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The patient signed an informed consent allowing the use of medical information and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act.

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Abstract:

Background and Purpose: Robot-assisted gait devices have become increasingly popular as they have been shown to increase the likeliness of independent ambulation in patients who have had a stroke, while also decreasing the physical burden on the physical therapist. However, there has been minimal research investigating the impact of these devices on activities of daily living (ADL) function. Therefore, the purpose of this case report is to describe the impact of robot-assisted gait training with task specific training on the ADL function and functional mobility of an individual who experienced a stroke.

Case Description: The patient was a 71-year-old male who experienced a right middle cerebral artery stroke 6 weeks prior to admission. The initial examination revealed impairments in strength, tone, balance, ADL function and functional mobility. Procedural interventions included gait training both overground and robot-assisted, task-specific training including bed mobility and transfers, balance activities, wheelchair management, stretching, and therapeutic exercise for strengthening.

Outcomes: After 14 treatment sessions, the patient improved his performance of ADLs, as indicated by a 25 point increase on the Barthel Index for a total score of 50/100. He also displayed improvements in strength, balance, and functional mobility, including the ability to ambulate with minimum assistance.

Discussion: Robot-assisted gait training with task-specific training was shown to improve performance of activities of daily living and functional mobility in this patient after a stroke. Due to the early discharge, it was uncertain how much more improvement in ADL function and mobility may have been gained with the intended amount of therapy. Future studies should investigate the benefits of robot-assisted gait training and task-specific physical therapy techniques on ADL performance in this population.

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Background

Stroke is the fourth leading cause of death and the leading cause of long term disability in the United States.[1] Each year, an estimated 795,000 people experience a stroke.[1] There are a variety of clinical manifestations which lead to decreased mobility and independence in activities of daily living (ADLs). Impairments may include paresis, sensory loss, cognitive deficits, aphasia, and visual issues. The presentation of impairments and length of disability is dependent on lesion location and severity. In people over the age of 65 who have had an ischemic stroke, 30% are unable to walk without assistance and 26% are dependent in ADLs 6 months post stroke.[1]

Traditionally, physical therapy management of stroke has included a combination of functional training, strength training, balance training and gait training. Research has shown that repetitive task specific training has been favorable in recovery from stroke, leading to significant improvements in lower extremity function.[2] Based on this principle, gait training has focused on repetitive practice both overground and on a treadmill. Both of these gait training methods have been shown to be taxing on therapists due to the amount of effort required to manage the patient's paretic limbs for proper placement and mechanics. It has been hypothesized that therapist fatigue is a limiting factor in the number of repetitions of the gait cycle the patient can perform in a session. Recently, there has been greater use of robot-assisted therapy in patients who have had a stroke. Robot-assisted gait training (RAGT) has the benefit of reducing the need for constant management of the paretic limbs by the therapist while also allowing for increased repetition of the gait cycle for the patient. This would enable for greater improvements in gait mechanics and functioning.[3]

Currently, there are two styles of robot-assisted gait devices being utilized in therapy and research. The first is a treadmill system with a combination of a robotic leg orthosis and a partial body weight support harness, such as the 'Lokomat'* system utilized in this case report. The other device also utilizes a partial body weight support harness, but instead is designed with footplates attached to a crank and rocker gear system. Both devices are proven to increase the likeliness of independent walking ability in patients who have experienced a stroke, with the most benefit seen in those patients who were unable to walk and were within the first three months after their stroke.[3] Presently, there is no evidence of significant increases in walking velocity or capacity in either RAGT device, as well as no evidence suggesting one device to be superior to the other.[3] Despite this, the 'Lokomat' system has been shown to lead to improved gait mechanics. In one study, patients who received therapy on the 'Lokomat' improved the single limb support time of their paretic limb from 0.19 seconds to 0.49 seconds, while those who participated in conventional physical therapy showed a decrease from 0.38 seconds to 0.35 seconds.[4]

Despite the current evidence, more research is necessary to determine any further benefits of robot-assisted gait devices. Current research gaps include comparisons between devices, associated costs, appropriate parameters for frequency and duration of training, how long benefits last, and assessment of any changes related to ADL functioning and quality of life.[3] Therefore, the purpose of this case report is to describe the impact of robot-assisted gait training in combination with task specific training on the functional mobility and ADL performance in an individual who experienced a middle cerebral artery (MCA) stroke.

Case Description

The patient was a 71 year old Caucasian male referred to physical therapy with a medical diagnosis of right MCA stroke. Prior to the stroke, he worked full time as a salesman for his own business and golfed once a week. The patient had a complex medical history that included multiple heart

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*Hocoma Inc, USA, 77 Accord Park Dr. Suite D-1, Norwell, MA 02061 complications and the following risk factors for stroke: diabetes mellitus, hypertension, dyslipidemia, and atrial fibrillation.

The patient was admitted to the emergency room 6 weeks prior to date of the initial examination where he immediately received tissue plasminogen activator (tPA) treatment. Imaging confirmed a sub-acute infarct of the region of the right basal ganglia with high grade stenosis of distal right M1 segment of the MCA. He scored an 11/42 on the National Institute of Health Stroke Scale, indicating he suffered a mild to moderately severe stroke. After one week in the acute hospital, the patient spent 5 weeks on the stroke unit of an inpatient rehabilitation hospital. While on that unit, the patient participated in traditional stroke rehabilitation, aquatic therapy and Lokomat[*] treadmill training. Outcome measures conducted at admission and discharge from the inpatient stroke unit included the Berg Balance Scale and the Functional Independence Measure, scores for which were 13/56 and 61/126 respectively.

At the conclusion of his stay on the stroke unit, the patient was transferred to the skilled rehabilitation unit and seen for his initial examination. The patient's medications at admission included drugs to control his blood pressure, diabetes, and cholesterol, as well as to reduce his risk of a recurrent stroke. The systems review revealed impairments in the cardiopulmonary system, the musculoskeletal system, and the neuromuscular system, details for which are included in Table 1. There was significant edema noted in left upper extremity that was more pronounced in the hand, as well as in the left lower extremity that was more pronounced in the foot. The client displayed decreased gross range of motion of the left lower extremity and decreased gross strength of bilateral lower extremities. The upper extremities were assessed by the occupational therapist, but it was noted that the patient had no active

[*] Hocoma Inc, USA, 77 Accord Park Dr. Suite D-1, Norwell, MA 02061

movement in his left upper extremity. The patient demonstrated impaired balance, locomotion, transfers and transitions.

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Clinical Impression I

Following the history and systems review, the client displayed decreased functional mobility with impaired active movement and strength following his stroke. Further tests/measures needed to determine the degree of impairments and their impact on his mobility included manual muscle testing and tone assessment. In addition, it would be crucial to perform sensation testing in order to determine the patient's risk for skin breakdown which could impede recovery. This patient was a good candidate for a case report due to his impaired function as well as his potential for participation in robot-assisted gait training.

Examination

The initial physical therapy examination was conducted 6 weeks after the patient's stroke (see Table 2 for details). The patient was unable to actively move his left upper extremity and had minimal active movement of his left lower extremity. Due to the absence of abnormal synergy patterns, manual muscle testing was performed to determine the impact of muscle weakness on mobility. The patient's sensation was intact, indicating he was at a decreased risk for skin breakdown. There was spasticity present in his left hip and knee extensors, as assessed by the Modified Ashworth Scale. This outcome measure, included in Appendix A, has been shown to have high reliability for the knee and fair reliability for the hip.[5] The examination also revealed that the patient was unable to ambulate due to decreased balance and safety. In order to assess ADL functioning and mobility, the Barthel Index was utilized (see Appendix B). The patient scored a 25/100, indicating he was completely dependent in those areas. The Barthel Index has been shown to have good reliability and validity, although no standardized cut-off scores have been accepted.[6,7] Despite this, it is suggested by Dromerick et al[8] that a score below 40 represents complete dependence and a score greater than 85 represents independence with minor assistance.

Clinical Impression II

Evaluation

The examination findings were consistent with the expected impairments following a right MCA stroke. The patient's hemiparesis and increased tone on the left side led to decreased range of motion and impaired sitting and standing balance. Due to the presence of right sided muscle weakness, some of the weakness of his left lower extremity may have been a result of decreased activity levels, but this was likely a minimally causative factor. The patient's tone and weakness were also contributing to his inability to independently perform bed mobility and transfers. This in turn caused him to be completely dependent in ADLs and functional mobility, as reflected in the Barthel Index score. This patient remained a good candidate for this case report due to his potential to benefit from robot-assisted gait training to improve his mobility and possibly his ADL functioning.

Diagnosis

Based on the patient's medical diagnosis and subsequent motor impairments, the diagnostic category from the *Guide to Physical Therapist Practice* that was selected was "Impaired Motor Function and Sensory Integrity Associated with Non-progressive Disorders of the Central Nervous System –

Acquired in Adolescence or Adulthood." Although the patient did not have impaired sensory integrity, his impaired motor function was consistent with this practice pattern.

Prognosis

Neurological recovery after stroke peaks at 3 months and can continue for up to 6 months, whereas functional recovery may continue for longer.[2] Since the patient experienced a stroke 6 weeks prior, there were still at least 6 weeks for neurological recovery to occur, as well as functional recovery. The most important factors for recovery are severity and age.[2] Although the patient was 71, he experienced a mild to moderate stroke, which placed him at a slightly better chance of recovery. He exhibited active movement of his paretic leg with no presence of abnormal synergistic patterns, indicating his potential for improving his strength and functional mobility. In addition, he was very motivated to return to independence in ADLs and mobility, was active prior to having a stroke, and had a very supportive family.

Factors that would impede recovery included his prolonged motor impairment, persistent incontinence, and complex past medical history.[9] His diabetes, heart issues, and hypertension continued to place him at a high risk of a recurrent stroke.[9] Additionally, sitting balance and active lower extremity movement have been determined to be predictors of recovery. Evidence has shown that patients who were unable to voluntarily move their affected limb and unable to sit independently for 30 seconds within the first 72 hours following their stroke had a 27% chance of achieving independent gait.[10] In contrast, those patients who had some voluntary movement of their affected limb and were able to sit independently within 72 hours post stroke had a 98% chance of achieving independent gait within a 6 month period.[10] Although there was no information provided about the patient's sitting balance in the 72 hours following his stroke, it can be assumed that he was unable to sit independently for 30 seconds in that time period since he could not do so 6 weeks after his stroke. This placed him at a low risk of regaining independence in gait. In contrast, evidence supporting robot-assisted gait training showed that he would make gains towards independence in gait due to his acute status. While the patient's recovery to independent gait was questionable, it was anticipated that participation in physical therapy would lead to improvements in strength and range of motion, and therefore would allow him to become more independent in functional mobility and ADLs.

Plan of Care

It was determined that the patient would benefit from participating in physical therapy for 6 weeks in order to address his impairments and functional limitations. The goals of the patient and his family included increasing the strength of his left side and increasing his independence in mobility. Short term and discharge goals were focused around the family's desired outcomes and included the following:

Short Term Goals (1 week):

1. Patient to be maximum assist of 1 with bed mobility for increased independence with function.
2. Patient to be maximum assist of 1 with stand-pivot transfers for increased household accessibility.
3. Patient to walk 10 feet on level surfaces with assist of 2 using an appropriate assistive device for safety with household mobility.
4. Patient to propel wheelchair 150 feet on level surfaces and 3% ramps with modified independence for increased functional mobility in the home.

Discharge Goals:

1. Patient to be modified independent with bed mobility for increased independence with function.

2. Patient to be supervision assist with stand pivot transfers with use of appropriate assistive device for increased household accessibility.
3. Patient to walk >50 feet on level surfaces with supervision assist using an appropriate assistive device for safety with household mobility.
4. Patient to walk up and down a 6 inch curb with appropriate assistive device with supervision assist for access to home.

Intervention

The patient was scheduled for five 1-hour PT sessions during the week. It was anticipated that he would be in rehabilitation for 6 weeks, but he and his family requested discharge after 20 days. Over the course of his stay, he participated in 14 treatment sessions which were coordinated with occupational therapy in order to ensure consistency with transfer techniques. Procedural interventions focused on the following: balance activities, gait training both overground and robot-assisted, task-specific training including bed mobility and transfers, wheelchair management, stretching to prevent contractures and strengthening of the lower extremities. Detailed descriptions of procedural interventions are included in Table 3. Due to coordination of care, occupational therapy focused on rehabilitation of the upper extremities. In addition, documentation and communication about the patient's functional status and discharge plan occurred on a daily basis with occupational therapy, nursing, and social work.

Balance training was a vital aspect of the plan of care, given that independent sitting balance is a precursor for ADL function. A recent study by Yoo et al[11] suggested that trunk stabilization exercises on an unstable surface lead to significantly increased balance control as compared to exercises on a stable surface. Therefore, sitting balance exercises were performed on a thick cushioned mat to allow for decreased stability in order to challenge the patient's postural control. The patient was progressed from static to dynamic sitting activities, such as upper extremity proprioceptive neuromuscular facilitation (PNF) patterns with trunk rotations, and was eventually progressed to static and dynamic standing balance activities in the parallel bars (see Table 3 for details).

The patient participated in robot-assisted gait training twice a week for an average of 30 minutes each session. As shown in Figure 1, the patient was suspended over the treadmill in a body weight support harness and was strapped into the robotic leg orthosis that provided an average of 55% of the force and direction needed for limb advancement during gait. Detailed parameters for each session are included in Table 4. During training, both verbal and visual cues were utilized to increase the patient's effort for limb advancement and foot clearance. During other treatment sessions, the patient participated in overground gait training in the parallel bars with assistance for balance, limb advancement, and prevention of hyperextension and buckling of the left knee. The patient donned an ace wrap on his left ankle to maintain dorsiflexion and prevent toe drag. The level of assistance was decreased as indicated over the treatment sessions and the patient was progressed to ambulation with a hemiwalker and assistance for stabilization of the left knee.

Task-specific training included bed mobility and transfers from multiple surfaces. The patient practiced compensatory methods for increased independence in bed mobility, such as the use of bed rails, along with assistance from another person. For transfers, he began with a stand-pivot method and was quickly transitioned to a squat-pivot method due to increased safety and decreased assistance required.

In addition, the patient was educated on fall prevention, safety during transfers, proper techniques for bed mobility, positioning to prevent injury and deformities, and his discharge plan. One treatment session involved educating the family on proper handling techniques. This included equipment management, proper positioning in bed and in the wheelchair, and how to safely assist with transfers and bed mobility while utilizing proper body mechanics.

Outcomes:

At discharge examination, the patient exhibited improvements in strength, balance, performance of ADLs and functional mobility (see Table 2 for data). The strength of his left hip and knee increased, but no changes were seen in his left ankle. His sitting balance improved significantly, as demonstrated by his ability to sit with supervision, while during initial examination he was unable to sit without support and frequently lost his balance posteriorly. He also improved his standing balance, requiring less assistance than previously. The patient improved his Barthel Index score from a 25/100 to a 50/100 at discharge, indicating he was no longer completely dependent in ADLs but still required assistance. He also made improvements in functional mobility, requiring less assistance for bed mobility, transfers, wheelchair propulsion, and ambulation. At discharge, he was able to perform bed mobility with moderate assistance of one person and was able to perform transfers with minimum assistance to the right side and moderate assistance to the left side. He was able to ambulate 40 feet in the parallel bars with minimum assistance at the left knee to prevent buckling and hyperextension, as compared to being unable to ambulate at the initiation of therapy. For detailed progression of overground ambulation across treatment sessions, see Figure 2.

Discussion:

This case report describes the progression of ADL performance and functional mobility of an individual after a stroke after participating in robot-assisted gait training and task-specific physical therapy. It was evident that the patient made good progress throughout the duration of his stay in sub-acute rehabilitation. His significant gains in functional mobility and ADL performance over 14 treatment sessions were felt to be results of the combination of robot-assisted gait training and task-specific training. Research has shown both to be beneficial interventions in stroke rehabilitation, and the combination of the two has proven to increase the number of people who return to independent gait, with no conclusions about the two intervention's effect on ADL performance. Although this patient still required assistance with ambulation, it was evident that he made significant gains in ambulation, requiring less assistance with each treatment session.

The patient increased his independence in ADL performance, improving his score on the Barthel Index from a 25/100 to a 50/100. This indicates that he was no longer completely dependent in ADLs, and that he had the ability to perform some parts of ADL tasks with some assistance. It was hypothesized that one positive factor towards increased independence in ADLs was his ability to sit with supervision at discharge. Additionally, it was hypothesized that his increased independence in ADL performance was an outcome of his improved balance resulting from balance training as well as the robot-assisted gait training. Swinnen et al[12] described RAGT as a beneficial intervention that leads to significant improvements in balance in patients who have had a stroke. It was felt that the combination of RAGT with the traditional balance training allowed for the greater improvements in balance in this patient.

It was difficult to determine the frequency and duration of RAGT due to the lack of evidence on optimal parameters. Contributing factors to parameters for RAGT in this case included availability of the device, patient fatigue during a session as well as the day after a session, and availability of therapists trained to use the device. In addition, the unanticipated early discharge of the patient impacted the number of RAGT sessions, but it was hoped that he would continue participating through the outpatient clinic in order to achieve maximal results while in the acute phase of his stroke.

One setback of this case report was the abbreviated time the patient participated in rehabilitation. Due to early discharge, it was uncertain how significant the change in ADL performance and mobility may have been with the intended amount of therapy. As expressed in the discharge goals, it was anticipated that the patient would have a higher level of independence in functional mobility that would continue to be improved upon with continued physical therapy. Despite this, it was demonstrated that robot-assisted gait training in combination with task-specific training was a beneficial intervention choice for this patient as it contributed to improvements in ADL performance and functional mobility. Future research should further investigate the benefit of robot assisted gait training and task-specific physical therapy techniques on ADL performance and functional mobility.

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Tables and Figures

Table 1: Systems Review

Cardiovascular/Pulmonary:	
Impaired	BP: 120/60mmHg; HR 86 bpm, RR 20 breaths per minute
	Edema noted in left upper extremity (more pronounced in the hand) and in the left lower extremity (more pronounced in the foot)
Integumentary:	
Not impaired	Skin integrity intact
Musculoskeletal:	
Impaired	Gross range of motion (ROM): right lower extremity within functional limits; decreased active and passive ROM of left lower extremity with left passive ROM ankle dorsiflexion to neutral; upper extremities assessed by occupational therapy
	Gross strength impaired in bilateral lower extremities; upper extremities assessed by occupational therapy
	Height: 73 inches Weight: 218 pounds
	Posture: forward head, forward flexed posture
Neuromuscular:	
Impaired	Impaired balance, locomotion, transfers and transitions
	Impaired motor control of left lower extremity
Communication/cognition:	
Not Impaired	Alert and oriented x4; no presence of aphasia

Table 2: Results of Tests and Measures Performed at Admission and Discharge

Test	Admission	Discharge
Sensation	Light touch intact bilaterally Proprioception: intact bilaterally	Light touch intact bilaterally Proprioception: intact bilaterally
Manual Muscle Testing (MMT)	Hip flexion: R 3+/5; L 2-/5 Hip extension: R 3/5; L 2-/5 Hip abduction: R 3/5; L 2-/5 Hip adduction: R 3/5; L 2-/5 Knee flexion: R 3+/5; L 1+/5 Knee extension: R 3+/5; L 2-/5 Ankle plantarflexion: R 3/5; L 1+/5 Ankle dorsiflexion: R 3/5; L 0/5	Hip flexion: R 5/5; L 2/5 Hip extension: R 5/5; L 2/5 Hip abduction: R 5/5; L 2/5 Hip adduction: R 5/5; L 2/5 Knee flexion: R 5/5; L 2-/5 Knee extension: R 5/5; L 3/5 Ankle plantarflexion: R 5/5; L 1+/5 Ankle dorsiflexion: R 5/5; L 0/5
Bed mobility: Rolling	Maximum assist x1 with use of bed rails	Moderate assist x1 with use of bed rails
Bed Mobility: Supine to/from Sit	Maximum Assist x2	Moderate Assist x1

Bed Mobility: Scooting in Supine	Moderate Assist x2	Moderate Assist x1
Transfers: Stand-pivot	Maximum assist x1 with contact guard assist x1 to either side	Minimum assist x1 to the right Moderate assist x1 to the left
Transfers: Sit to Stand	Maximum Assist x1 with Contact Guard Assist x1	Minimum Assist x1
Wheelchair mobility	Supervision for propulsion >150 feet with use of right arm and leg Assistance around obstacles and with leg rest	Independent for propulsion >150 feet with use of right arm and leg
Ambulation	Unable to assess ambulation at this time	40 feet with minimum assist at left knee (in the parallel bars)
Ambulation: Pattern		Decreased weight-bearing on left lower extremity, decreased weight shift to left, left genu recurvatum in left stance phase, right trunk lean with left hip circumduction during left swing phase
Balance: Static Sitting	Poor with loss of balance posteriorly; requires moderate assist with one hand prop	Good with supervision
Balance: Dynamic Sitting	Poor with loss of balance posteriorly and to left side	Fair with loss of balance to left side
Balance: Static Standing	Poor with maximum assist	Fair with contact guard assist and use of parallel bars
Balance: Dynamic Standing	Poor with maximum assist	Poor with minimum assist x1
Pain (Visual Analog Scale)	0/10	0/10
Range of Motion (ROM)	Left passive ROM ankle dorsiflexion to neutral	Decreased left knee extension, left ankle dorsiflexion to neutral, and decreased left hip internal rotation
Modified Ashworth Scale	1 in left hip and knee extensors Flaccid left upper extremity (assessed by occupational therapy)	1+ in left hip and knee extensors Flaccid left upper extremity (assessed by occupational therapy)
Clonus	6 beat clonus of left ankle	6 beat clonus of left ankle
Barthel Index	25/100	50/100

R: right; L: left; Maximum assist: patient can perform 25% - 49% of task; Moderate assist: patient can perform 50% - 74% of task; Minimum assist: patient can perform 75% or more of task; Contact Guard Assist: patient can perform task but requires hands-on contact; Supervision: patient performs task with supervision and without hands-on contact; Assistance levels adapted from the Functional Independence Measure.

Table 3: Procedural Interventions

Intervention	Frequency	Details
Robot-Assisted Gait Training	2 days a week for 4 total sessions	See chart below
Passive Range of Motion	3 times a week	Stretching of L LE into knee extension, hip internal rotation, ankle dorsiflexion 2 x 30 seconds
Therapeutic Exercise*	3 times a week	LE strengthening: inclusion of L quadriceps (long arc quads), L hamstring (seated knee flexion) , L gastrocnemius (seated ankle pumps), L hip flexors (seated marches)
Gait training	4 times a week	In the parallel bars and progressed to hemiwalker; ace wrap on L foot into ankle dorsiflexion to prevent toe drag; use of facilitation of L quadriceps with quick stretch/tapping techniques as needed and support to prevent L knee hyperextension and buckling
Balance activities	3-4 times a week	*Seated balance:* R UE beach ball hits D1 and D2 PNF patterns for R UE with resistance band L UE weight bearing during activities to increase proprioception/sensation *Standing balance in parallel bars:* Static standing Lateral weight shifts Forward stepping with weight shift 180 degree turns Cone tapping, alternating feet
Transfer training	4 times a week	Stand pivot and squat pivot from bed to/from wheelchair and from wheelchair to/from mat table; sit to stand from wheelchair
Bed mobility	As needed	Sit to/from supine towards right side, patient did not feel comfortable towards left side

*Performed when muscle activation was available; repetitions varied based on patient fatigue

R= right; L= left; UE= Upper Extremity; LE= Lower Extremity; PNF = Proprioceptive Neuromuscular Facilitation

Table 4: Parameters for Robot-assisted Gait Training

Session	**1**	**2**	**3**	**4**
Minutes	23	28	28	29
Speed (mph)	1.03	0.93-1.03	0.93-1.03	0.93
Distance (feet)	2000	2372	2368	2389
Guidance Force on Legs*	45% on left 30% on right	85-45%	50-65% on left 45-55% on right	35-45%
Weight support*	30 kg and coefficient of 0.43	30 kg and coefficient of 0.43	20-30 kg and coefficient of 0.43	35 kg and coefficient of 0.43
Notes	1 rest break required; cues to increase left knee flexion and to prevent dragging of feet; patient responded well to cues	2 rest breaks required; verbal cues and stepping over objects with left lower extremity reflecting decreased toe drag and increased patient effort evidenced via graphs	2 rest breaks required; visual cues to step over object leading to increased left foot clearance	2 rest breaks required; use of target to kick for increased step length as well as target to step over for increased left foot clearance

*Parameters adjusted during sessions based on patient response

Figure 1: Patient on the Lokomat Device

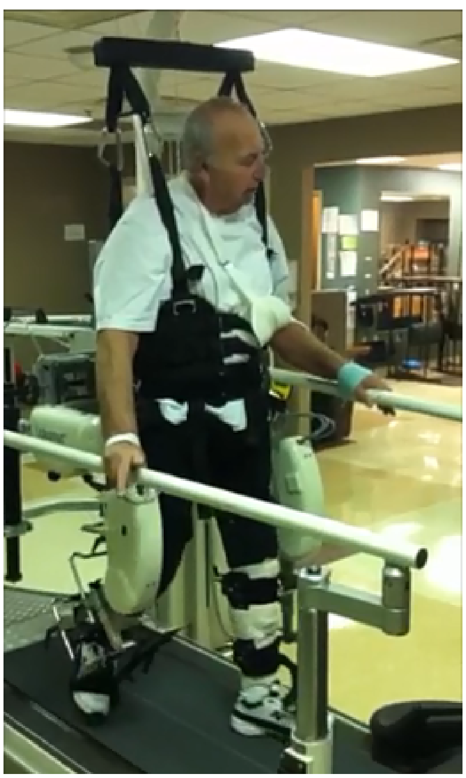
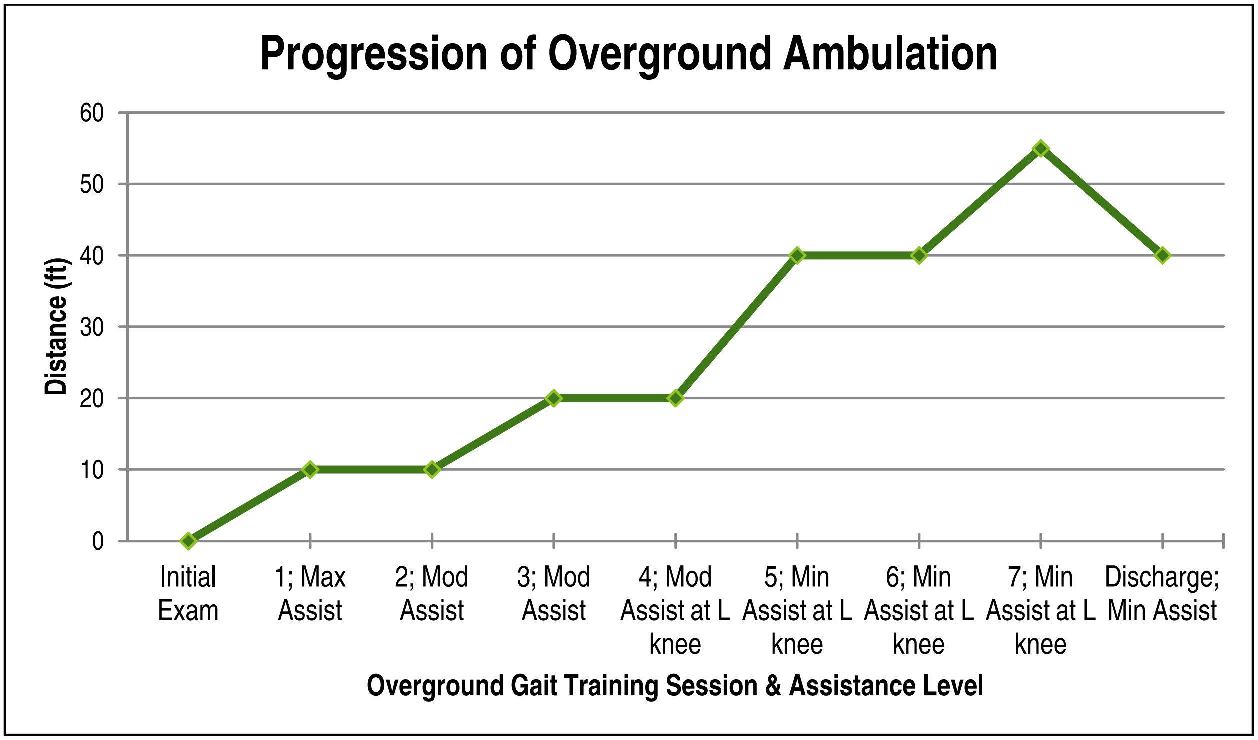


Figure 2: Progression of Overground Ambulation



Maximum assist: patient can perform 25% - 49% of task; Moderate assist: patient can perform 50% - 74% of task; Minimum assist: patient can perform 75% or more of task; Assistance levels adapted from the Functional Independence Measure.

Appendices

Appendix A. Modified Ashworth Scale

Grade	Description
0	No increase in muscle tone
1	Slight increase in muscle tone, manifested by a catch and release or by minimal resistance at the end of the range of motion (ROM) when the affected part(s) is moved in flexion or extension
1+	Slight increase in muscle tone, manifested by a catch, followed by minimal resistance throughout the remainder (less than half) of the ROM
2	More marked increase in muscle tone throughout most of the ROM, but affected part(s) easily moved
3	Considerable increase in muscle tone, passive movement difficult
4	Affected part(s) rigid in flexion or extension

Nolan KW, Cole LL, Liptak GS. Use of botulinum toxin type A in children with cerebral palsy. *Phys Ther*. 2006; 85(4):573-84.

Appendix B. Barthel Index

THE BARTHEL INDEX

Patient Name: ____________________________

Rater Name: ____________________________

Date: ____________________________

Activity	**Score**
FEEDING 0 = unable 5 = needs help cutting, spreading butter, etc., or requires modified diet 10 = independent	______
BATHING 0 = dependent 5 = independent (or in shower)	______
GROOMING 0 = needs to help with personal care 5 = independent face/hair/teeth/shaving (implements provided)	______
DRESSING 0 = dependent 5 = needs help but can do about half unaided 10 = independent (including buttons, zips, laces, etc.)	______
BOWELS 0 = incontinent (or needs to be given enemas) 5 = occasional accident 10 = continent	______
BLADDER 0 = incontinent, or catheterized and unable to manage alone 5 = occasional accident 10 = continent	______
TOILET USE 0 = dependent 5 = needs some help, but can do something alone 10 = independent (on and off, dressing, wiping)	______
TRANSFERS (BED TO CHAIR AND BACK) 0 = unable, no sitting balance 5 = major help (one or two people, physical), can sit 10 = minor help (verbal or physical) 15 = independent	______
MOBILITY (ON LEVEL SURFACES) 0 = immobile or < 50 yards 5 = wheelchair independent, including corners, > 50 yards 10 = walks with help of one person (verbal or physical) > 50 yards 15 = independent (but may use any aid; for example, stick) > 50 yards	______
STAIRS 0 = unable 5 = needs help (verbal, physical, carrying aid) 10 = independent	______
TOTAL (0–100):	______

Barthel Index. Stroke Center Website. http://www.strokecenter.org/wp-content/uploads/2011/08/barthel.pdf. Accessed November 22, 2014.