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Case Report

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Stroke Rehabilitation for a Patient with Substance Use and Psychiatric Disorders: A Case Report

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Abstract

Background and Purpose: The abuse of and addiction to opioids are serious global health problems. Strokes contribute to the disability and morbidity associated with drug abuse. There is also a high prevalence of comorbidity between Substance Use Disorders (SUD) and mental illnesses. The purpose of this case report is to outline Physical Therapy (PT) rehabilitation that utilized task-oriented and Gait Training (GT) in an Inpatient Rehabilitation Facility (IRF) to address gait and functional mobility in a patient post-stroke with both SUD and psychiatric disorders.

Case Description: The patient was a 56-year-old male admitted to an IRF for interdisciplinary care following a right frontal lobe middle cerebral artery stroke with a past medical history of SUD and psychiatric disorders.

Intervention: His PT plan of care focused on evaluation and treatment of his impaired strength and functional mobility with task-oriented and GT over a three-week timeframe.

Outcomes: The patient demonstrated improvements in Lower Extremity (LE) gross strength (3-/5 [fair minus] to 4/5 [good]), functional mobility (maximum assistance to supervision), gait pattern (increased cadence and step length), balance (poor to good), and Functional Independence Measure (FIM) scores (maximum assistance to supervision).

Discussion: Following a task-oriented approach and GT, the patient demonstrated improved LE strength, balance, functional mobility, ambulation, and FIM scores, which translated to increased independence and access to his environment. Future research is needed to address PT management of patients with stroke combined with SUD and psychiatric disorders.

Keywords: Psychiatric Disorder; Physical Therapy; Stroke; Substance Use Disorder

Introduction

Substance abuse, which includes alcohol, nicotine and illicit drugs, is a major public health concern. Illicit drug use includes the abuse of illegal substances such as cocaine and methamphetamine, and/or the misuse of prescription drugs and household substances. The abuse of and addiction to illicit opiate drugs such as heroin, and prescription opioids such as morphine, fentanyl, oxycodone and other pain relievers, are serious global health problems that affect the social and economic well-being of all societies [1]. In 2014 an estimated 1.9 million people in the U.S. had Substance Use Disorders (SUD) involving prescription pain relievers and an estimated 435,000 people were regular users of heroin in the past month, with the resulting consequences on the rise.[1,2] Drug abuse has been increasing among individuals between age 50-64, in part, due to the aging of the baby boomers whose rates of illicit drug use have been more than those of previous generations [2].

A separate health concern, stroke, occurs when blood is unable to flow adequately to the brain. Also known as Cerebral Vascular Accidents (CVA), strokes are the leading cause of adult disability, and the fifth leading cause of death in the United

States (US) [3]. Each year, 800,000 people experience a new or recurrent stroke [3]. Impairments in gait and functional mobility can occur as a result of a stroke, and improving gait and functional mobility is a common goal among patients with stroke undergoing rehabilitation, specifically Physical Therapy (PT).

Strokes contribute to the disability and morbidity associated with drug abuse.[4] Drug abusers have a 6.5 times increased risk of stroke, and drug abuse is a frequent cause of stroke in areas with a high prevalence of the problem [4]. The risk is higher for individuals who abuse drugs and currently have known risk factors for stroke such as high blood pressure, diabetes, heart disease, smoking, increasing age, and male gender [4]. There is also a high prevalence of comorbidity between SUD and mental illness [1]. Psychiatric disorders include a wide range of mental illness disorders that affect mood, thinking, and behavior [5]. In 2015, there were an estimated 10 million U.S. adults who suffered from a serious mental illness [5]. Individuals diagnosed with mental illness disorders are approximately twice as likely to suffer from a SUD [1].

Inpatient Rehabilitation Facilities (IRF) provide hospital-level 24-hour-a-day interdisciplinary care to patients who need intense rehabilitation of at least three hours daily, five days weekly [6]. There is strong evidence that interprofessional stroke care in an IRF not only reduces mortality rates and disability, but also enhances recovery and increases independence in activities of daily living (ADL's) [6]. Patients who have received >three hours of therapy have been shown to make significantly more functional gains than those receiving less [6]. Many techniques for improving functional mobility and gait in patients with stroke have been researched and shown to be effective such as task-oriented training and GT [7-10]. The purpose of this case report is to outline PT rehabilitation to address gait and functional mobility in a patient following a stroke with a history of both SUD and psychiatric disorders. With the catastrophic rise in substance abuse globally, and the correlation with stroke incidence, physical therapists are now more likely to see this clinical correlate in their patient caseloads.

Case Description

The patient provided written consent to participate in this case report. The patient was a 56-year-old African American male referred to the IRF following a right frontal lobe Middle Cerebral Artery (MCA) stroke with minimal involvement of the right parietal lobe. The patient's main concern, and primary symptom, was a complaint of left-sided weakness for approximately two days prior to seeking medical attention.

In addition to his stroke, the patient had a Past Medical History (PMH) of bipolar disorder, schizoaffective disorder, opioid use disorder, tobacco and marijuana use, Crohn's disease, hypertension, gout present in both wrists, and trigger finger in the right hand. He required extensive pharmaceutical interventions to address his multiple diagnoses and SUD (see the medication list in Appendix 1). The patient had a paternal family history of diabetes. The patient reported that he had been drug free for one year preceding his stroke, but relapsed one day prior to his stroke. His personal history of tobacco and drug use, and male gender, likely elevated his risk for incidence of stroke. The patient received secondary education through the 10th grade. He previously worked in retail, but was on short-term disability at the time of Initial Evaluation (IE). The patient was divorced, but he lived with his supportive, significant other at the time of admission. He lived on the second floor of an apartment with 16 stairs to enter. Prior to his stroke, he regularly participated in Physical Exercise (PE) including gym-based weight lifting. The patient had not received any prior physical rehabilitation interventions. He had, and was actively receiving, case management from a life counselor who was present at the facility during his admissions.

After a one-week acute care hospital stay, he was admitted to the comprehensive multidisciplinary IRF to evaluate and treat his impaired strength and functional mobility. The PT IE was completed one day following his admission. The patient presented with left hemiparesis, and impaired gait, transfers, bed mobility, balance, sensation, and speech. The patient also presented with lethargy and impaired cognition during the IE. The patient was evaluated by OT for his Left Upper Extremity (LUE) function and SLT for his speech, swallowing, and cognition. The systems review revealed unremarkable findings of the cardiopulmonary and integumentary systems. Right UE and LE strength were Within Functional Limits (WFL). LUE gross strength was 1/5 and LLE gross strength was 3/5. Static sitting balance was good, dynamic sitting balance was fair. Static standing balance was poor, dynamic standing balance was poor. He presented with partial sensation deficits of the LLE. He also presented with dysarthria Please see Appendix 2 for initial presentation during Systems Review. Tests and measures were performed to obtain objective data (Table 1).

Tests & Measures	IE Results	Discharge	Psychometric Properties
Functional Independence Measure Scale (FIM)	Bed/Chair/ Wheelchair-Transfers: 1/7 Walking Assist: 1/7 (Handrail) Stairs: 0/7	Bed/Chair/ Wheelchair-Transfers: 5/7 Walking Assist: 5/7 (Straight cane) Stairs: 5/7	Represents the activity domain of the ICF model [11]. Minimally Clinically Important Difference = FIM Total Score: 22 points, Motor Subscale: 17 points [12]. Excellent test-retest reliability [13]. High concurrent validity and responsiveness [14].
Numeric Pain Scale (NPS) (0-10)	Left Hip 4/10 (Pain from fall one week prior to admission)	0/10	Good validity and responsiveness.
Timed Up and Go (TUG)	17s with small base quad cane (below average)	14.7s with straight cane (below average)	Represents the activity domain of the ICF model [11]. Excellent test-retest reliability [15].
5x Sit to Stand (5xSTS)	Not able to be performed	22.2s (below average)	Excellent test-retest reliability, excellent interrater and intrarater reliability, and excellent validity [16].
IE: Initial Evaluation; ICF: International Classification of Functioning, Disability, and Health			

Table 1: Results of Tests & Measures with Psychometric Properties.

The FIM was administered to assess his functional mobility and independence (see FIM levels in Appendix 3). Due to safety concerns regarding the patient's impaired gait and balance, the TUG was performed to assess the patient's mobility, balance, walking ability, and fall risk one week after the IE. The five times sit to stand test (5xSTS) was used to assess functional lower limb muscle strength at discharge [16]. The Numeric Pain Scale (NPS) was used to assess the patient's pain level at IE [17]. Examination and evaluations tools including standardized functional outcome measures were chosen based on standards of care as described by the Guidelines for Adult Stroke Rehabilitation and Recovery from the American Heart Association and American Stroke Association [6]. See (Table 1) for descriptions and psychometric properties of the tests and measures.

The patient's primary medical diagnosis was ICD-10 code I63.511, cerebral infarction due to unspecified occlusion or stenosis of right middle cerebral artery. The primary PT diagnoses were ICD-10 code I69.354, hemiplegia and hemiparesis following cerebral infarction affecting left non-dominant side, and ICD-10 code R26.9, unspecified abnormalities of gait and mobility. Diagnostic methods for this patient included a Physical Exam (PE), functional outcome measures, MRI imaging, CT scan, telemetry monitoring, transesophageal echocardiogram, and X-ray. The timeline of the patient's course of care. Possible differential diagnoses to be assessed were left hip fracture due to complaints of left hip pain after a fall one week prior to admission, and the patient's fluctuating motor status. It was also unknown if the patient's fluctuating motor and mental status, and lethargy were due to medications, a recurrent stroke, or a Transient Ischemic Attack (TIA). The patient was re-evaluated via MRI imaging for a TIA or recurrent stroke due to symptoms of progressive weakness and numbness of the UE during week 2. Results of the MRI were negative.

The patient's significant PMH of psychiatric disorders and SUD, including tobacco use, presented a potential barrier for his PT participation, prognosis and recovery. Other potential barriers to recovery included fluctuating motor status, lethargy and poor motor control. However, considering his young age, motivation, and high Prior Level of Function (PLF), he was expected to have a good functional outcome with PT [18]. The most significant barrier for daily PT was the patient's medication schedule and his response. After administration of his morning medications, in particular Suboxone, he presented very lethargic with fluctuating motor status and alertness, which significantly decreased his ability to participate in PT. The patient's struggle with smoking cessation throughout his stay, for which he was also medicated, was challenging for him to overcome during his recovery.

Intervention

The types of physical therapy interventions administered included patient and family education and procedural interventions with an emphasis on physical activity. Patient education occurred daily with each treatment session. Topics included education on the patient's diagnosis, activity limitations, participation restrictions, interventions, equipment, and safety considerations. Family training regarding safety and assistance with ADL's and functional mobility at home occurred during the patient's discharge planning meeting. PT procedural interventions focused on task-oriented training for bed mobility, transfers, and ambulation. Interventions also included therapeutic exercise, therapeutic activities, neuromuscular re-education, balance training, stair training, and community re-entry. A summary of procedural interventions can be found in (Table 2).

Weeks/ Visits	Therapeutic Exercise	Therapeutic Activity	Patient Education	Gait	Neuromuscular Re-education	Community Re-entry	Equipment
Week 1 (Visits 1-8)	PRE'sAAROM Step-ups (4-6")	Bed Mobility Transfers	Diagnosis Plan of Care	Pre-gait activities GT with L AFO	FES	Outdoor ambulation on uneven surfaces; curbs; ramp; car transfer	HW SBQC L AFO
Week 2 (Visits 9-12)	Step-ups (6") PRE's	Transfers ↑/↓ Stairs x10	Safety Fall risk	Pre-gait activities GT			SBQC
Week 3 (Visits 13-19)	Step-ups/downs (6") PRE's PROM	Bed Mobility Transfers ↑/↓ Stairs x 18	DC to home Safety Fitness	GT	Standing balance: SLS		Straight Cane
Min A= minimal assistance, Mod A = moderate assistance, AAROM= Active-assist range of motion, PROM=Passive range of motion, AFO= ankle-foot orthosis, FES=functional electrical stimulation, μs= micro seconds, Hz= hertz, mA= milliamps							

Table 2: Procedural PT Interventions.

Therapeutic exercise included Lower Extremity (LE) strengthening, Range of Motion (ROM) exercises, and pre-gait activities to increase strength and control of the LLE (see Appendix 7). Resistance training has been shown to be an effective intervention to improve strength for patients with hemiparesis in order for them to be able to perform functional activities [19]. Therapeutic activities included task-oriented training for bed mobility and transfers. Studies on task-oriented training have found it may improve functional mobility, ADL performance, balance, and self-efficacy in patients with stroke [9,10]. Neuromuscular re-education included balance exercises to improve the patient's body awareness and stability in order to improve mobility and safety and decrease fall risk. To improve the patient's gait pattern, pre-gait exercises were performed including weight-shifting exercises and stepping strategies (see Appendix 6. Previous studies have shown that weight-shift training can improve overall gait pattern and speed [7]. Tactile facilitations, including stroking and tapping the involved musculature, and pre-gait exercises were incorporated to facilitate the hemiparetic LE. The patient responded well to tactile facilitation and demonstrated improved active movement of the LLE. Research has also shown that Repetitive Facilitation Exercises (RFE) can improve LE motor performance and functional ambulation [8].

GT was initially performed using Functional Electrical Stimulation (FES) with use of the Bioness L300™ (Bioness Inc., Valencia, CA) with leg strap on the anterior tibialis to facilitate dorsiflexion during ambulation (see Appendix 5). Early FES on the paretic LE has been shown to improve walking ability and performance of ADL's in patients following strokes [20]. This patient was also fitted for a left Allard Toe-OFF® AFO (Allard USA Inc., Rockaway, NJ) to assist with dorsiflexion during ambulation (see Appendix 5. He demonstrated an improved gait pattern with the use of the AFO. AFO's have been shown to improve weight bearing through the affected side and improve gait [21,22]. Initially, the patient ambulated with handrail use in the hallway and maximum assistance from two therapists. The patient progressed quickly and within two therapy sessions the FES was discontinued, as he was able to actively dorsiflex the left ankle. The AFO was also discontinued after one week due to improved dorsiflexion strength and gait pattern. He was then progressed to ambulation with a Small Base Quad Cane (SBQC), and again to ambulation with a straight cane as he demonstrated improved strength and gait pattern.

During the patient's three-week length of stay, he received therapy at least five days a week for a minimum of three hours per day, including PT, OT, and SLT. Early interventions focused on functional mobility and facilitation of movement of the hemiparetic left side [6]. The interventions were progressed as the patient demonstrated increased strength, balance, coordination, and endurance. Initially, PT sessions were limited due to the patient's lethargic state; but as the patient progressed, he became more alert and willing to participate. Treatment sessions became less restricted and longer, and the patient was able to tolerate full one-hour therapy sessions in the afternoon. During the typical 30-minute morning treatment sessions, the patient was difficult to arouse and remain alert, while in the afternoon he presented with an improved motor status and alertness. The patient's tolerability was assessed during PT interventions using the Perceived Rating of Exertion (PRE) scale, NPS, and vital signs.

Outcomes

Following three weeks of intense, skilled PT in an IRF with an emphasis on task-oriented and GT, the patient demonstrated improved LE strength (3-/5 [fair minus] to 4/5 [good]), dynamic

standing balance (poor to good), functional mobility (maximum assistance to supervision), and gait (increased cadence and step length), which translated to increased independence and access to his environment. The patient's long-term goals were met at discharge as seen in Appendix 4. Due to the supervision required for ADL's and functional mobility, he was discharged to a skilled nursing facility to further maximize his mobility and independence. The patient's follow-up tests and outcomes can be seen in (Table 1). The patient was highly motivated and cooperative during therapy sessions. The most significant unanticipated barrier for daily PT was the patient's medication schedule and his response to medications. There were no adverse events reported.

Discussion

Some of the strengths of the approach used that may have benefited the patient's outcome included the adaptation of the PT schedule, and the interventions administered including the prescription of a PE program. The patient was also very motivated to reach his goals and had a high PLF, which may have also contributed to his rapid progress in PT. Potential limitations to this approach that may have negatively impacted his outcomes included his fluctuating motor status, PMH, and SUD. The patient struggled with overcoming smoking cessation and drug addiction during his time in the IRF, which may have also further affected his progress in PT due to the mental and physical side effects of his addictions. Reactions to his multiple medications were also an issue. The revised scheduling pattern to accommodate his medications increased the patient's participation in PT, and may have had an impact on the patient's positive outcomes. Although the altered PT schedule increased his participation in PT in the afternoon, the patient's lack of participation in the morning may have hindered his progress. Had the treatment schedule been adjusted earlier in his treatment plan, the patient may have made more progress. Given the multiple medications he required and his co-morbidities, the patient's progress may have been hindered due to decreased participation and lethargy. With the rise in substance abuse, and the correlation with stroke incidence, physical therapists are now likely to see this clinical presentation in their patient caseloads. With a high motivation to find alternative treatments for SUD, physical therapists across the nation have started to take initiative towards this issue.

The purpose of this case report was to outline PT rehabilitation for a patient following a stroke with a history of both SUD and psychiatric disorders, and to help address a gap in the literature pertaining to this challenging patient population. There have been limited studies aimed towards this challenging population of patients with concurrent medical conditions and SUD regarding the therapeutic effects of exercise and PT. However, recent studies have suggested that PE may have positive effects when treating persons with SUD [23,24]. A meta-analysis by Wang, Wang, Wang, Li and Zhou [23] concluded there was strong evidence that PE may increase the abstinence rate, reduce withdrawal symptoms, and decrease symptoms of anxiety and depression in persons with SUD, with the effects on illicit drug abusers significantly greater than on abusers of other substances. The authors concluded that aerobic exercises of moderate and high-intensity, along with mind-body exercises, may be an effective and persistent treatment for persons with SUD [23]. A systematic review on exercise and physical activity in the management of SUD by Zschucke, Heinz and Strohle [24] found strong evidence for the efficacy of PE in smoking cessation, but weak evidence in alcohol and illicit drug abuse due to insufficient generalizability and poor methodology. They did, however, provide several possible mechanisms of potential benefit for patients with SUD including neurochemical alterations by PE; reduction in acute craving; endogenous reward; mood regulation; reduction of anxiety and depressive symptoms; stress reactivity; group activity and support; improved coping mechanisms; and improved self-efficacy [24]. As this patient struggled with multiple substance addictions and co-morbidities, the addition of a clinically prescribed PE program as part of his POC appears to have been well supported in the literature.

Future research is needed to more closely examine particular mechanisms of action of PE in SUD, what are the ideal settings for and dosages of PE, and how do we best motivate persons with SUD to adhere to PE [24]. Future research is also needed to address the outcomes of PT in patients with stroke combined with SUD and/or psychiatric disorders and the effectiveness of PE as a potential treatment strategy for this population. The opioid crisis is the largest drug epidemic in recorded history, and strokes contribute to the disability and morbidity associated with drug abuse [2,25]. As 600,000 drug overdose deaths have occurred in the US between 2000-2016, with death rates from opioids five times higher in 2016 than in 1999, the mortality component of this crisis has also become a sad reality [25]. Initiatives geared towards adequate pain management and support of individuals with SUD may help change the ominous landscape for this challenging patient population.

In response to this national health crisis, the Centers for Disease Control and Prevention (CDC) released a set of guidelines in 2016, and advocated for health care providers to reduce the use of opioids in favor of safer alternatives like PT [26]. The APTA (American Physical Therapy Association) has launched a national public awareness campaign about the safety and effectiveness of PT for pain management. APTA's #ChoosePT campaign raises awareness about the dangers of prescription opioids, and encourages consumers and prescribers to follow guidelines by the CDC [27]. PT is a safe and effective alternative to opioids and should be considered first-line therapy for individuals in need of chronic pain management [27].

This case report illustrates a complex clinical scenario not previously documented in the literature. Following intense, skilled PT in an IRF, the patient demonstrated improved LE strength, balance, functional mobility, ambulation, and FIM scores, translating to increased independence and access to his environment. The patient progressed quickly, and was able to meet his short-term and long-term goals. This POC appeared to be beneficial for this particular patient, and although we cannot extrapolate these findings to other patient populations, other clinicians may benefit from this case study when considering patients who present with multiple diagnoses including SUD.

Appendices

Appendix 1: Medications.

Medication at time of Initial Evaluation	Dosage	Route	Frequency	Indication
Allopurinol (Zyloprim)	100 mg	Oral	Daily	Gout
Aspirin	81 mg	Oral	Daily	Anti-inflammatory/ Anti-coagulant
Atorvastatin (Lipitor)	80 mg	Oral	At bedtime	Hyperlipidemia
Benztropine (Cogentin)	1 mg	Oral	BID	Anti-psychotic
Buprenorphine-Naloxone (Suboxone)	2 tablets	Sublingual	Daily	Opiate Addiction
Divalproex (Depakote ER)	1,000 mg	Oral	At bedtime	Bipolar disorder
Heparin Injection	5,000 units	Subcutaneous	Q12H SCH	Anti-coagulant
Mesalamine (Delzicol)	800 mg	Oral	TID	Chrohn's Disease
Nicotine (Nicoderm CQ)	1 patch	Transdermal	Daily	Smoking Cessation
Risperidone (Risperdal)	2 mg	Oral	At bedtime	Anti-psychotic
Acetaminophen (Tylenol)	650 mg	Oral	Q6H PRN	Anti-inflammatory
Alum + Mag Hydroxide- Simeth (Maalox/ Mylanta)	n/a	Oral	n/a	Antacid
Hydroxyzine (Atarax)	10 mg	Oral	TID	Antihistamine

Appendix 2: Systems Review.

	Initial	Discharge
Strength[a]	Left Lower Extremity (LLE): Hip Flexion: 3-/5 Knee Extension: 3-/5 Knee Flexion: 3-/5 Dorsiflexion (DF): 2+/5 Plantarflexion (PF): 3-/5	LLE: Hip Flexion: 3+/5 Knee Extension: 3+/5 Knee Flexion:4/5 DF: 4/5 PF: 4/5
Range of Motion (ROM)	Decreased L knee extension	Decreased L knee extension
Sensation	Partial deficits	Intact
Balance	Balance: Impaired Sitting: Static-Good Dynamic- Fair Standing: Static- Poor Dynamic- Poor	Double leg: Good Single leg: Fair Dynamic standing balance: Good
Transfers	Sit to stand: Mod to Max A x 2 Stand to Sit: Mod to Max A x 2 Squat Pivot: Mod to Max A x 2 (Patient required blocking of the L knee for all transfers.)	Supervision

Gait	Impaired Decreased stance time on the LLE, decreased step length, cadence Swing to pattern 10 feet in the hallway holding onto the handrail for assistance Required moderate to max A x 2 Required blocking of the L knee.	Supervision with straight cane Decreased stance time on LLE Swing through pattern 600+ ft
L=left, Mod A= maximum assistance, Max A= maximum assistance, x2= assistance of two therapists, [a]: 1=trace 2=poor 3=fair 4=good 5=normal		

Appendix 3: Functional Independence Measure (FIM) Levels.

Score	Category
7	Complete Independence (Timely, safely)
6	Modified Independence (Device)
5	Supervision (Patient completes 100%)
4	Minimum Assistance (Patient completes 75% or more)
3	Moderate Assistance (Patient completes 50%-74% or more)
2	Maximal Assistance (Patient completes 25%-49% or more)
1	Total Assistance (Patient completes less than 25%)

Appendix 4: Short-term and Long-term Goals.

GOALS:				
Problem List	Short-Term Goals (STG) Time: 1 Week	Long-Term Goals (LTG) Time: 2 Weeks	At Discharge:	
Bed Mobility:				
	Rolling to Right	Min A x1 with use of bed rail	CGA x1	Achieved
	Rolling to Left	Min A x1 with use of bed rail	CGA x1	Achieved
	Supine to Sit	Min A x1	CGA x1	Achieved
	Sit to Supine	Min A x1	CGA x1	Achieved
Transfers:				
	Sit to Stand	Min A x1	CGA x1	Achieved
	Stand to Sit	Min A x1	CGA x1	Achieved
	Transfer Bed to Chair	Min A x1	CGA x1	Achieved
	Transfer Chair to Bed	Min x1	CGA x1	Achieved
Gait:				
	Ambulation (Distance and Device)	Min A x1 50 ft with Hemi-walker	CGA x1 150 ft with Hemi-walker	Achieved
Stairs:				
	Stairs (Number of Stairs and Rails)	Min A x1 Ascend and descend 4 stairs with 2 rails	CGA x1 Ascend and descend 12 stairs with 1 rail	Achieved
Community Reintegration:				

	Community Re-entry	To be able to navigate uneven surfaces, curbs, ramps, and car transfer with min a x1.	To be able to navigate uneven surfaces, curbs, ramps, and car transfer with CGA x1.	Achieved
Strength and Endurance:				
	Decreased Strength and Endurance	To be able to perform therapeutic exercise 1 set of 20 reps each. (Hip flexion, knee flexion, knee extension, DF, and PF)	To be independent with HEP including the therapeutic exercises listed in the STG section for 3 sets of 20 reps each.	Achieved
Min A= minimum assistance, X1=Assistance of one, CGA= contact guard assistance, ft= feet, DF= dorsiflexion, PF= plantarflexion, HEP= home exercise program				

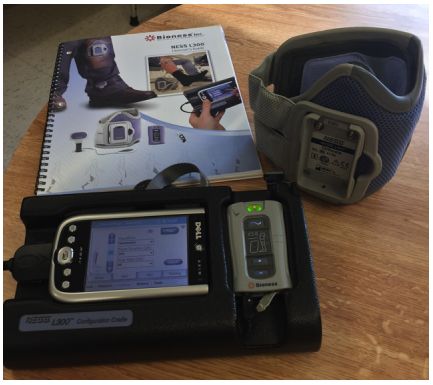
Appendix 5: Device Use to Assist with Dorsiflexion during Ambulation.

A. 

B. 

C. 

D. 

E. 

A-D: Allard Toe-OFF® left Ankle Foot Orthosis to assist with dorsiflexion during ambulation. A: Medial view B: Anterior view C: Posterior view D: Lateral view E: Bioness L300™ electrical stimulation with left anterior tibialis leg strap to facilitate dorsiflexion during ambulation.

Appendix 6: Strengthening and Pre-gait Exercises.

A. 
B. 
C. 
D. 

A-B: Single leg step ups A: Concentric single-leg step up on 6 in box to strengthen LLE. B: Eccentric single-leg step up on 6 in box to strengthen LLE. C-D: Pre-gait activities including weight shift and stepping exercises to improve ambulation. C: Weight shifting exercise D: Stepping exercise

Appendix 7: Therapeutic Exercise: Supine Straight Leg Hamstring Stretch.

Passive range of motion (PROM) hamstring stretch to improve terminal knee extension.

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