Gait Training, Robotic-Assisted

Indexing Metadata/Description

› **Device/equipment:** Gait Training, Robotic-Assisted
› **Synonyms:** Robotic gait training; robot-assisted gait training; robot-aided gait training; electromechanical gait training; robotic-assistedstep training; robotic locomotor training; robotic-assisted gait training
› **Area(s) of specialty:** Neurological Rehabilitation, Pediatric Rehabilitation, Orthopedic Rehabilitation
› **Description/use:** A method of gait training using assistive technology that makes use of automated devices to exert mechanical forces to move the body
  • Robotic-assisted gait training was developed to overcome disadvantages inherent in body-weight-supported treadmill training (BWSTT) used for restoration of gait following stroke, traumatic brain injury (TBI), spinal cord injury (SCI), and other neurological conditions\(^1\)
    – Without robotic assistance, two or three therapists are required to assist a patient’s gait during treadmill training
      - One therapist is required to manually place each affected leg and another therapist assists lateral weight shifting and upright trunk positioning
      - The correct assistance of leg movements during the training is crucial. The most advantageous input to the spinal cord is attained only if the legs are moved in as normal of a gait pattern as possible
      - As therapists start to experience fatigue, the patient’s gait can become asymmetrical and the benefit of repetitive practice decreases
  • Robotic-assisted gait trainers are mechanized devices that enable the repetitive practice of physiological gait patterns without relying on therapists. Other advantages include:
    – training can start earlier after trauma or neurological insult because the robotic devices generate more power than a human being
    – the duration of the training can be longer, allowing more opportunity for repetitive practice
    – training is less costly, with only one therapist required
  • Robotic-assisted gait training involves the use of an exoskeleton device to improve motor coordination\(^16\)
    – Exoskeletons utilize devices called actuators that assist in moving the patients’ legs during the gait cycle by utilizing preprogrammed gait cycles
    – Nearly all functional exoskeletons require an external support system to ensure balance of the individual
  • Feedback about the quality of movement and extent of muscle activity is important for gait training. These are difficult for patients to assess themselves, especially if sensory, proprioceptive, or cognitive impairments are present
    – Therapists have less contact with patients during robotic-assisted gait training compared to manually assisted partial BWSTT. Therefore, they are less able to assess the patients’ involvement
      - Muscle strength, muscle tone, and ROM of the lower limb might be measured by potentiometers and force transducers in some robotic devices
      - Online feedback about joint movement and force production can be provided
Commercially available robotic gait machines include the Gait Trainer, (GT) with variations referred to as GT I, GT II, and MGT (for Mechanized Gait Trainer) (Reha-Stim, Berlin, Germany), which control endpoint trajectories; the Lokomat (Hocoma Medical Engineering Inc., Zurich, Switzerland), the AutoAmbulator (Encompass Health, Birmingham, Alabama, United States), and the Walkbot (P&S Mechanics Co., Ltd., Seoul, South Korea), which use robotic exoskeletons and a treadmill; and the LOPES (Lower-extremity Powered ExoSkeleton, Laboratory Biomechanical Engineering, University of Twente, Enschede, the Netherlands), which is designed specifically for research.

For detailed information specific to stroke and TBI, please see Clinical Review...Stroke: Gait Training; CINAHL Item Number: T708722 and Clinical Review...Traumatic Brain Injury: Gait Training; CINAHL Item Number: T709258. See also the series of Clinical Reviews on spinal cord injury and cerebral palsy.

HCPCS codes: There are no specific codes for robotic-assisted gait training.

Reimbursement: Robotic-assisted rehabilitation is generally considered experimental and investigational for stroke and for all other indications (e.g., neuromuscular diseases) because of insufficient evidence of its effectiveness.

Indications for device/equipment

Robotic-assisted gait training is indicated for select patients with walking disabilities due to neurologic and orthopedic disorders, including:

- Stroke
- Paraplegia
- TBI
- Cerebral palsy
- Parkinson disease (PD)
- Multiple sclerosis (MS)
- Guillain-Barré syndrome
- Transverse myelitis
- Endoprosthesis surgery (e.g., total hip endoprostheses)
- Osteoarthritis
- Muscle weakness

The decision to use robotic versus manual partial body-weight-supported treadmill (PBWSTT) training is generally determined by clinical judgment of the therapist in agreement with the patient, taking into consideration the patient’s overground ambulation ability, trunk control, motor control, and spasticity.

Manually assisted PBWSTT might be indicated for patients who can actively step independently, whereas robotic assistance might be indicated for individuals with more deficits in walking.

- Robotic-assisted gait training can be used in combination with functional electric stimulation, which has demonstrated greater benefits than utilizing robotic-assisted gait training alone.
- Manual assistance can more easily be combined with electrical stimulation, can be adjusted through each gait cycle, and provides patients the opportunity to self-manage aspects of their gait cycle rather than being completely passive.

Guidelines for use of device/equipment

The Lokomat is a bilateral orthosis used along with a PBWSTT system that controls the patient’s movements in the sagittal plane.

- The patient is fitted with a weight-supporting harness that is placed around the hips and abdomen snugly enough to minimize upward slipping.
- The patient is wheeled via wheelchair onto the treadmill via a ramp.
- The harness is attached to the cables on the body weight support system.
- The patient is assisted to stand using a motor-driven lift.
- The gait orthoses system is secured to the standing patient by straps. Hip and knee joints are integrated into the exoskeleton structure. The robotic force arms and robotic drive motor positions are adjusted based on femoral and tibial length measurements.
- When the patient is set up, the treadmill is started and the patient is lowered to the treadmill. Treadmill speeds range from 1 to 3.2 km/hr (0.62 to 2 mph).
- Motorized actuators at the hips and knees are programmed to produce normal physiologic gait patterns and to reproduce normal kinematics of gait. A rubber foot lifter passively dorsiflexes the ankle during swing phase to assist clearance.
• The patient’s legs are moved with repeatable, predefined hip and knee trajectories

› AutoAmbulator(1)
• The patient is fitted with a hard-shelled harness that encloses the lower abdomen and trunk region with straps between the legs
• Weight-bearing is through the pubis and ischial tuberosities
• The patient is wheeled onto the treadmill via a ramp
• The hard-shelled harness is attached to the overhead lift mechanisms
• The articulated arms are locked into their operational positions. Each arm has motor-driven pivot joints at the hip and knee
• There is no integrated attachment to control for ankle plantar flexion and dorsiflexion. Ankle position might be set with an ankle foot orthosis or wrap bandage as required for limb clearance during swing
• Trunk stability is provided by adjusting braces that attach to each side of the shell and to the treadmill frame
• When the patient is set up, the treadmill is started and the patient is lowered to the treadmill. Treadmill speeds range from 0 to 2.4 km/hr (0 to 1.5 mph)

› Gait Trainer(1)
• Does not work in conjunction with a treadmill
• Based on a crank and rocker gear system, it provides limb motion similar to an elliptical trainer
• Consists of two footplates coupled to rockers
• A modified parachute harness is fitted and the patient is assisted to standing with a manually operated crank arm attached to the overhead support line and pulley
• The patient initially stands outside the device and is required to ambulate with or without assistance into the device and place feet in the footplates
• The patient does not have to be fitted to an orthotic device, so adaptation to different-sized patients, including children, is possible
• Due to the need for some ambulatory ability to get into the device, it might be more suitable for individuals with hemiplegia than individuals with paraplegia

› In all devices, parameters are set according to the individual’s needs
• Usually about 50% of body weight is supported by the harness at first. During subsequent sessions support might be decreased in approximately 10% increments as tolerated without knee buckling or toe drag
• Gait drive components are computer driven with a touchscreen control interface

Contraindications/Precautions to device/equipment

› Contraindications: (2) See specific contraindications/precautions to examination and contraindications/precautions under Assessment/Plan of Care
• Body weight greater than 300 lbs (136 kg)
• Severe fixed joint contractures
• Bone instability (nonconsolidated fractures, unstable spinal column, severe osteoporosis)
• Skin lesions on the lower extremities or torso
• Circulatory problems
• Severe vascular disorders of the lower extremities
• Cardiac contraindications to exercise
• Severe cognitive deficits
• Uncooperative or aggressive behavior
• Mechanical ventilation
• Extreme or uncorrected leg-length discrepancy
• Severe scoliosis
• Hip, knee, ankle arthrodesis
• Mobility restrictions due to inflammatory or infectious disorders (e.g., osteomyelitis)
• Orthosis not adaptable to the patient’s body (lower limbs)

› Precautions
• Precautions that apply to individual pathologies should be followed. Examples include:
  – Orthostatic hypotension
  – Autonomic dysreflexia
Bladder and bowel control problems
Decreased sensation
• It is recommended that the therapist or caregiver perform skin checks before and after treatment to monitor skin integrity
  Training duration might need to be modified if skin breakdown occurs
• Short training sessions with a high level of support are recommended initially
  Training duration should be increased gradually
  There is a risk of excessive strain on ligaments, tendons, joints, and bones if training sessions are too long or too frequent
  Patients might need to be reminded to progress slowly. It is not uncommon for patients to feel excited after the initial session, and to want more and longer sessions
• Clinicians should receive specialized training prior to implementing robotic-assisted gait training

Examination

Contraindications/precautions to examination: Depend on the underlying condition for which this device is used
• Contraindications
  - DVT – Therapist should stop evaluation immediately and contact physician if patient presents with signs of DVT
    - Signs of DVT include pain, swelling, redness, and feeling of warmth in the leg
• Complications associated with neurological conditions requiring precaution during examination might include:
  - decreased bone density
  - muscle atrophy
  - soft tissue contractures
  - decreased endurance
  - heterotopic ossification
  - venous stasis
  - infection
  - pain
  - pre- and postoperative restrictions
  - agitation, emotional lability

History
• History of present illness/injury for which the device is needed
  - Mechanism of injury or etiology of illness: Describe history of patient’s condition, including onset, progression, complications, and treatment. Document initial Glasgow Coma Scale score for TBI patients and initial ASIA Impairment Scale (AIS) score for SCI patients
  - Course of treatment
    - Medical management: Describe emergency management, hospitalizations, surgeries, immobilization, and weight-bearing status as relevant to the condition
    - Medications for current illness/injury: Determine what medications clinician has prescribed; are they being taken? Are they effective? Medications commonly prescribed for neurological conditions include:
      - Seizure prevention medications (e.g., levetiracetam [Keppra], phenytoin [Dilantin])
      - Medications for spasticity (e.g., tizanidine [Zanaflex])
      - Antidepressants
    - Diagnostic tests completed: Depends on underlying condition. Diagnostic imaging results such as radiographs, MRI, ultrasound, and EMG test results should be obtained when available
    - Home remedies/alternative therapies: Document any use of home remedies (e.g., ice or heating pack) or complementary therapies (e.g., acupuncture), what they are used for, and whether they help
    - Previous therapy: Document whether patient has had occupational or physical therapy for this or other conditions and what specific treatments were helpful or not helpful. Describe any gait training the patient has already completed
  - Aggravating/easing factors (and length of time each item is performed before the symptoms come on or are eased)
  - Body chart: Use body chart to document location and nature of symptoms
  - Nature of symptoms: Document nature of symptoms (e.g., pain, spasticity, weakness, sensory impairment)
  - Rating of symptoms: Where appropriate, use a visual analog scale (VAS) or 0–10 scale to assess symptoms at their best, at their worst, and at the moment (specifically address if pain is present now and how much)
Pattern of symptoms: Document changes in symptoms throughout the day and night, if any (a.m., mid-day, p.m., night); also document changes in symptoms due to weather or other external variables; document changes related to activity or fatigue

Sleep disturbance: Document number of wakings/night

Other symptoms: Document other symptoms patient might be experiencing that could exacerbate the condition and/or symptoms that could be indicative of a need to refer to physician (e.g., dizziness, bowel/bladder/sexual dysfunction, saddle anesthesia)

Respiratory status: Any history of respiratory compromise or use of supplemental oxygen?

Barriers to learning
- Are there any barriers to learning? Yes__ No__
- If Yes, describe ______________________

Medical history

Past medical history
- Previous history of same/similar diagnosis: Document history of same or similar diagnosis
- Comorbid diagnoses: Ask patient about other problems, including diabetes, cancer, heart disease, complications of pregnancy, psychiatric disorders, and orthopedic disorders
- Medications previously prescribed: Obtain a comprehensive list of medications prescribed and/or being taken (including OTC drugs)
- Other symptoms: Ask patient about other symptoms he or she is experiencing

Social/occupational history

Patient’s goals: Document what the patient hopes to accomplish with therapy and in general

Vocation/avocation and associated repetitive behaviors, if any: Does the patient attend school? If so, what grade level? Is the patient employed? If so, what is the nature of the work? Does the patient participate in recreational activities or sports? Are there any barriers to accessing the community?

Functional limitations/assistance with ADLs/adaptive equipment: Document information about the patient’s functional limitations as well as the level of assistance required for patient to complete each activity (include limitations with self-care, home management, work, community leisure)

Living environment: Document information about the patient’s living environment including stairs, number of floors in home, and with whom patient lives (e.g., caregivers, family members). Identify if there are barriers to independence in the home; any modifications necessary?

Relevant tests and measures: (While tests and measures are listed in alphabetical order, sequencing should be appropriate to patient medical condition, functional status, and setting)

Anthropometric characteristics
- Document patient’s height, weight, and BMI
  - Robotic-assisted gait training is contraindicated when body weight is greater than 300 lbs (136 kg)\(^2\)
- Measure lower extremity length and girth
  - Robotic exoskeleton must be able to accommodate femur length measured from greater trochanter to knee joint line (must be 35–47 cm [13.75–18.5 inches] for Lokomat)\(^2\)
  - Individuals with a major difference (> 2 cm/0.79 inches) in leg length might not be accommodated by robotic legs (Lokomat)\(^2\)

Arousal, attention, cognition (including memory, problem solving): Assess orientation to name, place, time, and situation; attention; short- and long-term memory; and problem solving as indicated. Obtain neuropsychological testing results where available. Problems occurring in neurological conditions might include:
- poor memory
- poor attention and concentration
- poor decision making
- impulsivity
- emotional lability
- disorientation
- language and communication difficulties
  - Inability to speak
  - Inability to understand when spoken to
• **Assistive and adaptive devices:** Describe any assistive and adaptive devices that patient uses. Assess need for splints or orthoses (e.g., ankle-foot orthoses) as indicated

• **Balance:** Assess sitting and standing balance using a standardized test such as Berg Balance Scale or Pediatric Balance Scale where indicated

• **Cardiorespiratory function and endurance:** Monitor blood pressure, heart rate, respiratory rate, and/or oxygen saturation as indicated. The Borg Rating of Perceived Exertion (RPE) Scale can be used to assess exercise intensity

• **Circulation:** Check lower extremity pulses for signs of diminished circulation

• **Functional mobility:** Assess functional mobility using standardized tests such as the Rivermead Mobility Index, Timed Up and Go (TUG) test, FIM, or WeeFIM as indicated by patient’s condition

• **Gait/locomotion:** Perform a complete gait assessment as able
  – What is the patient’s current ambulatory status?
  – Does the patient use assistive devices?
  - Note any compensatory strategies secondary to device use, such as forward trunk flexion with walker use or asymmetry with cane use
  - Observational gait analysis (OGA) such as Rancho Los Amigos OGA can be performed
  - Gait is divided into stance and swing phases and focus is on the cyclical movements occurring in gait cycle, noting asymmetries and deviations
  – Where available, obtain results of computerized 3-dimensional (3D) gait analysis
  - Reflective markers are mounted on the skin at specific locations on the pelvis and lower limbs
  - Spatiotemporal, kinematic, and kinetic data are captured
  – Where 3D gait analysis data are unavailable, clinical measurement of parameters such as cadence, step length, stance time on the affected leg, and width of base of support might be made
  – 10-meter walk test (10MWT) can be used to measure gait speed
  – Dynamic Gait Index (DGI) – assesses overall dynamic gait function and fall risk
  – Walking Index for Spinal Cord Injuries, Second Edition (WISCI-II) – assesses the amount of physical assistance needed as well as devices required for walking following SCI

• **Joint integrity and mobility:** Assess passive ROM and joint stability as indicated
  – Patients might be at risk for joint injuries due to abnormal gait patterns (e.g., knee hyperextension)

• **Motor function (motor control/tone/learning):**
  – Assess muscle tone, coordination, and voluntary movement ability
  – The Modified Ashworth Scale can be used to assess tone; the Spinal Cord Assessment Tool for Spasticity (SCATS) can be used to assess tone in patients with SCI
  – Movement disorders might include abnormal timing and trajectory of limb movements
  – Assess for presence of obligatory synergies, compensatory movement strategies, and selective voluntary muscle activation as indicated
  - The Fugl-Meyer Assessment of Motor Recovery or Chedoke-McMaster Stroke Assessment can be used for assessment of motor control in poststroke or TBI patients
  – Assess equilibrium and protective reactions
  – Assess eye-head coordination as indicated
  – Assess for cerebellar signs (e.g., intention tremor, dysdiadochokinesia, nystagmus) as indicated

• **Muscle strength:** Assess trunk and upper and lower extremity muscle strength using manual muscle testing (MMT) as appropriate
  – In presence of spasticity, MMT is not valid
  – Impaired motor control and abnormal muscle tone might obscure strength deficits

• **Neuromotor development:** Use a standardized test such as the Peabody Developmental Motor Scales, Second Edition (PDMS-2) as indicated
  – The Gross Motor Function Measure (GMFM) can be used to assess change in gross motor function in children with cerebral palsy

• **Observation/inspection/palpation** (including skin assessment): Assess for skin irritation or breakdown, particularly in areas that are in contact with the equipment (harness support and robotic orthoses)

• **Posture:** Assess body alignment for asymmetric posture in sitting, standing, and walking. Note asymmetry in weight-bearing. Assess spinal alignment and posture of head, neck, shoulders, trunk, pelvis, and lower extremities. Is the posture stooped (head forward and shoulders rounded)? Is the lumbar curve flattened or excessively lordotic?
• **Range of motion:** Assess bilateral lower extremity ROM and flexibility. Assess bilateral upper extremity, trunk and neck ROM as indicated

• **Reflex testing:** Assess deep tendon reflexes for asymmetry and hyper- or hyporeflexia as indicated. Assess for primitive reflexes in children with cerebral palsy and patients with neurological disorders

• **Self-care/activities of daily living (objective testing):** The Barthel Index might be used to assess ADLs

• **Sensory testing:** Assess bilateral upper and lower extremity light touch, temperature, and pinprick as indicated. Assess proprioception as indicated

---

**Assessment/Plan of Care**

› **Contraindications/precautions:** See Contraindications/Precautions to device/equipment and Contraindications/precautions to examination, above

› **Patients for whom robotic-assisted gait training is indicated are at risk for falls;** follow facility protocols for fall prevention and post fall-prevention instructions at bedside, if inpatient. Ensure that patient and family/caregivers are aware of the potential for falls and educated about fall-prevention strategies. Discharge criteria should include independence with fall-prevention strategies

› **Diagnosis/need for device/equipment:** Individuals with motor deficits making them unable to completely support their own weight and walk at functional speeds might benefit from robotic-assisted gait training

› **Prognosis**

• Factors affecting prognosis for recovery of ambulation after stroke or TBI include severity of injury or impairment and ambulatory ability at start of rehabilitation

• Prognosis for independent ambulation after TBI or SCI is poorer with increasing age

• Prognosis for walking recovery after SCI is very good for patients classified as D (incomplete with muscle grade ≥ 3 in at least half of key muscles below the injury) on the AIS. Patients classified as A (motor and sensory complete) at their first examination have a poor prognosis for functional walking. Motor incomplete (C) patients have a better prognosis for walking recovery than sensory incomplete patients (B)

• Prognosis for improving gait in patients with PD is uncertain. PD is progressive, and decline in motor function is expected within 5 to 7 years of diagnosis

› **Referral to other disciplines:** A multidisciplinary team might be involved in the care of patients with neurological disorders. Team members might include physiatrists, physical therapists (PTs), occupational therapists (OTs), orthotists, speech-language pathologists (SLPs), nurses, case managers, neuropsychologists, social workers, and vocational trainers/counselors

› **Treatment summary**

• Courses of robotic-assisted gait training are lengthy and expensive. Efficacy and cost-effectiveness have not yet been satisfactorily demonstrated

• Overall training efficacy depends on several different parameters

  – Conflicting results might reflect different methods used for enhancing activity during training interventions and protocols

  – For example, protocols might include reducing body weight support, increasing treadmill speed, and/or reducing guidance force

• Authors of a systematic review published in 2018 found that robotic-assisted gait training for patients in the subacute phase of recovery following stroke is effective for improving walking speed and overall functional mobility

  – A total of 7 trials were included in the review, with a total of 220 subjects (112 who had robotic-assisted gait training and 108 controls)

  – Research indicates that robotic-assisted gait training is effective when it is task specific, intensive, and delivered in the early phase following stroke

  – Authors were unable to draw conclusions about whether robotic-assisted gait training was more effective than traditional physical therapy based on current evidence

• Authors of a systematic review published in 2017 found that both overground gait training/traditional physical therapy and robotic-assisted gait training were equally effective for improving walking speed in patients with SCI. The authors could not make the same conclusion for improvements of walking distance; the data for walking distance outcomes were not conclusive

  – Systematic review included 13 randomized clinical trials comparing robotic-assisted gait training to traditional gait training, with a total of 586 subjects
Authors reported that conclusions regarding improvements in walking speed were robust despite the fact that any of the trials was susceptible to bias.

- Robotic-assisted gait training might result in increased hip torque and reduced hip stiffness in the paretic hip of patients in the subacute or chronic phase of stroke recovery [9]

- Based on a study conducted in South Korea with 17 patients with hemiplegia following stroke
- There was no control group for this study
- Subjects were treated with traditional physical therapy combined with progressive robotic-assisted gait training 5 days per week, for at least 8 weeks; subjects were seen for an average of 86 sessions
- Significant improvements of active and resistive hip torque as well as reduced hip stiffness during hip flexion were found on outcome measures (Functional Ambulation Category [FAC], modified Rankin scale [mRS], the Korean version of the modified Barthel index [K-MBI], and the modified Ashworth scale)

- Use of rhythmic arm swing during robotic-assisted gait training in patients with subacute stroke might result in improved outcomes compared to robotic-assisted gait training with arm in fixed position [10]

- Based on a small RCT conducted in South Korea with 20 subjects who were in the subacute phase of recovery following stroke
- Each subject completed 30 sessions of robotic-assisted gait training with either rhythmic arm swinging or stationary arm position
- Both groups exhibited significant improvements on all outcome measures (10MWT, Berg Balance Scale, TUG, Fugl-Meyer assessment, and modified Barthel index); the scores on the Berg Balance scale, Fugl-Meyer assessment, and modified Barthel index were significantly higher for the rhythmic arm swinging group

- Robotic-assisted gait training using a slow treadmill speed appears to result in greater overall improvements in walking for patients who have had a severe stroke compared to fast treadmill speeds [13]

- Based on an RCT conducted in Brazil with 18 subjects who were in the chronic phase of recovery following a severe stroke
- Each participant completed 30 sessions (6 weeks of training, 5 sessions per week)
- Baseline and outcome measures were FAC, TUG, 6MWT, 10MWT, Berg Balance Scale, and Fugl-Meyer Assessment; participants in the slow treadmill group made significant improvements on FAC, TUG, 6MWT, Berg Balance Scale, and Fugl-Meyer Assessment, whereas the fast treadmill group made significant improvements on the Berg Balance Scale only

- Improvements in walking speed, reductions of freezing of gait (FOG), improved postural stability, and improved spatiotemporal gait parameters have been reported to result from robotic-assisted gait training in patients with PD [2]

- Robotic-assisted gait training and traditional balance training were compared for treating postural instability and functional mobility in patients with PD [2]

- In an RCT in Italy, 66 patients with PD were assigned to robot-assisted gait training or balance training groups. Balance training focused on traditional interventions for postural reactions and coordination
- All patients received 12 45-minute treatment sessions, 3 days a week for 4 weeks
- Statistically significant improvements were seen in both groups using the BBS. However, robotic-assisted gait training was not found to be statistically superior to balance training for treatment of postural instability and functional deficits in persons with PD

- A systematic review and meta-analysis published in 2017 of 10 studies indicates that robotic-assisted gait training in patients with cerebral palsy improves walking speed, endurance, and overall gross motor abilities [8]

- Investigators in a neurorehabilitation unit in Italy studied the effects of robotic-aided gait training combined with physical therapy in children with acquired brain injury (ABI) [6]

- Twenty-three patients participated in 20 sessions of robotic-aided gait training and traditional manual physical therapy. Results from a pretest-posttest comparison demonstrated significant improvements in Gross Motor Function Measures (GMFM), 6MWT scores, gait analysis, and ROM throughout the whole gait cycle. Significant improvements were minimal to none in a control group of children with ABI who participated in manual physical therapy only

- Researchers in the United States studied predictors of recovery patterns in individuals trained with robotic gait training (Lokomat) post SCI [7]

- Forty subjects post SCI who had spastic hypertonia at their ankles were randomly selected for participation
- Two recovery classes (high and low walking capacity) were identified for each of the control and intervention groups. High capacity demonstrated shorter TUG time, higher 10MWT speed, and longer 6MWT distances. Those assigned to the low walking capacity group had poorer scores on the respective tests
Maximal voluntary ankle torque of each participant was measured prior to initial treatment and use of Lokomat. Torque scores were found to predict the classification and assignment to the high and low walking capacity groups. Subjects in the initial high capacity group showed significant improvement in speed and functional mobility. No significant change in endurance was seen in the high capacity group. Subjects in the low walking capacity group failed to demonstrate significant improvement.

Maximum voluntary torque might offer some predictability as to which patients will benefit from Lokomat training, thereby containing unnecessary expenses and effort.

Authors of a retrospective study conducted in Hong Kong have suggested that use of a robotic-assisted gait training device provides stroke patients benefits in terms of ambulation, mobility, and balance; however, no significant improvements were noted in comparison to standard physical therapy\(^{(15)}\).

Authors of a 2017 systematic review found that using a BWSTT device did not increase walking speed compared to regular gait training\(^{(12)}\).

Based on 13 RCT trials involving 586 participants that utilized BWSTT.

Robotic-assisted gait training combined with virtual reality can improve balance and gait abilities compared to standard physical therapy in patients who have had a stroke\(^{(18)}\).

Fifty patients with stroke were randomized into three groups: virtual reality robot-assisted gait training [VRGT (n = 12)], auditory stimulation robot-assisted gait training [ARGT (n = 12)], or control group (n = 16).

Groups in the VRGT and ARGT received 45 minutes of therapy 3 times a week for 6 weeks.

Standard physical therapy was given to all three groups for 30 minutes 5x/week for 6 weeks.

Results showed improvements in the Berg Balance scale, TUG, and 10MWT for all three groups; however, the VRGT group showed significant improvements in the Medical Research Council score and Fugl-Myer Assessment scores.

Virtual reality augmented robotic-assisted gait training can reduce dropout rates and extend training-time sessions compared to using only robotic assisted gait training\(^{(19)}\).

Twenty subacute stroke patients were randomized to either the virtual reality + robotic assisted gait training group or robotic assisted gait training only group.

Study consisted of 12 sessions over the course of 4 weeks.

<table>
<thead>
<tr>
<th>Problem</th>
<th>Goal</th>
<th>Intervention</th>
<th>Expected Progression</th>
<th>Home Program</th>
</tr>
</thead>
</table>
| Gait impairments                             | Increase independence in ambulation, increase gait speed | **Robotic-assisted gait training**  
Robots can deliver training more consistently as they do not fatigue | Frequency and duration of training sessions should be gradually increased  
Body weight support can be decreased, speed of treadmill increased, and/or guidance force decreased as patient progresses | A home program with emphasis on skill carryover is recommended. Activities should target enhancing community participation in daily activity |
| Decreased lower extremity strength and mobility | Maintain and increase lower extremity strength and mobility | **Robotic-assisted gait training**  
Subacute stroke patients can be trained to increase their VO\(_2\) and lower extremity strength using a robotic device during inpatient rehabilitation | As above | A home program of lower extremity strengthening and ROM exercises should be provided |
<p>| Decreased endurance                          | Increase endurance                              |                              |                                                                                      |                                                                                                   |</p>
<table>
<thead>
<tr>
<th>Patient is at risk for:</th>
<th>Minimize risks</th>
<th>Risk reduction strategies</th>
<th>Increased independence in risk prevention</th>
<th>Educate patient and caregivers about risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Falls</td>
<td></td>
<td>Regular skin inspection and monitoring of joint positions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin breakdown at equipment contact</td>
<td></td>
<td>Educate patient and family about fall risks and fall prevention strategies</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Joint injuries due to abnormal gait patterns</td>
<td></td>
<td>Maintain and use equipment according to safety standards and manufacturers’ specifications</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

See Description, Indications for device/equipment, and Guidelines for use of device/equipment, above

**Desired Outcomes/Outcome Measures**

- Outcome measures vary depending on diagnosis
  - Increased independence with ambulation
    - Walking endurance (6MWT)
    - Emory Functional Ambulation Profile
    - WISCI-II
    - FAC
  - Increased gait speed
    - Walking velocity (10MWT or 15MWT)
  - Improved patient/caregiver safety
    - DGI
  - Improved balance
    - Berg Balance Scale, Pediatric Balance Scale
  - Improved functional abilities
    - Rivermead Mobility Index
    - GMFM/PDMS-2
    - FIM or WeeFIM
    - Barthel Index
  - Increased lower extremity muscle activation/strength
    - Manual muscle test (MMT) scores where appropriate
    - EMG

**Maintenance or Prevention**

- Maintain the highest achievable ROM, strength, and function of the affected limbs
- Maintain fitness level and participation in activities
- Prevent falls
  - Increase awareness of patient and family members of risk of falls
The websites of commercially available robotic-assisted gait training provide information useful to patients and their families. Users should be made aware of their vested interest in promoting the technology.


### Coding Matrix

References are rated using the following codes, listed in order of strength:

<table>
<thead>
<tr>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>Published meta-analysis</td>
</tr>
<tr>
<td>SR</td>
<td>Published systematic or integrative literature review</td>
</tr>
<tr>
<td>RCT</td>
<td>Published research (randomized controlled trial)</td>
</tr>
<tr>
<td>R</td>
<td>Published research (not randomized controlled trial)</td>
</tr>
<tr>
<td>C</td>
<td>Case histories, case studies</td>
</tr>
<tr>
<td>G</td>
<td>Published guidelines</td>
</tr>
<tr>
<td>RV</td>
<td>Published review of the literature</td>
</tr>
<tr>
<td>RU</td>
<td>Published research utilization report</td>
</tr>
<tr>
<td>GI</td>
<td>Published quality improvement report</td>
</tr>
<tr>
<td>L</td>
<td>Legislation</td>
</tr>
<tr>
<td>PGR</td>
<td>Published government report</td>
</tr>
<tr>
<td>PFR</td>
<td>Published funded report</td>
</tr>
<tr>
<td>PP</td>
<td>Policies, procedures, protocols</td>
</tr>
<tr>
<td>X</td>
<td>Practice exemplars, stories, opinions</td>
</tr>
<tr>
<td>GI</td>
<td>General or background information/texts/reports</td>
</tr>
<tr>
<td>U</td>
<td>Unpublished research, reviews, poster presentations or other such materials</td>
</tr>
<tr>
<td>CP</td>
<td>Conference proceedings, abstracts, presentation</td>
</tr>
</tbody>
</table>

### References


