying.

C. To return to supine, the patient performs the D1 Extension pattern with the left lower extremity. The clinician places her right hand on the patient’s posterior knee region and her left hand on the plantar surface of the foot.

D. The patient moves through the D1 Extension pattern with her left lower extremity and completes the transition back to supine position. The clinician shifts her weight onto her back leg during the transition.
tool to enhance the patient’s ability to roll. Initially the patient is placed in the side-lying position and asked to “hold” while the clinician applies resistance to the patient’s trunk, as if trying to roll the patient back toward supine. The command to “relax” is given and the patient is passively rolled slightly back toward supine. The patient is then requested to actively roll toward side lying as resistance is applied. This sequence is repeated with the clinician progressively taking the patient through a greater range of motion until the patient is able to roll from supine to side lying against resistance. Slow Reversal, Slow Reversal Hold, and Agonistic Reversals may then be incorporated into the roll with focus on appropriate movement strategies, normal timing, trunk control, and effective use of extremity patterns.

**Prone Progression**

Prone lying and prone on elbows are the beginning postures of the prone progression. Use of an external support such as a wedge, pillow, or towel roll may be necessary to promote comfort due to joint or soft-tissue restrictions or respiratory dysfunction. The progression begins with the patient moving from prone to prone on elbows (mobility). The prone-on- elbows position provides minimal biomechanical stresses due to the low center of gravity, large base of support, and minimal number of weight-bearing joints. This situation provides an ideal opportunity for early weight bearing on the upper extremities. Activities such as weight shifting and reaching form a natural functional progression and promote co-contraction of the upper trunk and shoulder girdle muscles, asymmetrical use of the arms, and the foundation for bed mobility in prone or crawling.

Rhythmic Initiation utilizes manual cues and graded assistance to teach the patient to transition from prone to prone on elbows (see PNF Techniques section). Once the patient has learned to assume the position, Alternating Isometrics and Rhythmic Stabilization may be applied to the shoulder girdle or head to create stability. Controlled mobility may be facilitated first through lateral or diagonal weight shifting and then through use of unilateral upper-extremity patterns with Slow Reversal and Slow Reversal Hold techniques.

Lifting one arm reduces the base of support, providing greater biomechanical challenge to the patient. Patients often fatigue quickly in the prone-on-elbows position; therefore, the patient should be monitored for discomfort and proper postural alignment. Frequent verbal and manual cues may be needed to help the patient maintain appropriate cervical and thoracic spine extension, scapular adduction, and shoulder alignment; otherwise, excessive strain may be placed on the periarticular structures of the shoulder, such as the capsule and ligaments. Commando style crawling is defined as a skill level activity in this position. Manual cues at the anterior humerus to guide directional movement or on the scapula to promote stability may assist in developing effective movement strategies. This task also provides an opportunity to introduce reciprocal pelvic and lower-trunk rotation early in the prone progression.

**Quadruped**

Quadruped represents the first posture in the developmental sequence in which the COG is a significant distance from the supporting surface. The higher COG combined with less body surface contact and a greater number of weight-bearing joints make this posture much more challenging from a biomechanical perspective than any of those previously addressed. The added biomechanical stresses in addition to weight bearing on all four extremities create unique opportunities to pursue gains in strength, range of motion, balance, coordination, and endurance throughout the body. Musculoskeletal dysfunction and pain may prohibit or limit the therapeutic use of this posture, especially regarding the knees, shoulders, and hands. Padding the palms or knees and altering the amount of the hip and shoulder flexion through forward or backward weight shifting can improve patient comfort. This position may also place additional stress on the cardiovascular system; therefore, patients must be carefully screened for pre-existing conditions and monitored for signs of intolerance.

To obtain quadruped position from prone on elbows, patients may begin by moving their upper or lower trunk, or one lower extremity. This transition (mobility) can be enhanced through Rhythmic Initiation by using various manual contacts at the shoulders or pelvis. Intervention 9-25 demonstrates facilitatory manual contacts that allow for transition from prone on elbows to quadruped. Individuals with poor control of the lower trunk will have more difficulty completing this transition. Manual contacts on the ischial tuberosities help to guide the movement of the pelvis, as well as allow the clinician to provide assistance as needed. Once the patient is in quadruped, Alternating Isometrics and Rhythmic Stabilization are appropriate to create stability within the position. Examples of manual contacts are shown in Intervention 9-26. Only the creativity of the clinician limits the array of activities in this posture, especially during the controlled mobility stage of motor control. Some possibilities include forward, backward, and diagonal weight shifts; single-extremity patterns; and contralateral arm/leg lifts. Movement-oriented techniques such as Slow Reversal, Slow Reversal Hold, and Agonistic Reversals may be applied as indicated by patient abilities and impairments. Intervention 9-27 pictures the use of Slow Reversal in facilitation of rocking backward. Intervention 9-28 provides examples of activities utilizing the extremities to promote this stage of motor control. Combinations of techniques can be very effective in maximally challenging the patient. One example would be application of Rhythmic Stabilization to the trunk while the Slow Reversal technique is applied to an extremity pattern.

**Kneeling**

Kneeling is a logical progression from quadruped and provides an opportunity to exercise the trunk and lower
Extremities while the upper extremities are free or used for support (Adler et al., 2000). In kneeling, the hips are in extension and the knees in flexion, which can lessen the influence of an extensor synergy pattern in the lower extremity. Weight bearing through the lower extremities can also decrease extensor tone. Hip range of motion and strength can be gained in this position, as well as improvement in static and dynamic balance. Kneeling provides functional carryover as an intermediate position between floor activities and standing.

The transition from quadruped to kneeling (mobility) may be considered a continuation of the process of moving from prone on elbows to quadruped. Because the two transitions share key components, facilitation techniques are similar. Manual contacts are adjusted throughout the movement to most effectively facilitate shifting of the body posteriorly, as portrayed in Intervention 9-29. The transition to upright is cued by traction or approximation to the upper trunk or approximation to the pelvis. The applied force is small as the patient is already lifting his body weight against gravity. Once the patient is in a kneeling position with the trunk erect, Alternating Isometrics or Rhythmic Stabilization is used to create stability with suggested manual contacts pictured in Intervention 9-30. Manual contacts may be applied on the pelvis or on the lower or upper trunk, depending on the desired focus and lever arm.

There are many ways to promote controlled mobility in a kneeling position, especially because the upper extremities are free in this posture. Several examples are weight shifting in all directions with the trunk upright; chopping and lifting; and moving in and out of heel sitting or side sitting. Intervention 9-31 presents examples of activities that may be used to enhance achievement of the controlled mobility stage in
**INTERVENTION 9-26  Continued**

A. The clinician kneels behind the patient with manual contacts on the right and left sides of the pelvis. The verbal commands of “don’t let me push you to the right/left” are given as the clinician provides resistance in the frontal plane.

B. The clinician is positioned in half-kneeling and faces the top of the patient’s head. The clinician places one hand on either of the patient’s scapula and requests that the patient “hold this position.” The clinician alternates pressure from hand to hand to promote co-contraction in the patient’s trunk.

C. The clinician is positioned in half-kneeling just to the right of the patient’s pelvis. She places her right hand on the patient’s right scapula and her left hand on the left iliac crest. The patient is requested to “hold” as the clinician applies alternating forces.

**INTERVENTION 9-27  Slow Reversal Technique to Promote Rocking in Quadruped**

A. The clinician assumes half-kneeling behind the patient and places the heels of her hands over the ischial tuberosities. The patient is requested to “push back into my hands.”

B. The patient continues the weight shift until the buttocks approximate the heels or through the desired excursion. The clinician shifts her body weight to accommodate the patient’s movement.

C. The clinician changes her manual contacts to the ASIS region bilaterally and provides the verbal command to “pull your pelvis forward” as the patient returns to quadruped position.
Trunk control is trained by progressing from moving with an upright trunk in kneeling to moving the trunk into flexion or extension, and finally, moving with trunk rotation. These activities promote the hip and trunk control needed for sit to stand transfers. As in quadruped, Slow Reversal, Slow Reversal Hold and Agonistic Reversals are frequently utilized to apply appropriate resistance to selected patterns and movements of the upper extremities or trunk. Functional activities such as throwing/catching and writing on a chalkboard may be used to improve strength and endurance in the trunk, hip, and upper-extremity muscles while also increasing eye-hand and upper-extremity coordination.

Half-kneeling is the last posture in the prone progression and is necessary for floor to stand transfers. In cases of
unilateral or asymmetrical impairment, either lower extremity may assume the forward position as there are therapeutic benefits associated with either placement. The asymmetrical positioning of the lower extremities encourages dissociation of hip and knee musculature with the potential for functional carryover to higher-level activities such as walking and stair climbing. Similar activities and techniques as those used in kneeling can be applied successfully in half-kneeling to enhance the stability and controlled mobility stages of motor control.

**Sitting**
Sitting is the chief functional position for many activities, as well as the midpoint of the transition between recumbency and standing. The sitting position frees both upper extremities and loads the trunk in an erect position. Learning to weight shift and control the midline position of the trunk and pelvis helps develop the balance, strength, and neuro-muscular control necessary for efficient gait. Multiple combinations of trunk and extremity movements are possible in sitting, allowing patients to develop both mobility and stability in different body regions concurrently. Balance reactions can be facilitated in this position.

Ideal sitting posture is one in which the pelvis is neutral with normal spinal curvatures; the head is over the shoulders; and feet are firmly on the floor. Attention to these details will enhance the effectiveness of sitting activities and their carryover into functional tasks in higher-level postures.
**INTERVENTION 9-30** Alternating Isometrics and Rhythmic Stabilization Techniques to Promote Stability in Kneeling

**A.** The patient kneels at the edge of the mat table with the foot extending off the surface. The right hand is supported on a stool. The clinician stands and faces the patient. The verbal command of “don’t let me move you forward” is given. Symmetrical manual contacts are used to facilitate trunk extension. The clinician alternates between anterior and posterior hand placements to apply the Alternating Isometrics technique to enhance trunk stability.

**B.** The clinician kneels in front of the patient and places her hands on the patient’s anterior pelvis. The verbal command of “don’t let me push you back” is provided. Resistance is applied to match patient effort as Alternating Isometrics is applied. The clinician alternates between anterior and posterior manual contacts to sequentially facilitate both the trunk flexors and extensors.

**C.** The clinician stands in front of the patient and applies her hands to scapula and anterolateral pelvis. She requests that the patient “hold” the position as forces are applied to promote co-contraction of the trunk musculature during the Rhythmic Stabilization technique.
INTERVENTION 9-31 Activities to Promote Controlled Mobility in Kneeling

Continued
Because many people, especially those with neurologic dysfunction, tend to sit with the thoracic and lumbar spine flexed and the pelvis posteriorly tilted, facilitation is often required to assist patients in achieving an erect trunk. Postural correction should occur at the pelvis first because it is the foundation for upright sitting. The heels of the clinician’s hands are placed between the iliac crest and ASIS with the fingers pointing down and back toward the ischial tuberosities. The clinician may passively move the patient’s pelvis from a posterior to an anterior tilt to help the patient to gain awareness of the desired movements. To facilitate assumption of an anterior tilt position, the clinician may passively move the pelvis into a posterior tilt and give resistance down and back as the patient attempts to move the pelvis up and forward. Verbal cues such as “sit up tall” or “push your hips up to me” are utilized. Approximation or traction through the scapulae or shoulders provides a stimulus to move into an upright posture. Assistance is given if necessary for the patient to successfully achieve an upright posture. The therapist may be able to resist the stronger side and assist the weaker side, thus using the principle of overflow. Intervention 9-32 demonstrates methods of facilitating erect sitting posture using a variety of manual contacts.

Rhythmic Initiation and Hold Relax Active Movement are effective techniques to teach patients to assume an upright symmetrical sitting posture (mobility). Intervention 9-33 depicts use of the latter technique. Manual contacts are placed in the direction of the desired movement, unless assistance is needed during early rehabilitation. Once the patient has achieved vertical posture, Alternating Isometrics or Rhythmic Stabilization can be applied to create stability. Upper extremity weight-bearing activities, with or without facilitatory techniques, may be appropriate in sitting, especially during the stability stage of motor control. Further progression into the controlled mobility stage includes lateral weight shifts on the pelvis, unilateral upper-extremity patterns, trunk movements in cardinal or diagonal planes, and chops and lifts. Recommended techniques for promoting dynamic trunk control include Slow Reversal, Slow Reversal Hold, and Agonistic Reversal.

Emphasis may be placed on trunk rotation by incorporating lifting and chopping patterns. The combination of two extremities working together increases irradiation into the trunk musculature. Lifting patterns facilitate trunk extension, elongation on one side of the trunk, and a weight shift. Chopping promotes trunk flexion, shortening of the trunk on one side, and a weight shift. The direction of the weight shift with either movement pattern varies among patients. Resistive techniques (Slow Reversal, Slow Reversal Hold, Agonistic Reversal) are applied as appropriate to increase strength, motor control, endurance and coordination in the trunk and upper extremities. Intervention 9-15
provides an example of the use of trunk patterns in promoting erect sitting posture.

**Scooting**

The key to successful scooting is the weight shift that occurs prior to advancing the pelvis forward. In order for attempts at reciprocal scooting to be successful, a weight shift to the left must occur to unweight the right side of the pelvis. The right pelvis may then be advanced forward. The weight shift occurs in a lateral and slightly forward direction with elongation of the trunk to the left and shortening of the trunk on the right. Left trunk lengthening is facilitated by placing one hand on the patient’s left anterior superior shoulder and the other hand on the right anterior superior pelvis. The clinician stands in front of and to the left of the patient. An approximation force is applied concurrent with a verbal cue to “shift to me.” The patient responds by lengthening the trunk on the left and shortening the trunk on the right. A manual contact on the right side of the pelvis is used to facilitate the advancement of the right pelvis. The clinician assists the pelvis forward if the patient is unable to perform the movement. The sequence is repeated to obtain elongation to the right side of the trunk and advancement of the left pelvis. The clinician switches position from side to side as the motion of scooting is facilitated. If the patient is unable to perform the motion of reciprocal scooting, the clinician can isolate component parts, assisting as needed. Rhythmic Initiation and Hold Relax Active Movement are useful in teaching the patient the motions necessary for scooting. Once each component has been facilitated, the entire motion is then practiced to ensure motor learning of the task as a whole.
INTERVENTION 9-33 Hold Relax Active Movement Technique to Promote Assumption of Erect Sitting Posture

The patient sits without external support on the edge of the mat table with feet securely on the floor. The clinician stands in midstance position and faces the patient.

A. Manual contacts are placed on the patient’s posterior trunk in the intrascapular area. The clinician resists an isometric hold of the trunk extensors in the shortened range.

B. Upon the command to “relax,” the clinician passively moves the patient into the lengthened range of trunk extensors. She shifts her body weight posteriorly during the movement.

C. The patient actively returns to the upright sitting position while the clinician facilitates or resists concentric contraction of the trunk extensors. She shifts her weight forward as the patient moves into erect sitting.
Sit to Stand

Moving from a seated position into standing requires the patient to move the center of gravity over the base of support and lift the body against gravity. This is challenging for many patients. Forward inclination of an extended trunk with the hips flexed and the knees anterior to the feet brings the center of gravity over the feet and enables the weight of the body to be shifted forward and upward (Carr and Shepherd, 1998). As the patient continues to lean forward, the buttocks are lifted off the chair, and ultimately, the hips and knees are extended as the trunk moves into an erect standing posture. Sit to stand can be facilitated by assistance or resistance. It is important that normal timing of the movement is maintained regardless of the degree of assistance or resistance. Many patients extend the knees before the hips. This should be avoided as much as possible because it makes achieving an erect trunk position more difficult.

The clinician stands in front of the patient or on a diagonal when facilitating the transition from sitting to standing. Standing on a diagonal encourages a weight shift in that direction and is particularly recommended for the patient who tends to push up only with the stronger limb. Manual contacts vary based on the patient’s needs and abilities. Manual contacts on the upper trunk are effective for patients who have the ability to stand but need cues for the correct sequence or timing of the motion. Manual cues on the pelvis are more appropriate for patients who require greater facilitation with sit to stand. The clinician’s hands are placed on both sides of the pelvis in the space between the anterior superior iliac spine and the iliac crest. During the transitional movement, the clinician mirrors the forward movement expected from the patient. Failure of the clinician to weight shift backward and time the movement to match the patient’s will lessen the quality of the resulting movement. Only slight resistance is applied as the patient moves forward and up into a standing position. The verbal commands consist of “lean toward me and stand up.” The patient may use momentum to come to stand, thus preserving the normal timing of the motion. If the patient remains leaning forward too long before trying to stand, it is more difficult to generate sufficient force to achieve the transition. Manual contacts on the pelvis, the clinician’s movements, and concise verbal cues inform the patient as to which direction to move. Lifting patterns may be incorporated into the movement to enhance forward weight transfer and maintenance of erect trunk posture as pictured in Intervention 9-34.

If assistance is needed only on the weaker side, the clinician can maintain manual contact on the pelvis on the strong side and assist the weaker side through a manual contact on the posterolateral iliac crest or at the buttocks. If the patient requires more assistance, both of the clinician’s hands are placed on the buttocks in order to assist the patient into standing, maintaining appropriate timing during the transition. Practicing initially with a higher chair or hi-lo mat table eliminates some of the difficulty involved in generating adequate force to successfully complete the movement (Carr and Shepherd, 1998). Resistive lower-extremity patterns, bridging, and controlled mobility activities in sitting or kneeling help the patient to develop the requisite strength, coordination, and motor control to successfully perform a sit-to-stand transfer.

Standing

Safety and stability in standing are paramount to functional independence. Standing provides the foundation for many higher level functional tasks such as gait, stand-pivot transfers, activities of daily living, cleaning/cooking tasks, and work-related skills. The transition from the sitting position to standing comprises the mobility stage of motor control and was addressed in the previous section. Once the patient has achieved erect standing, approximation may be used at the pelvis to enhance co-contraction of the muscles in the lower extremities and create stability. The clinician stands and faces the patient on a diagonal with one foot forward while applying approximation.

A lumbrical grip (see Fig. 9-1) is used with the thenar eminence on the anterior superior aspect of the patient’s iliac crest and fingers pointing toward the ischial tuberosities. Approximation is given through both sides of the pelvis equally and directed downward and backward at a 45-degree angle toward the patient’s heels. Suggested hand placements are pictured in Intervention 9-35. The clinician gradually increases the amount of force used as the patient responds. Further stability can be developed through the use of Alternating Isometrics or Rhythmic Stabilization as is also shown in Intervention 9-35. The clinician may stand directly in front of the patient or on a diagonal while applying these techniques.

Varying manual contacts assists in providing the amount of resistance that appropriately challenges the patient’s abilities through changes in lever arm. The least resistance is experienced through use of contacts on the pelvis, and an intermediate amount through contacts on the thigh and lower trunk. The greatest resultant force is produced through hand placements on the lower leg, ankle, shoulder girdle, or upper extremity. Controlled mobility activities include weight shifting and squatting through partial range.

Pre-Gait Activities

In standing, controlled mobility activities are targeted at acquiring the skills needed to walk. Weight shifting is a fundamental movement that must be mastered before actual steps are attempted. Symmetrical standing may be used initially, with progression to midstance position (one foot forward) as soon as warranted. The midstance position in itself facilitates a weight shift from one limb to the other. Procedurally, the clinician uses contacts on the anterior pelvis similar to those used for scooting and the transition from sitting to standing. Intervention 9-36 shows several options for application of approximation and facilitation of pelvic control.
The patient stands with symmetrical foot placement. The clinician stands in midstance position and faces the patient.

A. The clinician applies approximation at the pelvis through manual contacts at the iliac crest. A verbal cue may be given to “stand up straight.”

B. The clinician applies approximation through the superior aspect of the shoulder girdle to promote upright trunk posture.

C. The clinician applies traction through hand placements over the scapula to promote upright standing.

D. Rhythmic Stabilization is applied with asymmetrical manual contacts at the shoulder and pelvis. Emphasis is on application of rotary forces to promote trunk co-contraction to enhance upright standing posture.
The patient stands in midstance position with her right lower extremity forward. The clinician also stands, but her relative position varies according to the specific patient situation and goal.

A. The clinician is shown standing in front of the patient to apply approximation through the pelvis. The heels of the clinician’s hands are placed symmetrically on the anterior superior aspect of the iliac crests.

B. An alternative position for application of approximation is pictured with the clinician standing behind the patient. Manual contacts are similar to those described above; however, the clinician’s hands are shifted posteriorly.

C. The clinician facilitates pelvic control through contact on the unloaded limb. The patient assumes midstance position with her weight shifted onto the forward lower extremity, in this case, the left. The clinician stands on the left side. She uses her right hand to facilitate, assist, or resist isometric control of the left lower extremity. She places her left hand on the patient’s right pelvis, near the ASIS. The patient is asked to “push your pelvis into my hand” to promote initiation of swing phase on the unloaded limb, in this case, the right.
Methods of Facilitating and Assisting with Swing Phase of Gait
Rhythmic Initiation assists the patient with the act of weight shifting by using a sequence of passive, active-assisted, active, and slightly resisted motions. Slow Reversal Hold can be an effective tool that simulates the sequence of isotonic then isometric muscle contractions utilized during gait. Lever arm may be varied through manual contacts at the pelvis, thigh, lower leg, or trunk. Contacts and resistance may be applied symmetrically or asymmetrically as indicated by patient abilities or responses. For example, appropriately strong resistance may be utilized through contact on the left midanterior thigh to produce overflow while less resistance is applied on the left anterior pelvis to facilitate movement.

Some patients tolerate only short periods of time in the upright position, due to multiple factors including cardiovascular status, balance, trunk control, coordination deficits, and deficiencies in mental processing. Musculoskeletal conditions, such as arthritis in the hips, knees, or spine, may also limit tolerance to standing. It is often appropriate to determine alternative activities in lower-level developmental positions to simulate the movements or muscle contractions required during standing and walking. Bridging and weight shifting in quadruped or half-kneeling represent controlled mobility activities with direct functional carryover into components of the gait process. Slow Reversal Hold and Agonistic Reversals facilitate and reinforce the types of muscle contractions and movement strategies most crucial to upright locomotion, as well as increase strength. Depending upon the patient’s unique abilities and needs, other suggested interventions include resisted extremity patterns in quadruped; Rhythmic Stabilization or...
Alternating Isometrics in quadruped, kneeling, or half-kneeling; and resisted LE patterns in side lying, especially D1 extension with emphasis on pelvic control. Some of these activities may also be adapted for inclusion in a home program.

After the patient achieves an adequate weight shift in the midstance position, further stability can be developed in the forward limb through use of Rhythmic Stabilization. Manual contacts may be altered to focus on control of the pelvis, knee, or ankle. The importance of stability in the stance phase of gait cannot be overemphasized. Efficient progression, or swing through, of the unloaded limb can occur only when the stance limb provides adequate support and security. Once this goal is reached, swing of the unloaded limb may be facilitated by an applied stretch to ipsilateral pelvis through a lumbrical grip on the ASIS. The direction of the force is posterior and inferior, toward the ischial tuberosity. Application of the stretch is timed with the verbal cue to “step forward.” Judiciously applied resistance may also facilitate greater movement. When the patient demonstrates sufficient control of the pelvis, manual contacts may be moved to the anterior thigh to facilitate further hip flexion. As the foot again contacts the surface, the process of weight shifting and stabilization of the forward limb resumes. Many options exist for continued gait preparation and training. Suggested manual contacts are shown in Intervention 9-36. Dependent upon the patient’s responses, several typical routes are pursued. Repeated forward and backward stepping may be practiced with or without applied stretch. The procedure for facilitating backward stepping is similar to that of forward stepping, with the therapist’s hands now placed on the patient’s posterior thigh. The therapist may also alternate focus on the swing and stance limb through the procedures previously described. Resisted Progression with manual contacts on the trunk, pelvis, or lower extremity is introduced when facilitation through stretch is no longer needed.

Retraining of a safe, efficient gait pattern in individuals with neurologic impairments is challenging for both the individual and the clinician. Although no one strategy is optimally effective for everyone, the following progression may prove helpful:

- Approximation and stability exercises in standing with feet symmetrically placed
- Approximation and stability exercises in midstance and then with the patient’s weight shifted forward onto the front limb
- Application of resistance at the pelvis of the advancing limb as the patient steps forward
- Repetitive stepping forward and backward with one limb
- Reciprocal gait with manual contacts at the pelvis and facilitatory stretch to the hip flexors at the initiation of swing phase
- Resistive reciprocal gait with manual contacts at the pelvis, then the trunk and lower extremities

PNF AND MOTOR LEARNING

Motor learning is defined as “a set of processes associated with practice or experience leading to relatively permanent changes in the capability for producing skilled action” (Shumway-Cook and Woollacott, 2001). From its conception, the intended outcome of PNF as a therapeutic approach has been to develop and refine functional movement strategies. In the preface to the second edition of their classic text, Proprioceptive Neuromuscular Facilitation: Patterns and Techniques, Margaret Knott and Dorothy Voss stated repeatedly that development and application of the PNF approach was targeted at maximizing motor learning. The following excerpt summarizes their perceptions:

... all of the procedures suggested for the facilitation of total patterns have a common purpose—to promote motor learning. Oddly this term strikes some physical therapists as new or foreign, yet we have always tried to “teach the patient” to perform a motor act and have been pleased when the patient has learned (Knott & Voss, 1968, p. xiii).

A positive environment that nurtures an interactive relationship between clinician and patient sets the stage for optimal learning and relearning of motor skills. This environment creates a place where the patient is motivated by realistic demands, clearly articulated expectations, and functionally relevant outcomes. Auditory, tactile, and proprioceptive input are crucial elements in promoting and reinforcing the motor performance that comprises the desired functional skills. The continual process of implementing techniques and patterns matched with the patient’s current abilities, observing the patient’s responses, and making appropriate modifications is key to optimal achievement of the patient’s functional goals.

CHAPTER SUMMARY

Kabat and Knott created an approach to patient treatment in the 1940s that continues to grow and evolve today. The PNF treatment approach has clinical application to a wide variety of patients and diagnoses. It consists of a philosophy and basic principles, which can be adapted and applied by clinicians to any functional activity. By incorporating the basic principles of PNF, clinicians broaden their repertoire of intervention strategies and are better able to customize therapeutic exercise programs to each patient’s unique needs. When using PNF principles to create specific activities and patterns of movement for individual clients, a checklist ensures that the basic principles are being followed. Such care allows the clinician to incorporate PNF techniques to address specific problems and enhance patient performance. When the emphasis of treatment is on function, PNF is a viable treatment option.
REFERENCES


REVIEW QUESTIONS

1. Define the term *appropriate resistance* according to the PNF approach.

2. What is irradiation? Describe how this phenomenon may be used to promote movement in individuals with hemiplegia.

3. What two PNF techniques are frequently applied to increase stability?

4. What activities, patterns, or techniques are appropriate to use when the outcome is improvement of the functional ability to roll to the left in a patient who has sustained a right CVA? How would clinician strategies change when teaching rolling to the right in the same individual?

5. A patient is having difficulty weight bearing on the right lower extremity after a left CVA. What interventions are appropriate to enhance the patient’s ability regarding right stance during gait?

6. A patient has weakness in the right gluteals. Identify activities to strengthen these muscles eccentrically. What PNF technique is most appropriate to address an eccentric deficit?

7. Hamstring shortness is limiting a patient’s ability to sit with the knees extended (long sitting position). What PNF technique promotes lengthening of this muscle group?