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Body Weight Supported Treadmill Training And Overground Gait Training In The In-Patient Setting For An Individual With Chronic Stroke: A Case Report

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The patient signed an informed consent allowing the use of medical information 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: The use of body weight supported treadmill training (BWSTT) and overground gait training (GT) has been shown to improve bilateral coordination and gait symmetry for patients experiencing chronic stroke. Evidence to support BWSTT rather than overground GT for use following chronic stroke is mixed and does not include representation for the young stroke population. The purpose of this case report is to describe the outcomes of gait speed, efficiency of gait, and fall risk in an individual following a chronic stroke managed with intense BWSTT and overground GT.

Description: 43 year old male was managed with BWSTT 5x/week for 12 weeks following a stroke. He presented with left hemiparesis, spasticity of his left upper and lower extremities, and decreased sensation on the left. He demonstrated decreased gait speed, functional strength, and range of motion.

Outcomes: There was a decrease in the level of assistance needed during ambulation from baseline to discharge. Although not statistically significant, his TUG, Gait Speed, 2 Minute Walk Test, and Berg also improved.

Discussion: The patient demonstrated mixed overall gains with management. Similarly, publications report various findings supporting BWSTT as well. Perhaps this can be attributed to a couple factors. One, stroke severity and symptoms vary among individual patients. Two, previous research has been performed on heterogeneous populations of patients that have had a stroke. Perhaps if a study was performed on a homogenous population of patients who have had a stroke, we may see different results. Further research is warranted in the area of BWSTT and a homogeneous patient population.

Background and purpose:

Although the relative rate of death due to stroke has declined over 35% since 2001, each year approximately 795,000 people experience a new or recurrent stroke in the United States, leaving a great portion of stroke survivors with spatiotemporal gait abnormalities.[1] Following discharge from inpatient rehabilitation, many patients who have had a stroke continue to experience activity limitations and participation restrictions, secondary to limited walking ability.[2] The use of body weight supported treadmill training (BWSTT) and overground gait training (GT) has been shown to improve bilateral coordination and gait symmetry for patients experiencing chronic stroke. BWSTT offers the opportunity for a patient to re-learn proper gait mechanics with proper posture, reduced weight bearing, and eliminated concern for balance. With the use of a harness, the body weight is reduced, and patients are often more confident and successful at initially re-learning gait mechanics. The harness enables the clinician to manually assist the patient's legs and pelvis to achieve proper gait patterns. The harness design, in conjunction with treadmill mechanics allows a progression from non-weight bearing to full weight bearing.[3] Currently, there is a lack of literature to support the use of BWSTT followed by GT in patients with left sided hemiparesis due to right middle cerebral infarct from idiopathic malignant hypertension. The purpose of this case report is to describe the outcomes of gait speed, efficiency of gait, and fall risk in a middle aged adult male following intense BWSTT in conjunction with overground GT, neuromuscular re-education, balance and strength training.

Case Description: The patient (RH) is a 47 year old veteran referred to physical therapy for difficulty with walking. He had a hemorrhagic stroke due to malignant hypertension four months prior to attending this physical therapy consultation and presented with left hemiparesis,

spasticity of his left upper and lower extremities, and decreased sensation on the left. He demonstrated decreased gait speed, functional strength, and range of motion (ROM). RH was considered a severe fall risk. RH had no other significant medical history prior to his stroke, however was since diagnosed with seizure disorder and high blood pressure. RH opted to reside as an inpatient to complete an intense twelve week therapy program as suggested by his physician and physical therapists. RH completed all required HIPAA forms in order to participate in this case report. Interventions included BWSTT, balance and overground GT, equipment and orthotic prescription, neuromuscular re-education, and functional electrical stimulation (FES). In conjunction with physical therapy, the patient received care from a neurologic specialist, nursing staff, occupational therapy, speech therapy, and attended recreational therapy outings at the facility. In addition, he was allowed to visit home on the weekends of his choosing.

HISTORY & SYSTEMS REVIEW:

Upon the initial examination of the patient (following collection of signed consent) as described by the Guide to PT Practice and through patient chart review, a systems review was conducted yielding the following:

Cardiovascular/ Pulmonary	
Impaired	High Blood Pressure- controlled by medication
Integumentary	
Unimpaired	Patient wore rigid AFO on left lower extremity
Musculoskeletal	
Impaired	Gross AROM impairments of left upper & lower extremity
	Gross strength impairments of left upper &

	lower extremity
Neuromuscular	
Impaired	Sensation: Absent light touch sensation on lateral left upper extremity & lateral left lower extremity Light touch sensation diminished on medial left upper extremity & medial left lower extremity Hypersensitivity noted on sole of left foot
	Tone: increased tone noted during passive range of motion of left upper and lower extremities
	Visual Field: unable to track left during ocular screen
	Balance: Decreased balance in bilateral stance; unable to attain single leg stance on left lower extremity
	Coordination: did not attempt to assess due to hemiparesis
	Proprioception: no evidence of proprioception at left elbow; no evidence of proprioception at left ankle
Communication, Cognition, Affect	
Impaired	Patient presented with flat affect; required increased time for processing information and answering questions
Legend:	
Ankle Foot Orthotic (AFO); Active Range of Motion (AROM)	

Medication List:	
ONABOTULINUMTOXINA 100 UNIT Injection	For spasticity
BACLOFEN 10MG/5ML 2AMP KIT INTRATHECAL	For spasticity
OXYCODONE 5MG/ACETAMINOPHEN 325MG TAB (as needed)	For pain
ASPIRIN 81MG (daily)	For heart
ATORVASTATIN CALCIUM 80MG TAB (daily)	For Cholesterol
CYCLOBENZAPRINE 10MG TAB (as needed at night)	For muscle pain

FLUOXETINE HCL 20MG CAP (2x/day)	For depression
LEVETIRACETAM 750MG TAB (every 12 hours)	For seizure disorder
LISINOPRIL 5MG TAB (1/2 tab every day)	For blood pressure

Patient Goals: To be able to walk without a cane; improve his balance; not fall again

CLINICAL IMPRESSION 1:

Following the subjective history and review of systems, it is hypothesized that RH presented with impaired strength, range of motion, sensation, and balance following a right hemorrhagic middle cerebral infarct due to malignant hypertension. The patient's primary complaint was his inability to participate in all daily and leisure activities. Additional tests and measures to confirm or refute this hypothesis included: Berg Balance Assessment, Timed Up and Go (TUG), 5x Sit to Stand, 10 Meter Walk Test, 2 Minute Walk Test, manual muscle testing of left upper and lower extremities, and tone assessment using the Modified Ashworth Scale. RH continues to be an appropriate candidate for this case report in order to advance the body of knowledge surrounding BWSTT and stroke rehabilitation.

TESTS & MEASURES:

Upon the initial and final examination of the patient, as described by the Guide to PT Practice, tests and measures were performed and are described below.

Initial Examination Results:		**Final Examination Results:**	**Psychometric Properties:**	
TUG (timed up and go)[4]	1:23" (with the use of SPC, left AFO & CGA) 1:55" (with the use of QC, CGA, no AFO) 1:52" (with	1:09" (with use of left FES for DF stimulation & supervision; No AD)	Test/Re-test Reliability	ICC= 0.96
			Interrater/ Intrarater Reliability	Not established for patients with stroke

		CGA, no use of orthotics or AD)				MDC	2.9 seconds
5x Sit to Stand [5]		42.72" (with the use of right upper extremity support from sit to stand, CGA, & AFO)		1:10" (with the use of right upper extremity support from sit to stand & supervision)		Test/Re-test Reliability	ICC= 0.994
						Interrater/ Intrarater Reliability	ICC = 0.999/ 0.970
						MDC	
2 Minute Walk Test [6]		32.3 feet (CGA, no AD) 52.5 feet (CGA, with SPC)		103 feet (with SBA & left Bioness FES for anterior tibialis stimulation)		Test/Re-test Reliability	ICC = 0.98
						Interrater/ Intrarater Reliability	ICC = 0.85/ 0.85
						MDC	13.4 meters
Berg Balance Assessment[7]		35/56		40/56		Test/ Re-test Reliability	ICC = 0.72
						Interrater/ Intrarater Reliability	ICC = 0.98/ 0.97
						MDC	4.9
10 Meter Walk Test (10MWT)[8]		Unable to get accurate result due to patient's slow speed and inability to complete the test		0.37 m/s (no AD, with supervision & left Bioness anterior tibialis stimulation)		Test/ Re-test Reliability	ICC = 0.95 to 0.99
						Interrater/ Intrarater Reliability	ICC = 0.998/ 0.87 to 0.88
						MCID	0.14 m/s
Tone Assessment: Modified Ashworth Scale (MAS) 0-4 scale[9]		**Left**	**Right**	**Left**	**Right**		
	Tricep	3	0	1	0	Intrarater Reliability for Upper Extremity	ICC= 0.77-0.88
	Bicep	2	0	0	0		
	Wrist Flexors	3	0	1	0		
	Wrist Extensors	1	0	0	0		
	Finger Flexors	3	0	1+			
	Hip Flexors	2	0	1	0	Intrarater reliability for Lower	ICC= 0.567
	Hip	1+	0	1+	0		

<table>
<tr><td rowspan="8"></td><td>Extensors</td><td></td><td></td><td></td><td></td><td>Extremity</td><td rowspan="2"></td></tr>
<tr><td>Quadriceps</td><td>3</td><td>0</td><td>1+</td><td>0</td></tr>
<tr><td>Hamstrings</td><td>0</td><td>0</td><td>0</td><td>0</td><td rowspan="5">MDC</td><td rowspan="5">1 point change in response to botox</td></tr>
<tr><td>Adductors</td><td>1+</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Abductors</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ankle DF</td><td>2</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Ankle PF</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td colspan="2" rowspan="3">Manual Muscle Test (MMT) [10]</td><td colspan="2" rowspan="3">Right upper and lower extremities within normal Limits (WNLs)

Left upper extremity not tested due to patient’s inability to hold test position

Left grip strength: trace to no grip when asked to squeeze therapist’s hand

Left Lower Extremity:
Hip flexion: 3+/5
Hip extension 4/5 with compensatory muscle activation
Knee flexion: 4+/5 with compensatory posterior lean
Knee extension: 5/5
Ankle DF: 1+/5</td><td colspan="2" rowspan="3">Left Lower Extremity:
Hip flexion: 4/5
Hip extension 3+/5 without compensatory muscle activation
Knee flexion: 4+/5 with slight compensatory posterior lean
Knee extension: 5/5
Ankle DF: 3/5</td><td></td><td>Psychometric properties unknown: MMT not suggested for patients with increased spasticity [10]</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="6">Legend:</td></tr>
</table>

SPC: Single Point Cane (SPC); Contact Guard Assistance (CGA); Quad Cane (QC); Assistive Device (AD); Functional Electrical Stimulation (FES); Dorsi-Flexion (DF); Minimal Detectible Change (MDC); Intraclass Coefficient (IC); Stand-by Assistance (SBA); Minimal Clinically Important Difference (MCID); Within Normal Limits (WNLs)	
Normative Data/ Interpretation of Tests and Measures:	
TUG: Timed up and Go	Cut off Score for Fall Risk: >14 seconds [4]
Berg Balance Assessment	Cut off Score for Fall Risk: < 45 indicates individuals may be at greater risk of falling Score of ≤ 40 associated with almost 100% fall risk [7]
10 MWT: 10 Meter Walk Test	Patients with a time of < 0.4 m/s are more likely to be household ambulators 0.4- 0.8 m/s indicates limited community ambulation >0.8 m/s indicates community level ambulation [8]
5x Sit to Stand	< 10 seconds (identifies balance dysfunction) [5]
Modified Ashworth Scale	0= no increase in tone 1= slight increase in tone manifested by a catch and release or by minimal restsance at the end ROM when the affected art is moved through flexion or extension 1+= slight increase in muscle tone manifested by a catch, followed by minimal resistance throughout the remainder (less than half) the ROM 2= more marked increase in muscle tone through most ROM but affected part(s) are easily moved 3= considerable increase in passive muscle tone, movement is difficult 4= affected part(s) rigid in flexion or extension[9]
2 Minute Walk Test	Cut off scores not established [6]
MMT	MMT not suggested for patients with increased spasticity [10]

CLINICAL IMPRESSION 2:

The initial clinical impression of RH's case was confirmed upon further evaluation and examination. RH's dominant symptoms and complaints resulting from chronic stroke were increased spasticity, decreased ROM and strength, decreased ability to motor plan and decreased reaction time. This patient's decreased ROM and strength and increased spasticity led to postural abnormalities, decreased balance, and decreased functional mobility. Subsequently, the patient required the use of a QC and manual assistance during ambulation and transfers and was unable to complete activities of daily living without assistance. His decreased functional strength and mobility, as indicated by the 5xsit to stand test, 2 minute walk test and TUG, demonstrated that the patient was at a severe risk for falling and was limited in his community participation. RH continues to be a good candidate for this case report in order to enhance the body of knowledge surrounding BWSTT in conjunction with overground GT for patients with left sided hemiparesis following a middle cerebral infarct due to idiopathic malignant hypertension.

Prognosis: With intense BWSTT, overground GT, neuromuscular re-education, balance and strength training, RH had the potential for recovery of function of his hemiparetic side during gait. According to Mulroy et al, seven out of fifteen subjects were classified as high responders following a 6-week training regimen consisting of twelve BWSTT sessions alternated with twelve sessions of either lower-extremity resistive cycling; lower-extremity progressive, resistive strengthening, or a sham condition of arm ergometry. As a "high responder" the subject achieved an increase in gait speed of at least 0.08 m/s from pre to post examination.[11] Although this patient had good familial support from his wife, she had interfered with his recovery in the past by disregarding physical therapist's suggestions to allow the patient the opportunity for neuroplasticity in the home environment. RH's progress may be limited by the severity of his

stroke, a massive hemorrhagic stroke of the right middle cerebral artery due to malignant hypertension. RH's malignant hypertension was of relative unknown cause, however, he has been diagnosed and medically treated for high blood pressure since the stroke event.

Diagnosis: According to the Guide to PT Practice, RH is classified in Pattern 5D, as a patient with Impaired Motor Function and Sensory Integrity Associated With Nonprogressive Disorders of the Central Nervous System—Acquired in Adolescence or Adulthood.

Plan of Care: Interventions to promote experience-dependent neuroplasticity will include (but not be limited to) BWSTT, overground GT, neuromuscular re-education, balance and strength training. BWSTT will allow the patient the opportunity for repetition of steps, offer patient error augmentation, provide a safe environment during increased intensity of training, and allow the physical therapist (PT) free hands for biofeedback. Overground GT following BWSTT targets specificity of training under normal environmental conditions for the patient. Incorporation of neuromuscular re-education, balance and strength training will be used in order to initiate facilitation of RH's spatiotemporal awareness and bilateral coordination and strength.

Patient Goals: To be able to walk without a cane; improve his balance; not fall again

Therapist Goals for patient:

- Short Term Goals:
    - Patient will demonstrate increased functional strength indicated by a decrease of at least 5 seconds on the 5x sit<>stand test within 5 weeks of start of care (SOC).

- Patient will demonstrate a decrease of at least 3.5 seconds on TUG within 5 weeks SOC to demonstrate a decreased risk for falls.

- Long Term Goals:
  - Patient will ambulated as a limited community level ambulator without use of AD within 12 weeks of SOC.
  - Patient will demonstrate a score of at least 41/56 on Berg Balance Scale at discharge to demonstrate functional improvement of balance and decrease risk for falls.

Interventions:

Coordination, Communication, Documentation: Each treatment session was documented using electronic medical record and any changes in plan of care were noted and explained at time of change. Communication with patient's referring provider and other members of the healthcare team occurred within the electronic medical record (EMR). There was extensive coordination with other healthcare providers through the EMR system in order to provide excellent patient care and coordinate visits.

Patient/ Family Instruction: At initial examination, patient was educated on his current medical status and precautions during ambulation. RH was advised to complete all ADLs as independently as possible, as long as he felt safe to do so. Increasing his independence would allow him more opportunities to increase his mobility. RH was also educated on the impairments that he presented with at his initial locomotor examination and the prospective prognosis for his recovery. RH's wife was educated on the importance of allowing RH to try to perform ADLs on his own in order to promote self-care independence and reduce patient frustration and depression.

Procedural Interventions:

Following initial examination, RH was instructed in several procedural interventions in order to begin to increase his functional mobility:

	Week 1	Week 4	Week 7	Week 10	Week 12
Intervention:					
BWSTT	70% BWS; 2 sets of 5'; @ 0.6-0.8 MPH	50% BWS; 3 sets of 6'; @ 0.8- 1.1 MPH	40% BWS; 3 sets of 10'; 1.1- 1.3 MPH	25% BWS; 3 sets of 10'; 1.3- 1.5 MPH	15%BWS; 2 sets of 15'; 1.5- 2.5 MPH
Overground GT	No AD; with CGA, ModA x1 for balance & safety; self-selected pace	No AD; with CGA, ModA x1 for balance & safety; increased speed	No AD; with CGA; use of metronome & music for increased cadence	No AD; with supervision; use of metronome & music for increased cadence	No AD; with supervision
Neuromuscular Re-education (NMR)	Fit, skin checks, and ambulation with traditional AFO	Bioness L300 cuff with procedural interventions	Static balance; LE functional strengthening	Independent with FES device	Static and dynamic balance; perturbations; obstacle courses
Legend: Body Weight Supported (BWS); Miles Per Hour (MPH); Moderate Assistance (ModA); Lower Extremity (LE)					

BWSTT: RH was scheduled for BWSTT followed by overground gait training 5x/week for 12 weeks. Each BWSTT session lasted approximately thirty minutes of the locomotor training (LT) training session. Initially it was thought that RH would be in therapy for 8 weeks, but requested additional LT following medication adjustment. BWSTT began at 70% BWS ambulating for 10 minutes. Body weight supports was decreased and ambulation duration was increased according to patient tolerance. Upon discharge, patient able to complete approximately 40 minutes of ambulation with 15% BWS.

- BWSTT promotes experience-dependent neural plasticity.[12] BWSTT allows for an increased number of steps taken by the patient (repetition), allows for patient error augmentation, provides a safe environment during increased intensity, and allows the PT free hands for biofeedback, if necessary.

Error augmentation: Trial and error feedback during motor tasks occurs mainly in the cerebellum, leading to motor memory development and adaptations.[12] BWSTT allows for increased error augmentation under a controlled and safe environment. The use of an overhead harness controls the upright position of the patient, reduces fear of falling, and allows for manual assistance to cue stepping, hip extension in terminal stance, and knee extension mid-stance. (See Figure 2).

Overground GT: RH was scheduled to perform overground GT following each BWSTT session. BWSTT followed by overground gait training is thought to show improvement in neuroplasticity by targeting specificity of training and salience of task.[13] RH performed overground ambulation without the use of an assistive device with manual assistance from the physical therapist. The frequency, duration and intensity of overground GT varied each session.

- Overground GT promoted task salience and the patient's specific goals of wanting to be able to walk without an AD. At the JAHVA Locomotor Clinic, overground GT following BWSTT is often used in order to promote carryover of task from a forced environment.

Additional Interventions: In addition to BWSTT and overground GT 5x/week, RH attended therapy in the LT clinic 3x/week exclusively for neuromuscular re-education, balance and strength training. Interventions included (but not limited to) stair training, balance recovery

strategies, single leg balance, dual task with ambulation, dual task during static stance, perturbations with static stance and with ambulation, and backward and sidestep walking.

- A variety of balance and functional strengthening exercises were needed in order to increase RH's functional strength and mobility to prevent further decline. Balance exercises were performed to specifically target the patient's needs for preventing future falls.

OUTCOMES:

Upon final examination RH only met one out of four of the therapist set goals for discharge planning. However, the RH was able to meet his self-reported goals of walking without the use of an AD, self-evaluated improvement of balance, and no reported falls outside of therapy.

Outcomes		
	Initial Examination	**Final Examination**
Ambulation	Using QC with CGA	No AD, no supervision required
Stairs	Unable to perform	Able to perform reciprocal ascension and descension of 2 flights of stairs with supervision and handrail on right
Balance	Unable to perform SLS on left; poor dynamic bilateral stance	Poor SLS on left; good dynamic bilateral stance

Leisure/ Community	Unable to participate	Able to participate in slower paced environments without supervision; plays golf with VA facility every Friday

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Goals	
NOT MET	Patient will demonstrate increased functional strength indicated by a decrease of at least 5 seconds on the 5x sit<>stand test within 5 weeks SOC.
MET	Patient will demonstrate a decrease of at least 3.5 seconds on TUG within 5 weeks SOC to demonstrate a decreased risk for falls.
NOT MET	Patient will ambulated as a limited community level ambulator without use of AD within 12 weeks of SOC.
NOT MET	Patient will demonstrate a score of at least 41/56 on Berg Balance Scale at discharge to demonstrate functional improvement of

	balance and decrease risk for falls.

DISCUSSION:

Although RH made personal progress over the course of 12 weeks, he did not demonstrate significant clinical gains. Upon discharge, RH was still considered a fall risk, according to the TUG and Berg Balance Assessment. He was classified as a household ambulator, according to the 10 meter walk test, indicating difficulty and limited ambulation in the community. However, RH demonstrated decreased need for assistance during ambulation upon final examination. He also demonstrated increased gait speed, distance, and proper reactive balance control under perturbed situations, suggestive of improved functional strength, efficiency of gait, and balance. Importantly, RH was pleased with the progress that was made. Factors that may have positively influenced RH's outcome included the therapy provided, changes in medication (including increased in dosages of baclofen and implantation of baclofen pump), use of FES instead of traditional AFO, and consistent emotional support. Factors that may have negatively influenced RH's outcome included setback with medication dose changes, excessive familial contact, and development of depression.

BWSTT as an intervention specifically for a young chronic stroke patient following a right middle cerebral hemorrhagic infarct due to malignant hypertension has little representation in medical literature. However, with the clinical experience and guidance provided in the locomotor clinic, intense locomotor training using a Therastride Body Weight Supportive Treadmill

combined with overground GT and other interventions was chosen for RH. Literature supports the use of BWSTT and/or traditional GT for rehabilitation of patients following a stroke.[13] The current body of evidence is also mixed, just as in RH's case, of the effectiveness of BWSTT as an intervention in varying stages of recovery for patient's following a stroke. This is most likely due to the heterogeneous population of patients studied for interventions following stroke. Perhaps if a homogenous population of patients were studied, very different outcomes would result.

Opportunities exist for conducting clinical trials utilizing BWSTT as an intervention for patient populations with similar severity of strokes and symptoms. Most publications offer a variety of information regarding acute, sub-acute and chronic patients with a wide range of function at baseline. It would also be viable and useful to publish further case reports on BWSTT for patients experiencing chronic stroke symptoms of various origins. It would be warranted to examine and study the patient's quality of life with an outcome assessment in order to obtain more objective data for improvement of quality of life following stroke rehabilitation.

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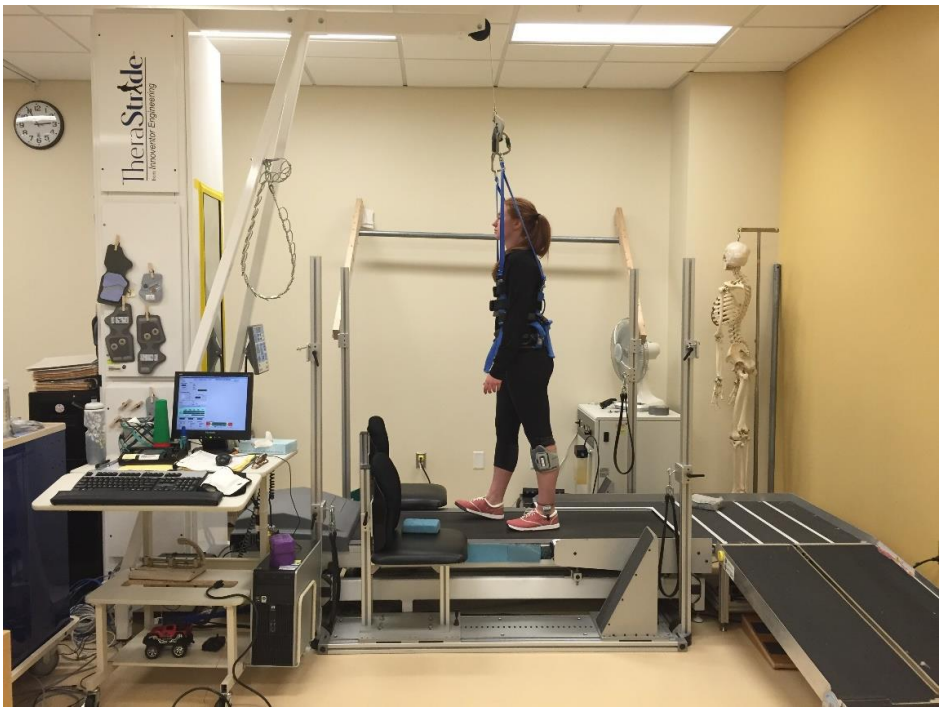
TABLES, FIGURES, APPENDICES:

Figure 1

Figure 2


TheraStride
from Innoventor Engineering