CHAPTER 14

Wheelchairs, Assistive Devices, and Gait Training

OBJECTIVES

After studying Chapter 14, the reader will be able to:

- Discuss the types of wheelchairs and wheelchair components.
- Measure the wheelchair for the patient.
- Identify wheelchair training techniques.
- Describe the two phases of human gait: the stance and the swing phase.
- List the types of assistive devices used in physical therapy.
- Explain and perform preambulatory activities at the parallel bars.
- Follow guarding techniques during ambulation on even surfaces and stairs.
- Discuss patients' weight-bearing categories.
- Differentiate between different weight-bearing categories such as non-weight bearing, partial weight bearing, toe touch weight bearing, and weight bearing as tolerated.
- List the six gait sequencing patterns used in gait training.
- Perform the six gait sequencing patterns using different assistive devices.
- Discuss standing and sitting activities using assistive devices.
- Describe ascending and descending stairs using crutches and the cane.

WHEELCHAIRS

What is a wheelchair?

A wheelchair is defined as a type of mobility device for personal transport.

Traditional wheelchairs have a seating area positioned between two large wheels with two smaller wheels called *caster wheels* at the front. The two large wheels can be self-propelled by the patient through hand rims or can be pushed by another person. Advances in wheelchair design have provided alternatives that accommodate obstacles and rough terrain. Lightweight wheelchairs are designed for racing and sports. Powered wheelchairs and scooters driven by electric motors can be controlled through electronic switches and enable mobility of patients having severe muscle weakness, paraplegia, or quadriplegia.

Usually, patients need to be measured and fitted for the wheelchair. For example, most patients who have spinal cord injury use a wheelchair as the primary means of mobility. Also, patients with spinal cord injury who have paraplegia and are able to ambulate with crutches may need a wheelchair to decrease their energy expenditure and to increase their speed in mobility and safety. For patients with spinal cord injury, the wheelchair would be a custom-prescribed wheelchair for each individual, dependent on the spinal injury level. In that situation, the wheelchair

becomes an orthotic type of device and should be prescribed by the physical therapist (PT).

Purposes of a wheelchair include the following:

- A wheelchair can be described as an orthotic mobility device because it can correct and straighten a deformity.
- A wheelchair can be compared with a brace that increases or maintains a patient's level of function.
- A wheelchair can provide adequate support to allow the patient maximum functioning.

Usually, when prescribing the wheelchair, the PT works with a rehabilitation team of health care providers such as a physician, nurse, psychologist, vocational counselor along with the patient and the patient's family. To create the best mobility device, including patient's postural support, the prescription wheelchair is planned by the PT after the patient evaluation, determination of goals and outcomes, and planning the intervention. During the patient evaluation, the PT obtains information about the patient's range of motion, muscular tone, motor control, stability, balance, coordination, ability of the patient to maintain a natural lumbar curve, and the patient's comfort.[1]

Patient's measurements are required for the following:

- Thigh length
- Leg length
- The distance from the seat to the lower scapula, midscapula, and shoulder
- The distance from hanging elbow to the seat surface
- The width across the hips, shoulders, and from outside of one knee to outside of the opposite knee

The patient and the patient's family provide information about the desired wheelchair function, such as whether it will be used for work or for playing sports (or both), information about the patient's home and work, patient's educational and recreational activities, methods to transport the wheelchair, and the funding sources. The goals, the outcomes, and the intervention are discussed and planned with the entire rehabilitation team, including the patient and the patient's family. The wheelchair's mobility goals take into consideration the patient's size, age, weight and stature, functional limitations, functional abilities, cognitive status, psychosocial status, the projections in changes in the patient's condition, and the expected use of the wheelchair.

Goals of proper wheelchair seating and positioning include the following:

- Prevention of deformities and pressure ulcers
- Normalization of tone
- Promotion of function (by efficient use of upper extremities)
- Optimization of the respiratory function
- Proper body alignment
- Increased sitting comfort and tolerance

In addition to the above goals, the patient needs to be able to propel the wheelchair as well as be alert and comfortable.

Examples of specialized prescription wheelchairs including the standard wheelchair:

- The standard wheelchair is recommended for patients who weigh less that 200 pounds.
- The heavy-duty wheelchair is recommended for patients who weigh more than 200 pounds; the heavy duty wheelchair also may be an extra wide wheelchair.
- The child's wheelchair is recommended for children up to 6 years old.
- The junior wheelchair is recommended for adolescent children or patients who are smaller than adults but larger than children.
- The amputation wheelchair is recommended for patients who have bilateral lower extremity amputations. These wheelchairs have the drive wheels positioned approximately two inches posterior to the (vertical) back supports to prevent the wheelchair from tipping

backward. The modification increases the length of the base of support because the patient's center of gravity while sitting in the wheelchair is located more posterior.

- The hemiplegia wheelchair is recommended for patients who have hemiplegia. The wheelchair is lowered approximately two inches to allow the patient to propel it using the uninvolved upper and lower extremity.
- The one-arm drive wheelchair is recommended for patients who need to propel the wheelchair by pushing the wheelchair using only one hand; the two outer hand rims of the two drive wheels are mounted only on one drive wheel and are connected by a linkage rod; the patient propels the wheelchair by simultaneously moving the two hand rims of the two drive wheels with one hand.
- The tilt-in-space wheelchair is recommended for patients who may be thrown out from the wheelchair because they have increased tone or severe muscle spasms in their hip extensors and knee extensors. It is also recommended for patients who need relief from pressure sores but are unable to perform push-ups in the wheelchair.
- The reclining wheelchair is recommended for patients who are unable to maintain an upright sitting position in the wheelchair and need to be in semireclining or reclining positions.
- The sport wheelchair is recommended for patients who are able to play sports. The wheelchair is lightweight with reinforced frames, has canted drive wheels, and low seats so that the patient can sit in a tucked position.
- The powered wheelchair is recommended for patients who are not able to self-propel or patients who have very low endurance while propelling the wheelchair. The wheelchair has a battery for power, and can be controlled using a joystick, a chin piece, or a mouth stick.

As in other areas of physical therapy, the physical therapist assistant (PTA) helps the PT in gathering data for the patient's measurements for the wheelchair. The PTA must have knowledge about the wheelchair components, wheelchair measurements, and wheelchair training.

Wheelchair Components

A wheelchair has two main components, the postural support system and the wheeled mobility base. The postural support system of the wheelchair includes the seats, the back, the armrests, the leg rests, and the footrests. The wheeled mobility base of the wheelchair includes the frame, the caster wheels, the drive wheels, the tires, and the brakes.

Wheelchair Seat

The standard wheelchair seat is called a *sling seat* (Figure 14-1). The sling seat in the standard wheelchair is not considered one of the best since it has the tendency to allow the patient to slide the hips forward and create an unwanted posterior pelvic tilt. Posterior pelvic tilt positioning can cause pressure sores (decubitus ulcers) at the ischial tuberosities. For this reason, most of the wheelchairs benefit from a solid insert seat that adds firmness to the surface and reduces the patient's propensity to slide forward and produce a posterior pelvic tilt. In addition, wheelchairs need seat cushions that are positioned on the seat to distribute the weight-bearing pressures, and as a result, to prevent pressure sores. The seat cushions are made of materials such as gel or layered foam, or are inflatable (such as the Rojo-Air low-profile cushion). Specialized prescription wheelchairs may have a

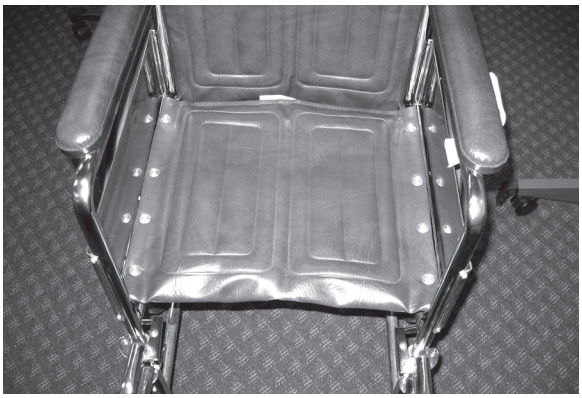


Figure 14-1 Wheelchair Seat (Sling Seat)
Source: Author

seat adaptation called *tilt-in-space*; such a specialized wheelchair is called a *tilt-in-space wheelchair*. The tilt-in-space seat has the entire seat and the back tilted backwards with a normal seat-to-back angle. The tilt-in-space seat is recommended for patients who have increased tone or severe muscle spasms in their hip extensors and knee extensors. It is also used for patients who need relief from pressure sores but are unable to perform push-ups in the wheelchair.

Wheelchair Back

The standard wheelchair back is called a *sling back* and supports only the middle back portion (the midscapula) but not the lower back (Figure 14-2). If the patient has poor stability of the trunk, the wheelchair needs a high back height (to the patient's acromion of the shoulder). However, if the patient needs to be functional and use upper extremities for activities of daily living or sports, the wheelchair needs a low back height, probably the sling back. In the long run, the patient using a low back height may have fatigue and back pain. In that situation, the patient may require a back support made of solid board (padded) that can be inserted in the wheelchair's back upholstery. Specialized prescription wheelchairs may have a reclining back for patients who are unable to maintain an upright position in sitting. This specialized wheelchair is called a reclining wheelchair. Usually, the reclining wheelchair contains an extended back and elevating leg rests for relief of pressure sores. It may also have head and trunk support. Patients who have quadriplegia (also called tetraplegia) or paralysis of upper and lower extremities and the trunk may have a specialized wheelchair with an electric reclining back. The electric reclining back wheelchair is a motorized wheelchair powered by batteries. Patients can control the electric wheelchair by using the hand, the chin, the head, or the mouth.

Wheelchair Arm Rests

The wheelchair has two arm rests (Figure 14-3) that can be removable or nonremovable. The two arm rests can be set at full length or at desk length. Removable arm rests are better than nonremovable because they facilitate lateral transfers. Desk length arm rests allow the patient to roll the wheelchair to a desk or under a table without any interference by the arm rests. The arm rests can be adjustable relative to the height, can be wraparound reducing the general width of the wheelchair, or they can have trays or troughs secured to the arm rests to provide additional postural assistance.

Wheelchair Leg Rests

The wheelchair has two leg rests that are made of a calf pad and front rigging. The leg rests contain two footrests (Figure 14-4). The leg rests can be fixed or detachable. Detachable leg rests allow the patient to transfer easier and to position in the wheelchair from the front. The leg rests can also be elevating leg rests. Elevating leg rests are indicated for patients who have severe edema in the lower extremities and for patients who are not able to sit in 90° of hip and knee flexion (with ankles in neutral) because they need postural support.

Figure 14-2 Wheelchair Back (Sling Back)
Source: Author

Figure 14-3 Wheelchair Arm Rests
Source: Author

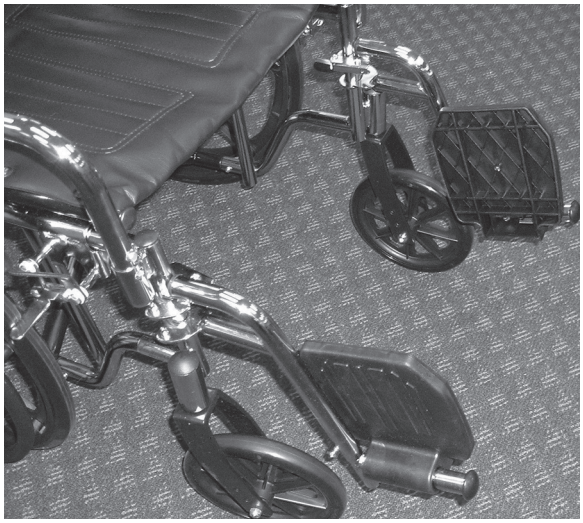


Figure 14-4 Wheelchair Leg Rests
Source: Author

Wheelchair Foot Rests

The wheelchair has two foot rests made of foot plates, heel loops, and straps for the ankles or the calf. The foot plates of the foot rests (folded down) provide a resting base for the feet (Figure 14-5), and can be removed during transfers. The role of the heel loops on the foot rests is to maintain the foot position and prevent backward sliding of the foot. The ankle straps (or the calf straps) are added to stabilize the foot on the foot plate.

Wheeled Mobility Base System

The frame of the wheeled mobility base system can be fixed or folding. The folding frame allows the patient to store and transport the wheelchair. The frame of the wheelchair can be heavy duty, lightweight, standard, or ultra-light weight. The lighter the wheelchair frame the easier for the patient to use the wheelchair in a functional way. The wheeled mobility base system includes two caster wheels and two drive wheels. The two caster wheels are small front wheels (Figure 14-6) usually 8 inches in diameter. Larger diameter caster wheels make the wheelchair easier to climb curbs but have a tendency to flutter. Some wheelchairs have locks on the caster wheels to add to the wheelchair's stability. The two drive wheels are large rear wheels used for propulsion and include two outer hand rims (positioned laterally) to propel the wheelchair (Figure 14-7). Some wheelchairs have large outer hand rims called *projections* to facilitate easier propulsion of the wheelchair. Usually, patients who have quadriplegia (or tetraplegia) and do not have enough strength in their hands need the projection hand rims to propel the wheelchair. The drive wheels of the wheelchair can also have friction hand rims that can help patients who have difficulty gripping the rims.

The wheelchair tires are part of the wheeled mobility system (Figure 14-8). The tires are fitted onto the rims of the propelling drive wheels and caster wheels. Narrow tires on the drive wheels have less rolling resistance and are suitable for use on hard, flat, indoor surfaces. Wide tires on the drive wheels are easier to propel on uneven outdoor surfaces. The tires can be standard hard rubber tires or pneumatic (air-filled) tires. The hard rubber tires are durable and require low maintenance. Hard rubber tires are recommended for use mostly indoors as on

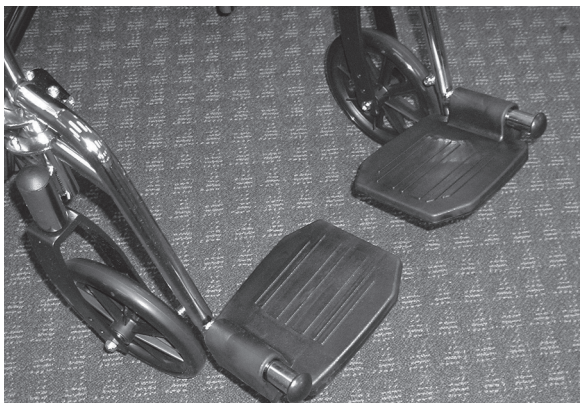


Figure 14-5 Wheelchair Foot Rests
Source: Author

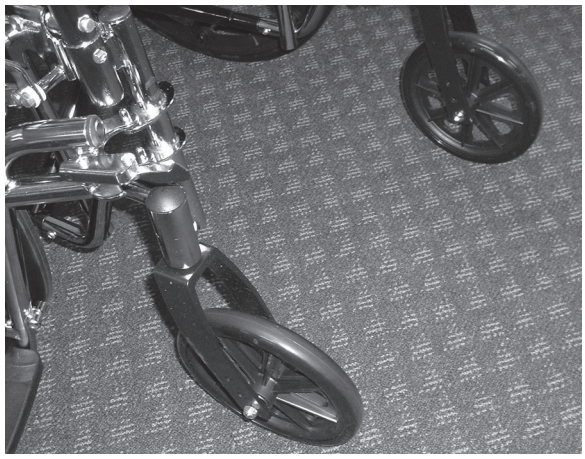


Figure 14-6 Front Caster Wheels
Source: Author

Figure 14-7 Rear Drive Wheels
Source: Author

uneven, outdoor terrain they cause a harsh ride. The pneumatic tires increase shock absorption creating a smoother ride. However, pneumatic tires used in the community and on uneven terrain require more maintenance than do hard rubber tires. The wheeled mobility base system includes two brakes that use a level system with a cam (Figure 14-9). *The brakes must be used in all transfers.* Some wheelchairs have added extensions to the brakes to allow patients ease in reaching the brakes for locking and unlocking.

Additional Attachments

The wheelchair may need additional attachments to better position the patient onto the seat, to prevent the wheelchair from tipping backwards, to allow braking in

Figure 14-8 Wheelchair Tires
Source: Author

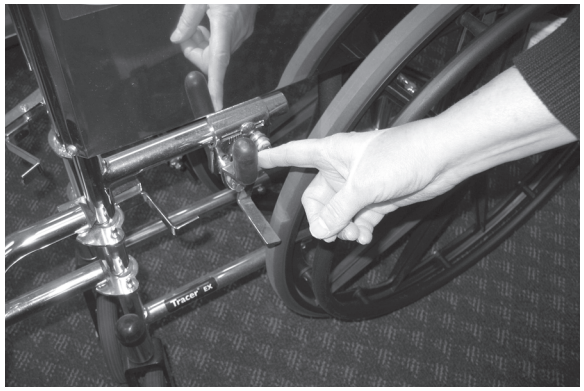


Figure 14-9 Wheelchair Brakes
Source: Author

reverse, and for holder devices. The seat attachments to help position the patient are seat belts that go over the pelvic area to increase patient's stability in the seat. Other wheelchair attachments for positioning the patient are the support components for the patient's head, neck, chest, and knees. For example, a type of hardware mounted on the wheelchair is a support component for the patient's head and neck when the patient has poor head control. The antitipping device is an extension attached to the back of the wheelchair stopping the wheelchair from going backward when the patient is leaning back. The reverse brake is a mechanical brake that automatically stops the wheelchair from going into reverse. The reverse brake is useful for patients who need to go up ramps or hills and need to occasionally rest during the ascent. The holder devices for a cane or for crutches are mounted at the base of the wheelchair. Holder devices are useful to the patient because they can transport assistive devices used by the patient in the community.

Wheelchair Measurements

When measuring the wheelchair for a patient the following factors must be considered:

- The wheelchair's size must be proportional to the patient's size.
- The patient's personal needs including the environment determine the type of wheelchair or the type of additional attachments to the wheelchair.
- The patient's measurements must be taken with the patient situated on a firm surface while sitting or lying supine.

Seat Measurements

Seat measurements are taken for the seat width, seat depth, and seat height. The seat width proper measurement is important for the patient's functional use. For example, a wheelchair seat that has excessive width is difficult for the patient to maneuver in tight places. In addition, an extra wide seat may cause the patient difficulties reaching the drive wheels, and propelling the wheelchair. A wheelchair seat that is too narrow width would cause pressure and discomfort on the patient's lateral pelvis and lateral thighs. The seat width must fit as close to the patient's body as possible.

How to measure the seat width of the wheelchair:

The seat width of the wheelchair is calculated by measuring from the patient's widest part of the hips (Figure 14-10), then adding 2 inches to the measurement.

The typical dimensions of wheelchair seat width for a standard adult wheelchair is 18 inches, for a narrow or a junior wheelchair it is 16 inches, and for an extrawide adult wheelchair it is 22 inches. The seat depth measurement is important for the patient's postural support and control. For example, if the seat depth is too short, the patient's thighs will not have the necessary support. Conversely, if the seat depth is too long, the patient's blood circulation to the posterior part of the knees can be interrupted. Also, the patient may not be able to sit properly; instead, they may sit with a posterior tilt causing pressure on the ischial tuberosities.

How to measure the seat depth of the wheelchair:

The seat depth of the wheelchair is calculated by measuring from the patient's posterior buttocks on the lateral side of the thigh to the popliteal fossa (Figure 14-11), then subtracting 2 inches from the measurement.

The typical dimensions of the wheelchair seat depth for a standard adult wheelchair, for a narrow or a junior wheelchair, and for an extrawide adult wheelchair is 16 inches.

The proper seat height is important for the patient's independent transfers and interaction with other people. The seat height must be measured relative to the entire wheelchair.

How to measure the seat height of the wheelchair:

The seat height of the wheelchair is calculated by measuring from the floor to the lowest point on the bottom of the foot plate of the footrest (Figure 14-12). The seat height can also be calculated by first measuring the patient's leg length then adding 2 inches to the patient's leg length measurement.

Figure 14-10 Measuring Seat Width
Source: Author

Figure 14-11 Measuring Seat Depth
Source: Author

Figure 14-12 Measuring Seat Height
Source: Author

Figure 14-13 Measuring Leg Length
Source: Author

Typically the footrest is approximately 2 inches from the floor. If the foot plates of the footrests are too low, the patient's knees will be positioned too low and the pelvis will slide forward. If the foot plates of the footrests are too high, the patient's knees will be positioned too high, increasing the pressure on the ischial tuberosities. The typical dimensions of wheelchair seat height for a standard adult wheelchair, for a narrow adult wheelchair, and for an extra-wide adult wheelchair is 20 inches, and for a junior wheelchair is 18.5 inches.

Leg Length and Back Height Measurements

How to measure the leg length of the wheelchair:

Wheelchair leg length measurement is calculated by measuring from the patient's bottom of the shoe to posteriorly under the popliteal fossa (Figure 14-13), then subtracting 2 inches from the measurement.

If the patient needs to use a seat cushion, the height of the seat cushion must be subtracted from the total leg length measurement of the wheelchair. If the leg length measurement is too short, the patient would put too much weight on the ischial tuberosities causing pressure sores. If the leg length measurement is too long, the patient will slide forward in the wheelchair.

The wheelchair back height measurement depends on the amount of support the patient needs. For example, patients whose wheelchairs have high backs may have difficulties fitting the wheelchair into a car. In such cases, the patients may be furnished with a removable high back support if they need to have a higher back. Another difficulty for a patient having a high back, especially for a patient having quadriplegia (tetraplegia), is that the increased height does not allow the patient to use the projecting hand rims of the drive wheels or the wheelchair brakes. The wheelchair back height is calculated by measuring from the seat platform to the patient's lower angle of the scapula or to the top of the shoulder (depending on the patient's needed back support). If the patient is using a seat cushion, the height of the cushion must be added to the patient's measurements.

Wheelchair Training

Wheelchair training is required for patients who are not familiar with the use of the wheelchair. The training consists of patient instruction and practice sessions in the use of the wheelchair, wheelchair safety, and wheelchair maintenance. Wheelchair training also includes instruction in wheelchair propulsion. For example, patients who have spinal cord injuries need to learn wheelchair mobility on level surfaces including doorways and elevators, and progress to outdoors, uneven surfaces, curbs, ascending and descending stairs, and falling safely. Patients who have sufficient upper extremity strength and upper trunk control learn how to propel the wheelchair using one or two upper extremities, moving forward and backward, on flat surfaces, on uneven surfaces, turning by pushing hard with one hand then the other hand, or pulling one wheel

backward while pushing the opposite wheel forward for sharp turns, and doing "wheelies," or balancing on the rear drive wheels with the front caster wheels off the ground. The PTA tips the wheelchair back into the wheelie position, then has the patient practice balancing in the wheelie position.

How to do a wheelie:

To go into a wheelie position, the patient places the hands posteriorly on the hand rims of the drive wheels, then pulls the hand rims forward abruptly and forcefully. At the same time, the patient's head and trunk are moved forward to keep the wheelchair from tipping backward.

How to ascend a curb in a wheelchair:

Ascending a curb in a wheelchair is accomplished by having the patient place the front caster wheels up on the curb and pushing the rear drive wheels up the curb by using momentum for assistance.

How to descend a curb in a wheelchair:

Descending a curb in a wheelchair is accomplished by having the patient descend backward leaning with the head and trunk forward or by descending forward in a wheelie position.

Patients with spinal cord injuries who have quadriplegia (tetraplegia) need to learn powered wheelchair mobility by focusing on driving skills and safety, using the switches by turning them on and off, and safely stopping the wheelchair. Wheelchair safety includes instruction on how to safely ascend or descend ramps. For example, when ascending ramps forward, the patient is instructed to move the hips forward, lean the trunk forward, and push equally on the hand rims using smooth forward motion.[2] Using the brakes while stopping and when transferring constitutes an important safety measure.

Patients also need to be instructed on how to fall safely from the wheelchair or when getting up from the wheelchair using assistive devices. For example, when falling forward from the wheelchair or when using an assistive device, the patient should reach forward with both upper extremities. Then, when contacting the floor with both hands, the patient should try to flex the elbows padding the force of the fall.[2] After that, the patient needs to turn the pelvis to be able to land on one hip, or if touching the floor first with the knees, trying to side sit on one hip. When, falling backward, the patient releases any assistive device, and flexes the trunk and head while reaching forward. In this position, the force of the fall is absorbed by the buttocks and the patient's head is protected.[2] In regard to wheelchair maintenance, the patient needs training in topics such as cleaning the wheelchair, making sure that the tires (pneumatic) are filled with enough air, and checking and changing the powered wheelchair batteries as necessary.

ASSISTIVE DEVICES AND GAIT TRAINING

Components of Human Gait

Gait is defined as a person's method of walking. The human gait is unique to each individual. Sometimes, people relate a person's gait characteristics with that person's character. Gait patterns can reflect a person's occupation, health status, body structure, personality, and other physical and psychological attributes. For example, a staggering gait is descriptive of a person who may be inebriated or very weak. A bouncy gait or a cheerful type of gait can depict a happy person, full of energy and enthusiasm. The human gait has been analyzed by scientists and described as an activity involving coordinated, progressive, and rotary (circular) movements of the body segments. Gait is a very complex activity to analyze. For this reason, gait was divided into phases and subphases to make the analysis feasible.

The description of gait in the phases and subphases identifies the activities of a person's lower extremity (called the reference extremity) from the beginning to the end of the gait cycle. The traditional or older terminology describing the gait cycles divided the gait into two large phases called the stance phase and the swing phase. The stance phase starts when a person's lower extremity contacts the ground and continues as long as the person has contact with the ground. The stance phase is the longest phase of gait, making up 60% of a person's gait cycle. The swing phase starts when the toe of a person's one lower extremity leaves the ground and ends just prior to the same lower extremity contacting the ground. The traditional subphases of the stance cycle are called heel strike, foot flat, midstance, heel off, and toe off. The tra-

ditional subphases of the swing cycle are called acceleration, midswing, and deceleration. In the Rancho Los Amigos (RLA) newer description of the gait cycle, in the stance phase of gait, the patient's foot of the leading leg strikes the ground making an *initial contact*. Then, still in the stance phase, the other subunits—the *loading response*, the *midstance*, the *terminal stance*, and the *preswing* occur. In the RLA description, the swing phase starts with the *initial swing*, continues with the *midswing*, and ends with the *terminal swing*. See Table 14-1.

Analyzing the Stance Phase of Gait

The stance phase of gait that makes the most of the gait cycle (60%) is observed at one lower extremity, called the reference extremity. When analyzing the stance phase, the subphases of the stance phase take place very fast. The heel strike represents the point in the gait cycle when a person's heel of the lower extremity of reference contacts the ground. Looking at the muscle activity, when the person contacts the ground the quadriceps muscles and ankle dorsiflexors (anterior tibialis, extensor hallucis longus, and extensor digitorum longus) perform the heel strike activity. The foot flat represents the point in the gait cycle when the sole of the foot of the reference extremity makes contact with the ground (immediately after the heel strike). Gastrocnemius and soleus muscles are involved in foot flat. The midstance represents the point in the gait cycle at which full body weight is taken by the reference extremity. At midstance, hip and ankle extensor muscles are contracting to control the forward motion of the trunk, while hip abductors stabilize the pelvis. The heel off represents the point in the gait cycle immediately after the midstance when the heel of the reference extremity leaves the ground. Ankle plantarflexors have peak activity immediately after the heel off to propel the body forward.

Table 14-1 Traditional Versus RLA Gait Elements

Traditional	RLA
Heel strike	Initial contact
Heel strike to foot flat	Loading response
Foot flat to midstance	Midstance
Midstance to heel off	Terminal stance
Toe off	Preswing
Toe off to acceleration	Initial swing
Acceleration to midswing	Midswing
Midswing to deceleration	Terminal swing

The toe off represents the point in the gait cycle that follows the heel off when the toe of the reference extremity is still in contact with the ground. Hamstrings and quadriceps muscles contribute to forward propulsion of the person's reference extremity during the toe off.

Analyzing the Swing Phase of Gait

The swing phase of gait makes up 40% of a person's gait cycle. It is observed at one lower extremity, called the reference extremity. When analyzing the swing phase, the subphases of the swing phase are also taking place very quickly. The acceleration represents the point in the gait cycle when the swing phase starts. The acceleration subphase starts at the toe off of the reference extremity until the midswing subphase of the same reference extremity. Hip flexor muscles (iliopsoas) help to accelerate the extremity and propel it forward. The midswing is the middle subphase portion of the swing phase when the reference extremity moves directly beneath the person's body. Hip and knee flexor muscles and ankle dorsiflexors contract to achieve foot clearance of the reference extremity. The deceleration is the end subphase of the swing phase, when the reference extremity is slowing down with the knee extended in preparation for the heel strike. At the deceleration subphase, the hamstrings muscles work hard to decelerate the reference extremity in preparation for the heel strike.

Assistive Devices

What is gait training?

Gait training, also called ambulation, involves learning the action of walking or moving about freely. Ambulation is a functional activity that can be initiated early in the rehabilitation process.

However, many patients are not able to ambulate without using an assistive device.

Assistive devices compensate for the following:

- Decreased muscular strength of the trunk and lower extremities

- Weight-bearing restriction in the lower extremity (or extremities)
- Decreased functional mobility and body function
- Decreased stability, balance, and coordination
- Increased pain during ambulation
- Neurological deficits
- Amputations
- New prosthetic or orthotic devices

Parallel Bars

In physical therapy, there are three basic groups of assistive devices or ambulatory aids:

- Canes
- Crutches
- Walkers

What are the most stable assistive devices?

The most stable assistive devices are walkers, followed by crutches, and finally by canes.

The parallel bars are also considered assistive devices. However, parallel bars are used for preambulatory activities, when the initial instruction and demonstration of the gait sequence takes place. Parallel bars give a patient the most stability. Parallel bars are also used when a patient needs maximal stability, safety, and support. The parallel bars are measured by having the patient's elbows bent at 20° to 30°. Parallel bars can also be measured by adjusting the parallel bars at the level of the patient's greater trochanter of the hip.

Canes

What is a cane?

A cane is an assistive device used to widen the patient's base of support and increase the patient's balance and stability. The cane is not used to reduce weight bearing on the lower extremities (limbs).

DID YOU KNOW?

"Glue-footed" or "magnetic" types of gait describe a gait in which the individual has difficulty initiating the first step as if the feet were glued to the floor. Once the gait is initiated, the individual takes small, shuffling steps.

Usually, the cane is held in the opposite hand to the involved or affected lower extremity. The cane can unload forces on the involved lower extremity by up to 30%. Also, the cane is used to relieve pain with ambulation. There are three kinds of canes: the standard cane, the quad cane, and a type of cane called the hemi-walker (Figure 14-14). The standard cane is made of wood or aluminum. The aluminum cane can be adjusted for height by pushing a pin lock. Some wood canes have an adjustable base for height and some are fixed. The wood or the aluminum cane has a rubber tip that is at least one inch in diameter, and a handle that is *J* shaped or offset. The quad cane, also called the four-point contact cane provides a broader base of support and increases patient's stability more than the standard cane. The disadvantage of the quad cane is that it provides a slower gait than the standard cane. In addition, the quad cane may not fit on stairs. To assist with stairs, there is a small-based quad cane available that fits stairs. The hemi-walker is a four-point contact cane that provides a broader base of support than the quad cane. The hemi-walker is more stable than a quad cane. However, the

Figure 14-14 Three Types of Canes
Source: Author

hemi-walker cannot be used on stairs, and provides a slower gait than the quad cane. As an assistive device, a cane must be measured prior to gait training to fit the patient.

The cane is measured with the patient wearing shoes, as follows:

- The cane must be six inches to the side from the lateral border of the patient's toes (Figure 14-15).
- The top of the cane must be at the approximate level of the patient's greater trochanter (Figure 14-15).
- The patient's elbow must be flexed at 20° to 30°.

There are two types of gait sequence using the cane. They are:

- The patient simultaneously advances the involved or the affected lower extremity and the cane (Figure 14-16a) followed by the uninvolved (or unaffected) lower extremity.
- The patient first advances the cane (Figure 14-16b), then the involved lower extremity, followed by the uninvolved lower extremity. This gait sequence is slower.

Figure 14-15 Measuring for a Cane
Source: Author

Crutches

What are crutches?

Crutches are assistive devices used to increase the patient's base of support, to moderately improve the patient's lateral stability, and to reduce weight bearing on the lower extremities.

The advantages of crutches are that they improve the patient's balance, and can be used on stairs. The disadvantages of crutches are that they are awkward in small areas, and that they can create damage to the radial nerve and the axillary artery if the patient leans on the crutches. Crutches can be made of wood or aluminum. There are two types of crutches, axillary and forearm crutches (Figure 14-17). Axillary crutches are also called regular or standard crutches. Each axillary crutch contains the bar, the handgrip, and the double uprights (that are joined distally). Crutches have rubber tips with a diameter of 1.5 to 3 inches that minimize the possibility of slippage on wet surfaces. The axillary crutches can have an attachment for a hand, a wrist, or a forearm called a platform. A platform is used when the patient can not bear weight through the hand, wrist and/or forearm. Patients using the platform may have fractures or arthritis.

The forearm crutches are also called Lofstrand crutches or Canadian crutches. These crutches have a triceps cuff. Each crutch contains a single upright, a forearm cuff, and a handgrip. The advantage of forearm crutches is that the patient can use his or her hands while ambulating with forearm crutches. The patient does not need to hold the crutches' handgrips because the patient has the cuffs secured on the forearm. For this reason, forearm crutches are recommended for patients who cannot bear weight through their hands, such as patients who have arthritis. The disadvantage of the forearm crutches is that they provide slightly less lateral support and stability than axillary crutches.

Axillary crutches measurements include the following:

- For axillary crutches measurements the patient should be wearing shoes.

a

b

Figure 14-16a and 14-16b Gait Sequence with a Cane
Source: Author

- While standing, the axillary crutches are measured from a point 2 inches bellow the patient's axilla to a point of 6 inches in front and 2 inches lateral to the patient's foot (Figure 14-18). In a supine position, the axillary crutches are measured from the axilla to a point 6–8 inches lateral to the patient's heel.
- The cuff of the forearm crutch is measured to cover the proximal third part of the forearm at approximately 1–1.5 inches below the patient's elbow.

Walkers

What is a walker?

A walker is an assistive device that provides the patient with a wide base of support, increased anterior and lateral stability, and a reduction in weight bearing on one or both lower extremities. The walker is the most stable ambulatory assistive device.

The parallel bars are the most stable, but they can be used only in the clinical facility (and not at home). The walker is made of aluminum, consisting of a frame and four adjustable legs. Each leg has a rubber tip to prevent sliding. An advantage of the walker is that it is easy to use.

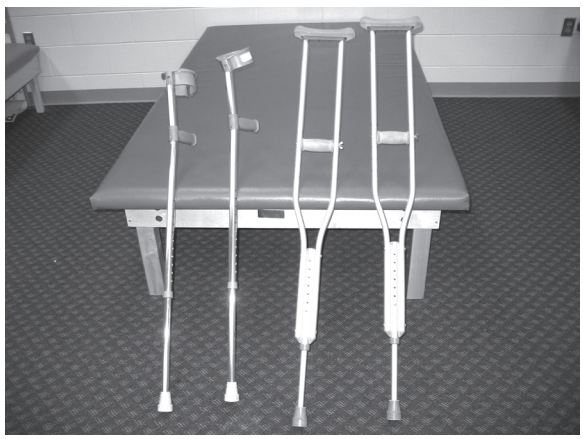


Figure 14-17 Axillary and Forearm Crutches
Source: Author

Figure 14-18 Measuring Axillary Crutches
Source: Author

The disadvantages of the walker are that it is cumbersome in small spaces and not appropriate for stairs. Walkers are prescribed for patients who have poor balance, lower extremity injuries, and debilitating disorders. Walkers are especially effective in many situations when patients have lower extremity injury, but they cannot use crutches because of difficulty in the manipulation of crutches.

There are six types of walkers: rigid, folding, rolling, reciprocal, stair climbing, and hemi-walker. The rigid walker is very stable and can be used by patients who have enough strength in their upper extremity to lift the walker and move it forward. The folding walker, also called a standard walker (Figure 14-19), is beneficial for patients who travel as it can be folded to fit in the trunk of a car (Figure 14-20). The rolling walker can have two (Figure 14-21) or four wheels. The rolling walker with four wheels may need hand brakes to provide stability with stopping. The rolling walker has less stability than the standard walker; however, it facilitates functional ambulation for patients who are unable to lift the standard walker and move it forward. The reciprocal walker allows for one side of the walker to move independently of the other side (Figure 14-22). The reciprocal walker facilitates a reciprocal gait pattern and is useful for patients who are unable to lift the walker with both hands and move it forward. The stair climbing walker (also called a hinge walker) is a type of walker that has two posterior extensions and additional handgrips on the rear legs. For some patients, the stair climbing walker does not provide enough stability. The hemi-walker, also categorized as a cane, is used as a balance support. The hemi-walker does not reduce weight bearing in the lower extremity. The hemi-walker is used on the unaffected lower extremity and has a handgrip in the center front of the

Figure 14-19 Standard (Folding) Walker
Source: Author

walker. All of the walkers, except for the stair climbing and the hemi-walker, can have attachments such as a platform, a fold-down seat, or a carrying basket. The walkers are all measured by having the patient standing with the elbow at 20 to 30 degrees of flexion, and the top of the walker approximately at the level of the greater trochanter.

> How to ambulate with a walker:
>
> Patients must be instructed to ambulate with walkers by lifting the standard walker or pushing the rolling walker forward to the point when the walker's back legs are at the same level with the patient's toes.

If the walker is moved forward at a point over the patient's toes, the patient needs to take a large step. In that situation, the patient may lose his/her balance. In addition, large stepping may interfere with the patient's weight-bearing restrictions.

Figure 14-20 Placing Walker in Trunk of Car
Source: Author

Gait Training

Gait training can be a motivational activity for many patients, including those with neurological deficits. Early walking prevents vascular impairments such as deep vein thrombosis and also helps patients who are deconditioned. Because many patients who walk early in the rehabilitation process have difficulties with balance and may fall, gait training starts as a preambulatory activity at the parallel bars. In preambulatory activity at the parallel bars, patients safely learn to walk, to become stable during walking, and to use assistive devices. To increase a patient's independence in ambulation, the patient must be progressed away from the parallel bars as soon as the patient's stability improves.

After the preambulatory activity at the parallel bars, ambulation first takes place indoors on level surfaces, then progresses to stairs, negotiating curbs and ramps, opening doors and passing through doorways (including elevators), and learning falling techniques. Outdoor ambulation follows indoor training by instructing the patient on how to use assistive devices on outdoor surfaces and uneven terrain, including climbing stairs, negotiating ramps and curbs, crossing a street, and getting in and out of private and public transportation.

Preambulatory Training at the Parallel Bars

During parallel bars instruction, the PTA must demonstrate to the patient the entire progression of training. Then the progression is divided into components, and each component has to be explained to the patient and reviewed with the patient for understanding prior to the patient's actual performance. The patient must wear appropriate footwear and clothing. Slippers, loosely fitting shoes, and loose clothes become safety hazards during parallel bars training as well as gait training in general. At the parallel bars, the

Figure 14-21 Rolling Walker
Source: Author

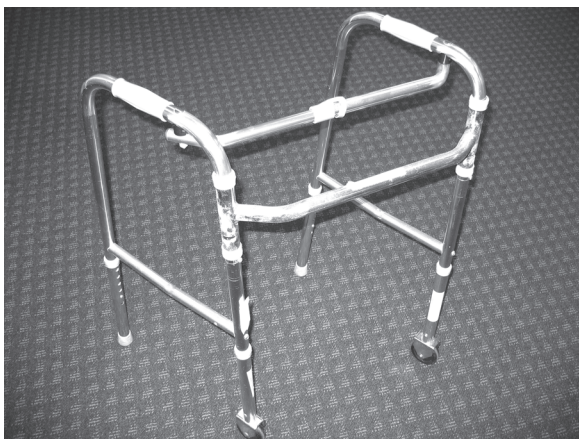


Figure 14-22 Reciprocal Walker
Source: Author

PTA must guard the patient by standing in front of the patient and slightly lateral to the affected lower extremity.

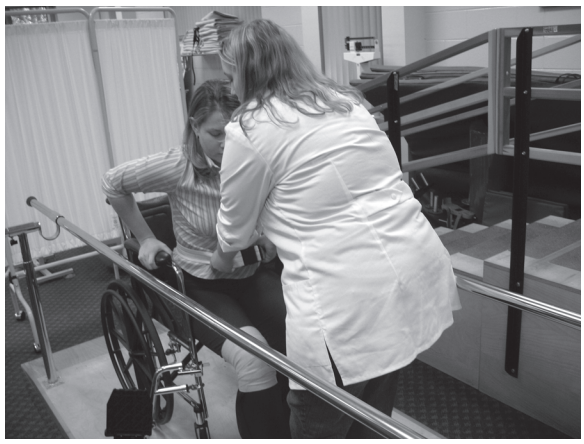
The following activities describe the preambulatory parallel bars training:

- The patient, sitting in the wheelchair, is brought to the parallel bars for preambulation activity. The PTA obtains the patient's verbal consent to perform the procedure.
- The PTA places the safety belt on the patient.
- The PTA instructs and demonstrates to the patient the entire progression before breaking down the preambulatory activity into parts (or components).
- Each component is reviewed with the patient prior to the patient's actual performance.
- The PTA is positioned inside the parallel bars.
- The PTA must be aware to lock the wheelchair, to remove the patient's feet from the wheelchair's footrests, and to remove the footrests.
- First, the patient is instructed to move his or her body forward and to scoot to the edge of the wheelchair by moving his or her hips forward.
- Then the patient has to place the foot of the uninvolved (or unaffected or strongest) lower extremity slightly posterior to the foot of the involved (or affected) lower extremity (Figure 14-23a). In this position, the strongest extremity will be in the best location to help the patient stand.
- Then the patient leans his or her trunk slightly forward and pushes with his or her arms on the armrests to stand up (Figure 14-23a). The PTA may need to assist the patient by holding the patient by the safety belt (Figure 14-23b).
- When the patient's hips are elevated toward half of the standing position with the trunk leaning forward, he or she can place each hand onto a parallel bar.

The patient should not pull himself or herself to a standing position using the parallel bars. Pushing on the armrests of a locked wheelchair is the safest position to learn to stand up.

Initial activities at the parallel bars are dependent on the patient's weight-bearing status and treatment goals. During preambulatory activities, the patient's circulatory status should be monitored by assessing the patient's pulse, respiration, and blood pressure. Some patients can experience orthostatic hypotension. At the parallel bars, the patient's balance in standing is assessed by the PTA, who considers the patient's center of gravity (COG) in relation to the patient's base of support (BOS). The initial balance activities at the parallel bars take place prior to ambulation activities. The following are balance activities at the parallel bars to increase patient's stability in ambulation:

a



b

Figure 14-23a and 14-23b Parallel Bars Training
Source: Author

- Anterior and posterior weight shifts
- Lateral weight shifts
- Hip hiking by maintaining a wide base of support, holding with both hands on the parallel bars, and elevating the pelvis, first on the right side, then on the left side
- Stepping forward and shifting the weight forward
- Stepping backward and shifting the weight backward
- Standing push-ups by placing hands anterior to the thighs, flexing the head forward (Figure 14-24), and simultaneously lifting the body by extending the elbows and depressing the shoulders

After selection of the gait pattern and the appropriate weight-bearing status, the patient is instructed to walk forward at the parallel bars, by pushing down on the parallel bars (and not pulling up on the bars). Other ambulatory activities include turning toward the uninvolved lower extremity, by stepping in small circles and not pivoting on a single lower extremity, and returning to sitting. If the patient uses an assistive device in gait training, the patient is instructed to ambulate forward using the device, turn by stepping in small circles, and returning to sitting.

When returning to the sitting position, the patient is instructed as follows:

- Back up toward the wheelchair until you can feel the wheelchair on the back of your knees.
- Release the stronger hand from the parallel bars, and reach down for the wheelchair armrest (Figure 14-25a).
- Lean slightly forward and reach back with the other hand for the wheelchair armrest.
- Keeping the head and trunk forward, gently sit back into the wheelchair (Figure 14-25b).

Guarding Techniques

Guarding the patient during preambulatory or ambulatory activities is essential for patient and therapist's safety.

When do you need to use a safety belt?

A safety belt needs to be applied prior to preambulatory or ambulatory activity.

Figure 14-24 Standing Push-ups at the Parallel Bars
Source: Author

The therapist must always hold the patient by the safety belt (Figure 13-6), not by grabbing the patient's arm, hand, or clothing.

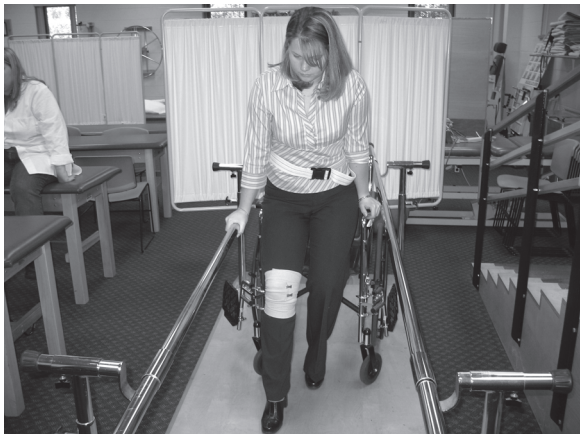
PTA's guarding position on level surfaces:

On level surfaces, the therapist's guarding position is standing posteriorly and laterally to the patient's affected or involved lower extremity.

PTA's guarding position ascending stairs:

Ascending the stairs, the therapist's guarding position is behind and slightly to the side of the patient's affected or involved lower extremity (Figure 14-26).

Ascending stairs, the PTA advances one step after the patient has advanced one step keeping the feet in an anterior posterior stance with one foot on the step on which the patient is standing and the other foot on the step below the step on which the patient is standing. If the patient is ascending stairs holding on the handrail, the therapist must guard the patient from behind and on the opposite side of the handrail, regardless of the position of the involved lower extremity.



a

b

Figure 14-25a and 14-25b Returning to a Sitting Position
Source: Author

PTA's guarding position descending stairs:

Descending the stairs, the therapist's guarding position is in front of the patient and slightly to the side of the patient's affected or involved lower extremity (Figure 14-27).

Descending stairs, the PTA places his or her feet in an anterior and posterior stance with one foot on the step to which the patient will step and the other foot on the step lower than the one to which the patient will step. If the patient is descending stairs holding the handrail, the therapist must guard from the front of the patient and on the opposite side of the handrail, regardless of the position of the involved lower extremity.

Key points of control while guarding the patient:

The key points of control that need to be watched by the therapist while guarding the patient are the patient's shoulder, the opposite pelvis, and the safety belt.

Figure 14-26 Guarding While Ascending Stairs
Source: Author

Figure 14-27 Guarding While Descending Stairs
Source: Author

Safety measures for losing balance forward:

If the patient loses balance forward, the PTA must use one hand to pull the patient back by the safety belt and hold the patient's anterior shoulder with the other hand while assisting the patient to regain balance (Figure 14-28).

If balance cannot be regained and the patient is falling forward, the patient must be instructed to remove the assistive devices and reach for the floor while the therapist retards the patient's forward fall by holding the patient by the safety belt. During the fall, the patient can be instructed to cushion the fall by bending the elbows and turning the head to one side.[2]

Safety measures for losing balance backward:

If the patient loses balance backward, the PTA must use one hand to hold the patient by the safety belt and assist the patient by placing their other hand on the patient's posterior shoulder, all the while the therapist uses his or her lower extremity to brace the patient's involved pelvis so the patient can regain balance (Figure 14-29).

If balance cannot be regained and the patient is falling backward, the patient must be instructed to remove the assistive devices while the therapist lowers the patient toward the floor by holding onto the safety belt.

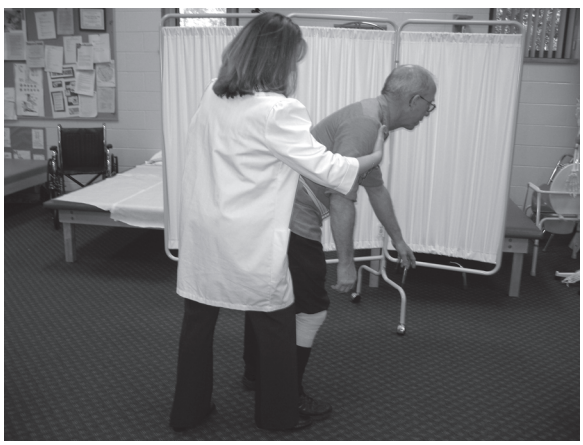


Figure 14-28 Safety Measures for Losing Balance Forward
Source: Author

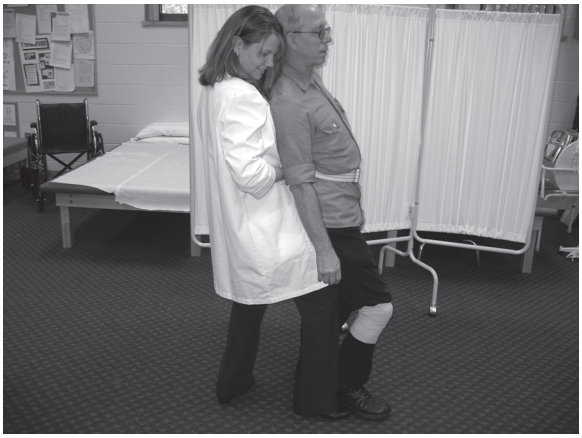


Figure 14-29 Safety Measures for Losing Balance Backward
Source: Author

Patient's Weight-Bearing Status

Who determines the patient's weight-bearing status?
The referring physician (MD or DO) always determines the patient's weight-bearing (WB) status.

Types of weight-bearing categories include the following:

- NWB—Non-weight bearing: 0% of patient's weight.
- PWB—Partial weight bearing: From toe touch weight bearing to 20% to 50% of patient's weight.
- TTWB—Toe touch weight bearing: Just touching the floor with patient's heel. In the past, TTWB was performed by having the patient touch the floor with the affected toe. Because it is an abnormal walking pattern it was changed to heel touch weight bearing.
- WBAT—Weight bearing as tolerated: As much weight as tolerated by the patient.
- FWB—Full weight bearing: The patient's entire weight.

There are four major types of weight bearing categories, non-weight bearing (NWB), partial weight bearing (PWB), weight bearing as tolerated (WBAT), and full weight bearing (FWB). Typically, the weight-bearing restrictive categories (except for FWB) are indicated for only one lower extremity, called the *involved* or the *affected* lower extremity. Rarely two lower extremities require a weight-bearing restriction status. In NWB status, no weight bearing is permitted on the involved lower extremity. In PWB status, a limited amount of weight bearing is allowed on the involved lower extremity ranging from toe-touch weight bearing (TTWB) to a percentage of weight bearing such as 20% to 50% of the patient's body weight or a specific poundage such as 15 pounds. In TTWB, the heel of the patient's involved lower extremity contacts the floor instead of the toe, which allows a limited amount of weight bearing. Touching the floor with the toe causes a foot plantar flexion that is an abnormal pattern at the beginning of the stance phase of the gait cycle because the heel strike is the first subphase of the stance phase. In TTWB, the patient needs to be instructed to perform *a light (just touching) TTWB heel strike.*

What do PWB and TTWB categories require?

PWB and TTWB categories always require that the involved PWB or TTWB lower extremity and the assistive device advance simultaneously followed by the uninvolved lower extremity.

WBAT status permits the patient to place as much weight on the involved lower extremity, as he or she can tolerate. During the WBAT, the patient can use either one-handed assistive device or two-handed assistive devices. In FWB status there are no weight-bearing restrictions for the patient at all. Full weight bearing is permitted on the involved lower extremity. Typically, the patient's pain in the affected lower extremity can be a limiting factor during FWB.

Gait Sequencing Patterns

Generally, there are six gait sequencing patterns used in physical therapy: four-point gait, three-point gait, two-point gait, swing-to, swing-through, and an alteration of the three-point gait called modified three-point gait.

What gait patterns require two assistive devices?

Four-point gait and two-point gait patterns always require two assistive devices such as two crutches or two canes.

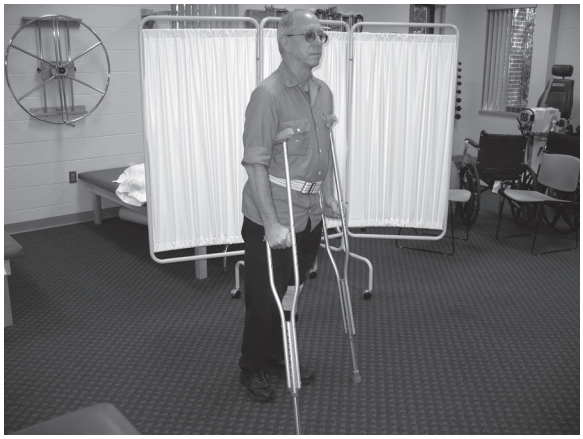
A patient's gait pattern is selected by the PT after considering the amount of weight bearing permitted on the involved lower extremity, the patient's cognitive status, and the severity of the patient's condition or disorder.

Four-Point Gait Pattern

A four-point gait sequence pattern is a slow, stable gait necessary for patients who have weaknesses in their lower limbs due to muscle atrophy, patients having balance and coordination difficulties, and patients who have had orthopedic surgeries and are in the weight bearing categories of WBAT or FWB. The four-point gait sequence always uses two assistive devices, such as crutches or two canes. It provides maximum stability with three points of support while one lower extremity is moving. Four-point gait is the safest gait sequence pattern when used in crowded areas. It is also appropriate for patients who need stability because they have balance difficulties. The four-point gait sequence is also appropriate for WBAT and FWB gait categories. A PWB category would be difficult to sequence with a four-point gait because in PWB the assistive device and the involved extremity must be advanced simultaneously, and the normal four-point gait sequence would be affected.

A four-point gait sequence for a patient with WBAT status using crutches requires the following steps:

- **The right crutch advances (Figure 14-30a).**
- **Then the left involved WBAT lower extremity that is the opposite extremity of the right crutch advances (Figure 14-30b).**
- **Then the left crutch advances (Figure 14-30c).**
- **Finally, the right uninvolved lower extremity opposite to the left crutch advances (Figure 14-30d).**



a

b

c

d

Figure 14-30a Four-Point Gait WBAT: Right Crutch to Advance; 14-30b: Left Involved Lower Extremity to Advance; 14-30c: Left Crutch to Advance; 14-30d: Right Lower Extremity to Advance

Source: Author

The same sequence follows a four-point gait pattern using two canes. The sequence of a four-point gait using crutches and starting with the right lower extremity proceeds as follows: first the right crutch advances, then the left lower extremity, then the left crutch, and then the right lower extremity. The sequence of a four-point gait using two canes (in two hands) and starting with the right lower extremity proceeds as follows: first the right cane advances, then the left lower extremity, then the left cane, and then the right lower extremity. Moving backward using the four-point gait pattern with crutches follows these steps:

- The patient moves backward by first moving one crutch backward, then stepping backward with the opposite involved lower extremity.
- The patient then moves another crutch backward, and steps backward with the opposite uninvolved lower extremity.

Three-Point Gait Pattern

What is a three-point gait?

A three-point gait sequence pattern is also called a non-weight-bearing (NWB) gait.

This type of gait can be taught to patients who have an NWB status, a PWB status, a WBAT status, or a TTWB status. A three-point gait can be done using assistive de-

vices such as a walker or crutches. A three-point gait is indicated for patients who have involvement of one lower extremity. For example, patients who have a lower extremity fracture can use a three-point gait pattern. Three-point gait sequence NWB status with a walker requires the walker and the involved NWB lower extremity to advance together (Figure 14-31). Then, the uninvolved lower extremity steps (or jumps lightly on one foot) to the walker. The patient needs good strength in the upper extremities, trunk, and the uninvolved lower extremity to be able to perform a three-point gait pattern with an NWB status. A three-point gait NWB status using crutches follows the same sequence as the three-point gait NWB status using a walker: both crutches and the involved NWB lower extremity advance together (Figure 14-32), then the uninvolved lower extremity jumps (or hops) to the crutches.

A three-point gait pattern for a patient with a PWB status using a walker requires the following steps:

- The walker and the involved PWB lower extremity advance together (Figure 14-33a).
- The patient distributes his or her body weight onto the walker and onto the hands, partially bearing weight on the involved lower extremity.
- Then the uninvolved lower extremity is advanced (Figure 14-33b).

Figure 14-31 Three-Point Gait NWB with a Walker
Source: Author

Figure 14-32 Three-Point Gait NWB with Crutches
Source: Author

A three-point gait pattern for a patient with a WBAT status using crutches requires the following steps:

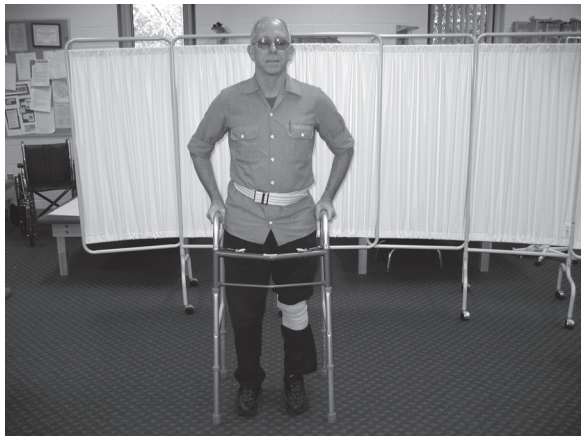
- The crutches and the involved WBAT lower extremity advance together (Figure 14-34a).
- The patient can bear their weight as much as he or she can tolerate.
- Then the uninvolved lower extremity is advanced (Figure 14-34b).

A three-point gait pattern for a patient with a TTWB status using crutches requires the following steps:

- The crutches and the involved heel of the TTWB lower extremity advance together (Figure 14-35). The heel touches the floor with very little of the patient's weight. This is done in such way that the patient takes the weight off the involved heel and puts the weight onto the crutches and the hands.
- Then the uninvolved lower extremity is advanced.

The three-point gait sequence includes the following: walker or crutches and the involved lower extremity together followed by the uninvolved lower extremity. Backward movement using the three-point gait with

a



b

Figure 14-33a and 14-33b Three-Point Gait PWB with Walker
Source: Author

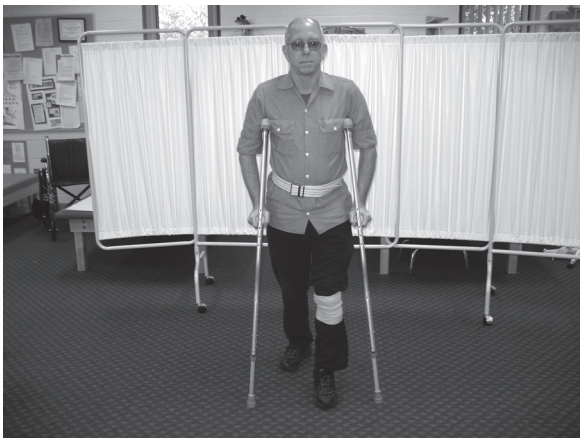
crutches requires the patient to simultaneously move the involved lower extremity and the crutches backward, then to move the uninvolved lower extremity back.

Modified Three-Point Gait Pattern

The modified three-point gait sequence requires the use of a walker or bilateral ambulatory assistive devices such as crutches. It is used for patients who are in WBAT or FWB categories. The modified three-point gait sequence is recommended for patients who do not have enough strength or the energy requirements to perform ambulatory activities. Patients in the PWB category would not use a modified three-point gait because the involved PWB lower extremity and the assistive device need to advance together. If that happened, the modified three-point gait would become a three-point gait pattern. The modified three-point gait pattern is a slower gait than the three-point gait.

For example, a patient with a WBAT gait status with a walker would advance the walker first (Figure 14-36a), then the WBAT involved lower extremity would be advanced (Figure 14-36b), and then the uninvolved lower extremity (Figure 14-36c).

The modified three-point gait sequence includes the following: the assistive device (walker or crutches), then



a

b

Figure 14-34a and 14-34b Three-Point Gait WBAT with Crutches
Source: Author

Figure 14-35 Three-Point Gait TTWB with Crutches
Source: Author

the involved lower extremity, and then the uninvolved lower extremity. Backward movement using the modified three-point gait with a walker requires the patient to first move the walker backward, then the involved lower extremity, and then the uninvolved lower extremity.

Two-Point Gait Pattern

The two-point gait sequence requires more balance than the three-point or four-point gait patterns. It also has to have two assistive devices such as crutches or two canes.

What is a two-point gait sequence?

The two-point gait sequence is the closest to the normal gait pattern and allows for natural arm and leg motion during the gait cycle.

The two-point gait offers good support and stability from two opposing points of contact. However, it requires coordination. The patient can ambulate slightly faster with a two-point gait than a four-point gait, but the stability will be less with a two-point gait.

A two-point gait pattern can be used with FWB, PWB, TTWB, and WBAT gait categories.

The two-point gait for a patient with a PWB gait status using crutches requires the involved PWB lower extremity and the opposite crutch to advance simultaneously (Figure 14-37a); then the uninvolved lower extremity and the opposite crutch together (Figure 14-37b). During PWB with crutches, while stepping with the PWB extremity and the crutches, the patient distributes his or her body weight onto the crutches and onto the hands, partially bearing weight on the involved lower extremity.

A patient with WBAT gait status using crutches in two-point gait requires the right crutch and the involved WBAT left lower extremity to advance simultaneously; then the left crutch and the uninvolved right lower extremity advance simultaneously. The two-point gait pattern sequence includes the involved lower extremity and the opposite crutch advanced simultaneously, followed by the uninvolved lower extremity and the opposite crutch advanced simultaneously. Backward movement for the two-point gait pattern with crutches requires the patient to simultaneously move the affected lower extremity and the opposite crutch, then the unaffected lower extremity and the opposite crutch.

Swing-To and Swing-Through Gait Patterns

Swing-to and swing-through are typically used for patients who have paralysis of both lower extremities and trunk instability, such as is caused by a spinal cord injury or spina bifida.

What type of assistive device do swing-to and swing-through require?

Swing-to and swing-through gait patterns require crutches.

In swing-to, the crutches are advanced together, then the patient swings both lower extremities forward to meet the crutches (Figure 14-38). In swing-through, the crutches are advanced together then the patient swings forward both lower extremities past the crutches (Figure 14-39). The swing-to gait pattern is safer than the swing-through gait pattern.

Standing and Sitting Activities Using Assistive Devices

Patients using axillary crutches with FWB or WBAT status need to be taught how to independently get up from a chair and sit down in a chair with crutches. For NWB or PWB status, the patient may need assistance (to get up from a chair or sit down in a chair) from the PTA or a member of the family. The safest chair for the patient to learn how to stand and sit independently is a chair with arms or a wheelchair. The patient holds the crutches with

a

b

c

Figure 14-36a, 14-36b, 14-36c Modified Three-Point Gait WBAT with Walker
Source: Author

his or her upper extremity on the side of the involved lower extremity.

One alternative sequence from getting up with crutches from a wheelchair is the following:

1. The patient moves his or her body forward and scoots to the edge of the wheelchair by moving his or her hips forward.
2. Then he or she places the foot of the uninvolved (or unaffected or strongest) lower extremity slightly posterior to the foot of the involved (or affected) lower extremity (Figure 14-40a).
3. Then the patient leans his or her trunk slightly forward and pushes with his or her arms on the crutches (both bundled together) and the wheelchair armrest and stands up (Figure 14-40b). In this position, because the crutches are on the involved side of the lower extremity, the patient has a large base of support in standing.
4. Then the patient (with the free hand) reaches for one crutch and places it in the axilla on the uninvolved side of the lower extremity.
5. Then he or she positions the other crutch into the opposite axilla.

a

b

Figure 14-37a and 14-37b Two-Point Gait PWB with Crutches
Source: Author

Patients using walkers also need to be instructed to get up from a wheelchair or a chair with arms using the walker.

The following sequence of activities takes place:

1. The walker is positioned in front of the wheelchair within the patient's reach.
2. The patient is instructed to scoot forward to the edge of the wheelchair.
3. The patient is instructed to place the foot of the uninvolved lower extremity slightly posterior to the foot of the involved lower extremity (Figure 14-41a).
4. The patient is instructed to lean forward and push with both hands on the wheelchair's armrests (Figure 14-41b).
5. When standing, the patient is instructed to reach and grasp the walker's handgrip with one hand while the other hand is still holding the wheelchair's armrest (Figure 14-41c).
6. The patient is instructed to reach and grasp the walker's other handgrip with the other hand (Figure 14-41d).
7. The patient is instructed to establish proper balance prior to ambulation while holding onto the walkers' handgrips.

Figure 14-38 Swing-to Gait Pattern
Source: Author

The same sequence follows getting up from a wheelchair with arms using the cane. The only difference is that the cane should be positioned on the side of the chair of the uninvolved lower extremity. For example, if the patient has weakness on the right lower extremity, but the left lower extremity is not affected, the cane must be positioned on the left side of the wheelchair. When getting up in standing, the patient must grasp the cane with his or her left hand while holding on the wheelchair's armrest with the right hand to establish proper balance for ambulation (Figure 14-42).

For NWB or PWB gait categories, the patient uses the same procedures for getting up from the chair except that the therapist or a member of the patient's family needs to help the patient. The therapist or a family mem-

Figure 14-39 Swing-through Gait Pattern
Source: Author

ber holds the patient by the safety belt on the side of the affected lower extremity.

Ascending and Descending Stairs Using Assistive Devices

Ascending and descending stairs require the patient to always use the uninvolved lower extremity to step up first and the involved lower extremity to step down first. To remember the sequence, the patient may be instructed to say: "Good guys (*the unaffected lower extremity*) go to heaven (*steps up*), bad guys (*the affected lower extremity*) go to hell (*steps down*)."

For a patient ascending stairs using crutches with an NWB status on the involved lower extremity, follow these steps:

- The PTA must be behind the patient and holding the patient by the safety belt (Figure 14-43). One foot is on the step the patient stands on and the other foot is on the step below;
- The patient's uninvolved lower extremity steps up first while the crutches support the involved NWB lower extremity (Figure 14-43).
- Then the patient moves the involved NWB lower extremity and the crutches together simultaneously up onto the same step as the uninvolved lower extremity. The same sequence follows for each step.

For a patient ascending stairs using a cane, follow these steps:

- The PTA must be behind the patient and holding the patient by the safety belt
- The therapist has one foot on the step the patient stands on and the other foot on the step below.
- The patient cane is on the hand of the uninvolved lower extremity.

a

b

Figure 14-40a and **14-40b** Getting up with Crutches from the Wheelchair
Source: Author

- The patient moves the uninvolved lower extremity up first while the cane supports the involved (weak or painful) lower extremity.
- The patient moves the involved lower extremity and the cane together up onto the same step as the uninvolved lower extremity. The same sequence follows for each step.

For a patient descending stairs using crutches with an NWB status on the involved lower extremity, follow these steps:

- The PTA must be in front of the patient and holding the patient by the safety belt (Figure 14-44).
- The patient simultaneously moves the involved NWB lower extremity and the crutches together down one step; at the same time, the patient partially flexes the involved hip and knee.
- The patient moves the uninvolved lower extremity down onto the same step as the involved lower extremity. The same sequence follows for each step.

a

b

c

d

Figure 14-41a, 14-41b, 14-41c, 14-41d Getting up with a Walker from the Wheelchair
Source: Author

Figure 14-42 Getting up with a Cane from the Wheelchair
Source: Author

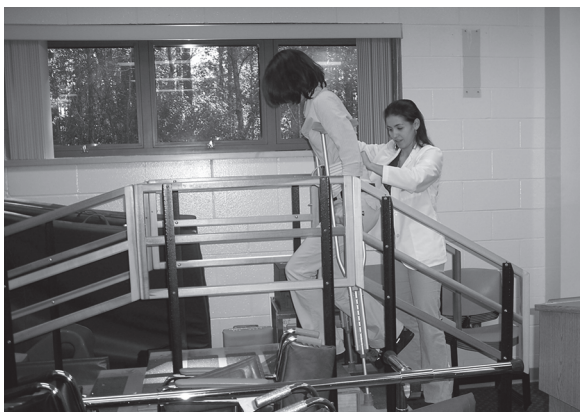


Figure 14-43 Ascending Stairs Using Crutches with NWB Status
Source: Author

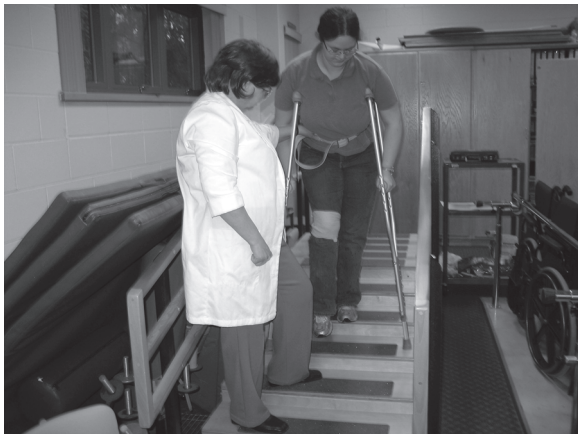


Figure 14-44 Descending Stairs Using Crutches with NWB Status
Source: Author

For a patient descending stairs using a cane, follow these steps:

- The therapist must be in front of the patient; one foot is on the step the patient stands on and the other foot is on the step below.
- The patient's involved lower extremity and the cane together go down together first; at the same time, the patient partially flexes the involved hip and knee.
- The patient moves the uninvolved lower extremity down onto the same step as the involved lower extremity. The same sequence follows for each step.

SUMMARY OF PART V

Part V has presented the last three chapters of this text. Part V includes assessment of vital signs, such as blood pressure, pulse, respiration, and temperature. Treatment area and positioning of the patient for treatment were also discussed. The PTA's proper body mechanics during patient transfer and ambulation were described as well as the different forms of transfers and sequencing patterns during gait training. Topics such as universal precautions, wheelchair measurements, types of assistive devices, weight-bearing categories, guarding techniques in ambulation, and other ambulatory activities were introduced with concentration on the student's performance skills.

Laboratory Activities for Part V

The following activities are suggested to the instructor to involve students in the application of laboratory performances:

- ❑ Describe and demonstrate assessing vital signs.
- ❑ Role-play the therapist and patient by preparing the area for the patient's arrival, draping the patient prior to treatment, and establishing a therapeutic relationship with the patient.
- ❑ Demonstrate positioning for a patient with hemiplegia.
- ❑ Perform lifting techniques using the "five Ls."
- ❑ List and demonstrate bed mobility transfers.
- ❑ List and demonstrate sitting and standing transfers including the sliding board transfer.
- ❑ Practice hand washing for medical asepsis. Watch and critique another student's hand-washing technique.
- ❑ Give a class presentation describing the components of a wheelchair.
- ❑ Participate in a wheelchair training session at the local hospital.
- ❑ Working in groups of two, perform wheelchair measurements.
- ❑ Practice wheelchair training activities indoors.
- ❑ Analyze a classmate's subphases of gait and identify the major muscle groups involved in each subphase.
- ❑ Describe different types of assistive devices and perform the necessary measurements.
- ❑ Practice gait training using different assistive devices and gait sequencing patterns; practice on even surfaces and stairs.
- ❑ Perform guarding techniques on even surfaces and stairs.
- ❑ Demonstrate getting up with crutches or a walker from a wheelchair.

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3. O'Sullivan JJ, Ellis JJ, Makovsky HW. The five "Ls" of lifting. *Physical Therapy Forum*. 1991; 10:14.