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Proprioceptive Neuromuscular Facilitation And Overground Gait Training For A Patient Following A Left Central Medullary Stroke: A Case Report

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The patient signed an informed consent form allowing the use of medical information for the case report. She was informed on the institution's policies regarding the Health Insurance Portability and Accountability Act (HIPAA).

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Key Words: Proprioceptive Neuromuscular Facilitation, Overground Gait Training, Left Central Medullary Stroke

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ABSTRACT

Background and Purpose: Central medullary stroke is a rare type of stroke that is characterized by contralateral hemiplegia sparing the face, contralateral loss of deep sensation, and ipsilateral hypoglossal paralysis. It makes up a small percentage of the types of strokes that affect nearly 795,000 Americans every year. While there has been extensive research on rehabilitation principles for the general treatment of stroke, there has been little research on rehabilitation for patients following a central medullary stroke. The purpose of this case report was to describe a multifaceted intervention program with the emphasis on proprioceptive neuromuscular facilitation (PNF) and overground gait training (OGT) for a patient following a left central medullary stroke.

Case Description: The patient was a 71-year-old female who received daily physical therapy (PT) for six weeks at an inpatient rehabilitation facility. The interventions included coordination, balance, gait, and functional mobility, with focus on PNF and OGT. Her progress was tracked using the Function in Sitting Test (FIST), Barthel Index (BI), and the Encompass Health Rehabilitation Functional Skills Assessment (EHRFSA).

Outcomes: The patient experienced significant improvement in all three outcome measures. Her score for the FIST improved from 29/56 to 56/56, while her score on the BI improved from 45/100 to 70/100. On her initial examination the patient was dependent for all aspects of mobility, but at discharge required only minimum/no assistance.

Discussion: Interventions such as PNF, OGT, and functional mobility exercises may have been beneficial for this patient in regard to the improvement in gait and decreased need for assistance.

More research on PNF and OGT, along with other beneficial interventions for patients with central medullary stroke is warranted.

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BACKGROUND AND PURPOSE

A cerebrovascular accident (CVA), or more commonly known as a stroke, is caused by blockage of blood flow to the brain (ischemic stroke) or when a blood vessel in the brain bursts (hemorrhagic stroke).[1] Approximately 795,000 Americans experience a stroke every year and it is the leading cause of long-term disability.[1] Strokes are also responsible for more than 130,000 deaths in the United States every year.[1]

The severity, size, and location of the stroke can be a big predictor in a patient's prognosis. Depending on the location of the stroke, a person can have different impairments. If a stroke occurs on the left (L) side of the brain, a person can experience paralysis on the right (R) side of their body, speech or language problems, short-term memory impairments, and are often hyper-aware of their deficits.[2] If a stroke occurs on the R side of the brain, a person can experience paralysis on the L side of their body, vision problems, memory loss, and impulsive behavior.[2]

Central medullary stroke, also known as Dejerine syndrome, is a rare type of stroke (less than 1% of ischemic strokes) that is characterized by three symptoms: contralateral hemiplegia sparing the face, contralateral loss of deep sensation, and ipsilateral hypoglossal paralysis.[3,4] This stroke affects the medullary pyramid, which is supplied by the vertebral arteries (upper third of medullary pyramid) and the anterior spinal artery (lower two thirds of medullary pyramid). Prognosis is usually good if the lesion occurs at the upper third of the medullary pyramid, as hypoglossal paralysis is commonly absent.[5] However, if the lesion occurs at the lower two thirds

of the medullary pyramid, prognosis is poor due to respiratory weakness.[5] Risk factors for this type of stroke include hypertension, diabetes, hyperlipidemia, cigarette smoking, and atrial fibrillation.[6]

Regardless of the location, people who have strokes often have balance and gait impairments, which can increase their chance of falling and limits their ability to participate independently in activities of daily living (ADLs).

Physical therapy (PT) can be effective at improving mobility in patients who have had a stroke, especially PT at an inpatient rehabilitation facility (IRF). In a study of 222 patients who experienced a stroke, Chan et al[7] found that patients who went to an IRF scored eight points higher on the Activity Measure for Post-Acute Care (AM-PAC), a test that measures a patient's functional abilities, in comparison to patients who went to a skilled nursing facility (SNF) or received home health or outpatient therapy. This is significant because individuals with higher AM-PAC scores are at a lower risk of being readmitted to the hospital.

There are several areas of dysfunction that a physical therapist can address, such as deficits in balance, motor control, strength, gait, and range of motion. One of the PT treatment plans used to address these deficits is proprioceptive neuromuscular facilitation (PNF). PNF can be done in order to increase range of motion (ROM) and increase muscular strength and power.[8] In 2019, a case report by Alagappan[9] looked at the effects of PNF on balance and gait of a patient with hemiparesis. The patient performed PNF patterns for his upper limb, lower limb, and trunk. After treatment, he had improvements in his Berg Balance Score (BBS), weight bearing symmetry, functional ambulation category, and Fugle-Meyer scale (lower extremity component), indicating that PNF might be a useful treatment option to improve balance and gait in patients who have had a stroke.

Overground gait training (OGT) can also be beneficial in increasing a person's functional mobility and independence following a stroke. According to States et al, [10 (p.627)] overground gait training was defined as "a physical therapist's observation and cueing of a patient's walking pattern along with related exercises but does not include high-technology aids such as electrical stimulation or body weight support." Although there was some clinical support for the use of body weight supported treadmill training (BWSTT) for patients who have had a stroke, a randomized controlled trial by Lura et al[11] found that OGT and BWSTT garnered similar results in acute stroke gait rehabilitation. Both groups resulted in an average increase of their Functional Independence Measure (FIM) by 3.4, indicating a positive change in patient status in response to treatment and also indicates a decrease in disability. One of the only significant differences was that gait speed increased in the OGT group. This is promising as OGT may be a viable treatment option for patients following a stroke, especially if the therapy facility does not have the funds to afford a BWSTT device.

There have been several studies that have looked at the benefits of OGT in stroke rehabilitation, but there was limited research regarding the use of a combination of both OGT and PNF, especially for patients with the diagnosis of L central medullary stroke. The purpose of this article was to describe the use of PNF and OGT in an inpatient rehabilitation setting for a 71-year-old female following a L central medullary stroke.

PATIENT HISTORY AND SYSTEMS REVIEW

The patient provided written informed consent to participate in this case report. She was a 71-year-old Caucasian female who experienced a CVA. Her magnetic resonance angiogram (MRA) indicated that she had a L central medullary stroke. She scored a 14 on the National Institutes of Health Stroke Scale (NIHSS). This scale ranges from 0-42, with a higher score

indicating greater severity, so the patient's score indicated she had a moderately severe stroke.[12] Her past medical history included type II diabetes, hypertension, Graves' disease, and hyperthyroidism. See Table 1 for a full medication list. She was retired and lived in a one level home with her daughter since her husband had recently passed away. The patient's main impairments were R sided weakness, poor activity tolerance, and deficits in gait, which were affecting her long-term goal of returning home with as little assistance as necessary. She had notable deficits in multiple systems; refer to Table 2 for a full systems review. She did not have any family history of stroke, nor had she had any previous interventions regarding her current condition. From the patient's perspective, she did not have extensive knowledge of her condition, but she was motivated to return home. She was receptive to her medical team's guidance and recommendations and adhered to her plan of care (POC). Her primary problem was mobility deficits due to R sided weakness. There were no other potential differential diagnoses that needed to be addressed, as her deficits were consistent with her medical diagnosis of L central medullary CVA. The plan for examination included the Function in Sitting Test (FIST), the Encompass Health Rehabilitation Hospital Functional Abilities Scale, and the Barthel Index, in addition to gross strength and sensation testing. This patient was a good candidate for a case report because she had good potential of making progress with skilled therapy using PNF and OGT as primary interventions. Due to the lack of research involving patients who have had a central medullary stroke, the implications of this case report could guide future research about this type of CVA.

EXAMINATION: TESTS AND MEASURES

The FIST was used to assesses the patient's sitting balance. See Appendix 1. This 14-item test was designed for patients who are non-ambulatory at the time and have challenges with

maintaining their sitting balance.[13] The Barthel Index has been shown to be a reliable and valid measure that evaluates a patient's independence with activities of daily living (ADLs), as well as measure a patient's rehabilitation potential. [14-16] See Appendix 2. The Encompass Health Rehabilitation Functional Abilities Scale was also performed. This was a mandatory assessment tool administered on all patients admitted to this IRF. It was used for billing purposes, writing PT goals, and for comparing patient outcomes from initial treatment to discharge. See Appendix 3.

The patient's gross strength was tested in her R and L lower extremities (LE). Sensation testing included light touch, proprioception, deep pressure, and localization. Refer to Table 3 for all tests and measures, including psychometric properties.

CLINICAL IMPRESSION: EVALUATION, DIAGNOSIS, PROGNOSIS

Based on the examination data, the patient's impairments were consistent with a L CVA. She continued to be appropriate for this case report due to her motivation and potential for recovery. The patient's ICD-10 medical diagnosis was I69.351: Hemiplegia and hemiparesis following cerebral infarction affecting right dominant side. Her PT diagnosis was Z74.09: Other reduced mobility. Based on the patient's current level of function at the time of examination, her prognosis for improvement with PT was good. The patient had lived a previously healthy lifestyle and also had a very supportive family that was willing to physically assist her upon discharge. However, the patient's age was a negative prognostic factor,[17] as well as the severity of her stroke. Her past medical history of hypertension and diabetes also served as negative prognostic factors.[18]

While the patient was at the IRF, it was planned that she would receive PT, occupational therapy (OT), and speech therapy. It was also planned that she would be referred to an orthotist, provided she made progress in her walking ability. Upon discharge, the patient was going to be

re-tested on all of the initial evaluation tests (FIST, Barthel Index, Encompass Health Rehabilitation Functional Abilities Scale). Her interventions would include neuromuscular re-education, LE strengthening, trunk strengthening, balance training, and gait training. Refer to Table 4 for short and long-term goals.

INTERVENTION AND PLAN OF CARE

Coordination of the patient's care was done with OT, nursing, PT, social work, and the rehabilitation doctor. The patient was seen by a speech language pathologist for swallowing difficulties, which resolved, and she was discharged after four visits. The patient's upper extremity deficits and activities of daily living (ADL) were addressed by the OT. Her diabetes and pain management were managed by the nursing staff. There was clear communication among her healthcare team of therapists, doctors, nurses, social worker, and family members. There was a weekly team meeting with the patient's healthcare team where her progress, discharge plan, and any barriers to a safe discharge were discussed. Documentation was completed for each treatment session using an electronic documentation system. In the daily documentation, therapists described the patient's progress during her session and noted any changes to the patient's POC.

Patient education was provided throughout her time at the rehabilitation center. She was instructed on the importance of stretching her R wrist and fingers to avoid a contracture, to keep her R arm in a neutral position in her wheelchair arm trough to avoid shoulder subluxation, and to weight shift periodically in her wheelchair to avoid pressure sores. She was also educated on the correct use of her hemiwalker and how to verbally direct her caregivers to assist with

donning and doffing her custom ankle-foot orthosis (AFO). Her son and daughter received family training on how to safely assist her with bed mobility, car transfers, gait, and stairs.

Over the course of six weeks, the patient received 30 PT treatment sessions, five times a week. These sessions lasted one and a half hours. Based on her tolerance, she either had the full hour and a half session, or it was split up into a morning (one hour) and afternoon (30 minute) session. She was compliant during her rehabilitation stay and participated in all sessions. The treatment sessions for this patient focused on PNF patterns (see Appendix 4), OGT, and functional mobility training. See Table 5 for interventions.

PNF

PNF has been shown to be a useful technique for facilitating muscle activity in patients with acute stroke.[19] This therapeutic intervention utilizes several biomechanical principles, such as "the use of gravity to facilitate weak muscles, the use of eccentric contractions to facilitate agonist muscle activity, and the use of diagonal movement patterns to facilitate the activation of bi-articular muscles" [19 (p.102)] The purpose of PNF for this patient was to facilitate muscle activation of the patient's R quadriceps and hamstrings in order to improve her LE strength and motor control. PNF patterns were also utilized to facilitate muscle activation at her trunk to improve her independence with rolling and getting in and out of bed. Emphasis was given on strengthening the hip flexors, knee flexors, and knee extensors of her paretic limb in order to progress her gait ability and tolerance. In a systematic review of gait training strategies by Eng and Tang,[20] the strength of these muscle groups was moderately to highly correlated (r= 0.5-0.8) to self-selected or fast walking speed.

Overground Gait Training

OGT was done to improve the patient's walking tolerance, balance, and functional mobility. In the beginning of OGT, one of the patient's biggest limitations was decreased R ankle dorsiflexion strength, which prohibited her from being able to independently complete the swing-through phase of gait. This problem was addressed by using an elastic bandage to create a dorsiflex-assist wrap. See Figure 1. She was later fitted with a custom AFO. Her training program included elements of balance, repetitive task training, and motor planning. See Table 5 for more detail of OGT progression. The patient originally relied heavily on verbal cues for the sequencing of her gait, for example, "Move walker forward, lean to the L, R foot step, L foot step." As she progressed, she required fewer verbal cues from the therapist. She also required several tactile cues in the beginning for weight shifting, blocking R knee buckling, and later blocking R knee hyperextension. At week four, she regained adequate strength and motor control to independently prevent her R knee from buckling. By week five and six, she required less assistance until she was eventually able to walk up to 200 feet with her hemiwalker with only supervision/touch assistance. Walking ability can be an important predictive factor in people who have experienced a stroke. People who are unable to independently walk after their stroke have an increased probability of death, a lower chance of reintegrating into the community, and have a higher chance of secondary complications common after a stroke, such as osteoporosis and heart disease.[21]

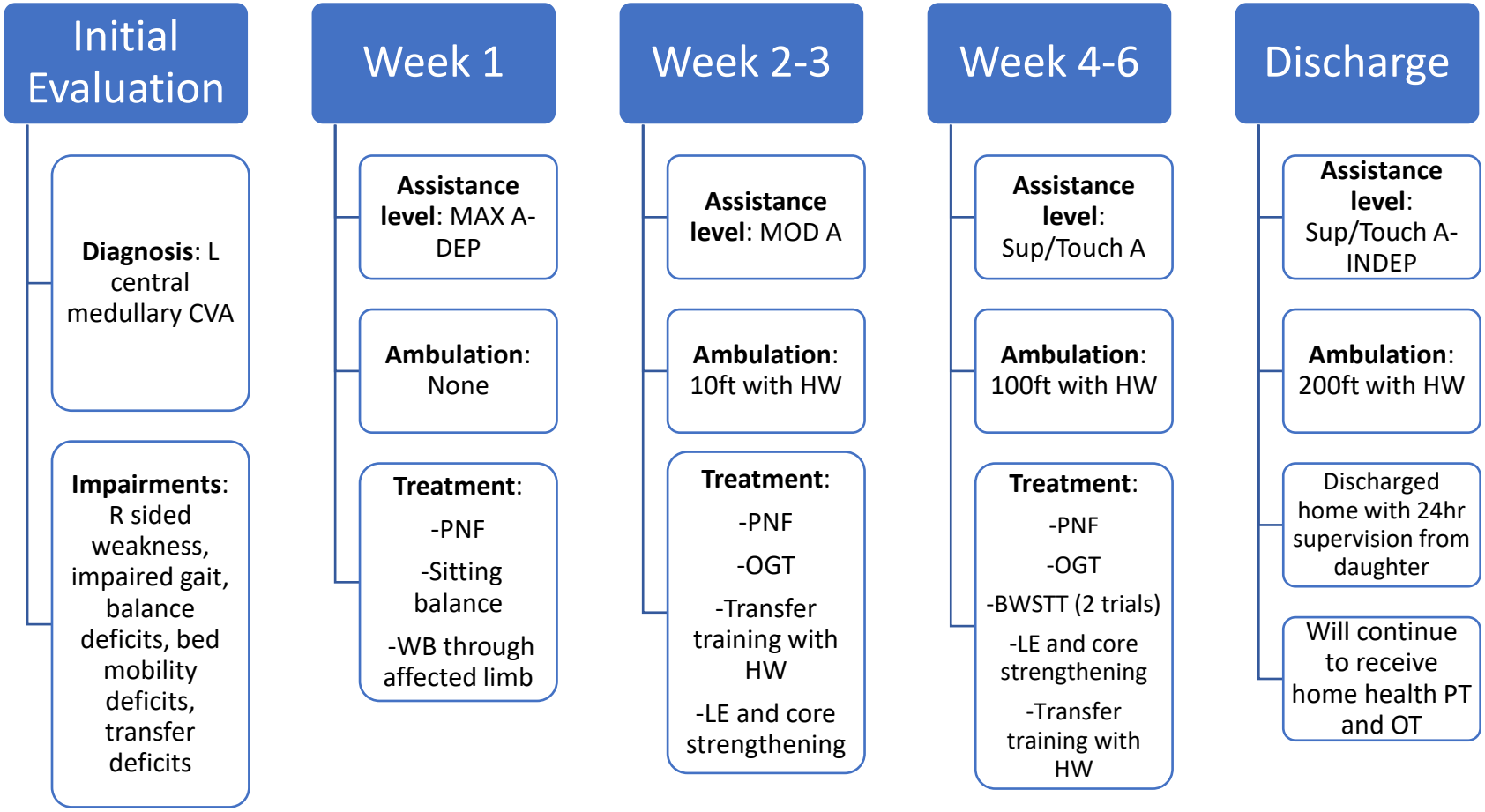
Body Weight Supported Treadmill Training (BWSTT)

During her stay, the patient trialed the BWSTT system (LiteGait, Tempe, AZ), however, this treatment technique was discontinued after two trials, as she expressed frustration and R shoulder pain. It was decided that the patient would be more appropriate for conventional gait training than continued trials of BWSTT. A systematic review suggested that while BWSTT can be successful for certain types of patients, it is not superior to conventional gait training.[22]

Functional Mobility Training

The purpose of functional mobility training was to increase the patient's independence with ADLs and decrease caregiver burden. This training focused on activities such as bed mobility and transfers. To accomplish this training, the motor learning principle of task-specific training was applied. This principle emphasizes repetitive, intensive practice of activities that are meaningful to the patient, and it has been shown to improve activities such as transfers and gait after stroke. [23]

TIMELINE



L= left, CVA= cerebral vascular accident, R= right, MAX A= maximum assistance, PNF= proprioceptive neuromuscular facilitation, WB= weight bearing, MOD A= moderate assistance, HW= hemiwalker, OGT= overground gait training, LE= lower extremity, Sup/Touch A= supervision/touch assistance, BWSTT= body weight supported treadmill training, INDEP= independent

OUTCOMES

Upon admission, the patient's biggest limiting factors were R sided inattentiveness, poor safety awareness, and poor insight into her deficits. She often let her R arm dangle out of her wheelchair and would sit on it. This was addressed with consistent verbal cues from the PT and ongoing patient education from her healthcare team. With continued therapy and education, the patient became more attentive to her R side and demonstrated better safety awareness and insight into her deficits. The patient tolerated her interventions well and was motivated to work hard. She never refused a session and adhered to her POC. The patient showed significant improvements from her initial evaluation to discharge. See Table 4. She improved her Barthel Index score by 30 points, indicating that she had made functional gains with ADLs. She improved her FIST score from 27/56 to 56/56, indicating that she had regained her sitting balance and could sit unsupported without risk of falling.

The patient made significant functional gains on the Encompass Health Rehabilitation Functional Abilities Skills assessment. Upon admission, the patient required maximum to total assistance for all functional mobility tasks, but upon discharge, she improved to a modified independent/minimum assist level. See Table 4. Despite these great improvements, she was not safe to be discharged independently due to her inconsistent safety awareness and memory deficits. It was recommended that she have 24-hour supervision and receive continued OT and PT at home. She was discharged to her daughter's home. Both her daughter and son received family training to provide the proper care needed to assist her.

DISCUSSION

This case report demonstrated the intended purpose of providing an overview of a comprehensive inpatient rehabilitation POC for a patient who experienced a L central medullary stroke. Her treatment sessions focused on PNF, OGT, and functional mobility training. While there have been some studies that discussed the pathology and identification of central medullary strokes, there has been limited research on therapeutic treatment options for patients with this rare type of stroke.

One of the strengths of this case report was the amount of time the patient spent at the IRF. The patient was at risk for early discharge due to a decision by her insurance company, however the therapy team advocated for two extra weeks, which were approved. These added days were followed by immense improvement in the functional abilities of the patient. She made gains in ambulation distance, sitting and standing balance, transfer ability, and required less overall assistance with tasks compared to her baseline. Neuroplasticity principles such as early treatment, repeated bouts of meaningful activity, and appropriate intensity appeared to be beneficial for this patient as she regained motor control of her R LE.[23] PNF patterns also contributed to the patient's strength gains, as it encouraged stronger muscular contractions of the agonist and antagonist muscles of her R LE.[19]

Future research on treatment options such as BWSTT or the use of functional electrical stimulation (FES) could be explored. The patient in this case report trialed BWSTT with very little success, but this does not indicate that it could be a viable treatment option for someone with a central medullary stroke. Dobkin and Dunkin[22] suggested that BWSTT could be a potentially beneficial tool for severely disabled patients who require more external support.

The patient also participated in FES training of her UE with the OT, where she experienced gains in motor control of her shoulder, elbow, and finger flexors. It could be hypothesized that she could have potentially benefitted from FES on her R LE as well. It would be appropriate to explore this treatment method to see if similar results would be found at the LE.

This case report suggests that a multifactorial treatment approach for patients who have experienced a L central medullary stroke may be beneficial to one's recovery. The combination of PNF, OGT, and functional mobility training appeared to be beneficial to this patient's outcomes, as she made improvements from her baseline function. There has been extensive research on treatment options for stroke, but there needs to be further research on whether there are superior treatment methods for patients who have experienced this rare type of stroke.

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TABLES and FIGURES

Table 1. Medications List

Medication	Purpose
Acetaminophen	Provide pain relief
Amlodipine	Control high blood pressure
Ascorbic acid	Treat low levels of Vitamin C
Atorvastatin	Treat high cholesterol
Calcium-Vitamin D	Treat low levels of Vitamin D
Clopidogrel	Blood thinner
Collagenase	Treat wound on shin
Diclofenac topical	Provide pain relief
Donepezil	Cognition enhancing drug
Fluoxetine	Treat anxiety and depression
Glipizide	Treat Type 2 diabetes
Linagliptin	Treat Type 2 diabetes
Metformin	Treat Type 2 diabetes
Omeprazole	Treat acid reflux
Potassium Chloride	Treat low levels of potassium
Pregabalin	Nerve pain medication

Table 2. Systems Review

System	Intact/Impaired	Notes
Cardiovascular/Pulmonary	Intact	
Musculoskeletal	Impaired	Gross R UE and LE strength were impaired; R shoulder subluxation of 1cm
Neuromuscular	Impaired	Balance, motor control, gait, transfers, and coordination were impaired
Integumentary	Impaired	Wound on R shin as a result from her fall; bruising on R sided ribs 7-9
Communication	Intact	
Affect, Cognition, Language, Learning Style	Intact	

R= right, UE= upper extremity, LE= lower extremity

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406 **Table 3. Test and Measures**
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Tests & Measures	Initial Evaluation	Discharge	Psychometric Properties
Function in Sitting Test[12]	29/56	56/56	Test-retest reliability (ICC=0.97)[23] Intra-rater reliability (ICC=0.99)[23] Inter-rater reliability (ICC=0.99)[23]
Barthel Index[15]	45/100	70/100	Inter-rater reliability (ICC=0.94)[24] Correlation to Berg Balance Scale and Fugl Meyer motor assessment (Pearson's r > 0.78, p<0.0001)[24]
Encompass Health Functional Abilities Scale			No available psychometric properties
Roll Left and Right	MAX A	INDEP	
Sit to Lying	DEP	INDEP	
Lying to Sitting on Side of Bed	DEP	SUP/TOUCH A	
Sit to Stand	DEP	SUP/TOUCH A	
Chair, Bed to Chair Transfer	DEP	SUP/TOUCH A	
Car Transfer	Not Att MC	SUP/TOUCH A	
Picking Up Object	Not Att MC	IND (with reacher)	
Walk 10 Feet	Not Att MC	SUP/TOUCH A	
Walk 50 Feet with Two Turns	Nott Att MC	SUP/TOUCH A	
Walk 150 Feet	Not Att MC	SUP/TOUCH A	
1 Step (Curb)	Not Att MC	SUP/TOUCH A	
4 Steps	Not Att MC	SUP/TOUCH A	
12 Steps	Not Att MC	Not Att MC	
Wheel 50 Feet with Two Turns	MOD A	INDEP	
Wheel 150 Feet	MAX A	MOD A	

RLE Gross Strength	**Initial Evaluation**	**Discharge**	
Hip Flexion	1/5	3+/5	
Hip Extension	1/5	3/5	
Hip Abduction	1/5	3+/5	
Hip Adduction	1/5	3+/5	
Knee Flexion	1/5	3/5	
Knee Extension	1/5	3/5	
Ankle Dorsiflexion	0/5	1/5	
Ankle Plantarflexion	1/5	1/5	
RLE Sensation	**Initial Evaluation**	**Discharge**	
Light Touch	Impaired on plantar aspect of R foot	Not tested	
Proprioception	Intact	Not tested	
Deep Pressure and Localization	Impaired throughout LE below knee	Not tested	

INDEP= independent, SUP/TOUCH A= supervision/touch assistance, MOD A= moderate assistance, MAX A= maximum assistance, DEP= dependent, Not Att MC= not attempted due to medical concern

Table 4: Short and Long-Term Goals

	Short-Term Goals	**Long-Term Goals**	**Goal Met/Not Met**
Bed Mobility (Rolling L and R, Sit to Lying, Lying to Sitting on Side of Bed)	MOD A	INDEP	Not Met
Sit to Stand	N/A	INDEP	Not Met
Chair, Bed to Chair Transfer	MOD A w HW	INDEP	Not Met

Car Transfer	MOD A w HW	INDEP	Not Met
Picking Up Object	N/A	SUP/TOUCH A	Met
Walk 10 Feet	N/A	SUP/TOUCH A	Met
Walk 50 Feet with Two Turns	MOD A w HW	SUP/TOUCH A	Met
Walk 150 Feet	N/A	SUP/TOUCH A	Met
Walk 10 Feet Uneven Surface	N/A	SUP/TOUCH A	Met
1 Step (Curb)	N/A	SUP/TOUCH A	Met
4 Steps	N/A	SUP/TOUCH A	Met
12 Steps	N/A	SUP/TOUCH A	Not met
Wheel 50 Feet with Two Turns	N/A	INDEP	Met
Wheel 150 Feet	INDEP	INDEP	Not met

MOD A= moderate assistance, w HW= with hemiwalker, INDEP= independent, SUP/TOUCH A= supervision/touch assistance N/A= not applicable

423 **Table 5: Interventions**

Interventions	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6
Sitting Balance/Standing Balance	Sitting on mat without UE support, reaching outside BOS	Static standing in // bars (2 min x 3)	Static standing with HW (2min x 3)	Static standing w/o UE support (30s x 5)		
Transfers	Sit ⇆ stand (PRN) Bed ⇆ chair (squat pivot)	Sit ⇆ stand in // bars (2 x 3) Bed ⇆ chair (stand pivot)	Sit ⇆ stand from raised treatment table (2x5) Bed ⇆ chair (stand step with HW) Toilet transfer (stand step with grab bar)	Sit ⇆ stand from wheelchair (2x5 and PRN) Bed ⇆ chair (stand step with HW) Toilet transfer (stand step with grab bar	Sit ⇆ stand from wheelchair (2x5 and PRN) Bed ⇆ chair (3x3; stand step with HW) Toilet transfer (stand step with grab bar)	Sit ⇆ stand from wheelchair (2x5 and PRN) Bed ⇆ chair (3x3 stand step with HW) Toilet transfer (stand step with grab bar) Car transfer (stand step with HW)
Bed Mobility	Supine ⇆ Sit (PRN)	Supine ⇆ Sit (PRN)	Modified supine⇆ sit (part task training; 3x5) Supine ⇆ Sit (PRN) Rolling (3x)	Supine⇆ sit (3x) Rolling (3x)	Supine⇆ sit for paretic and non-paretic side (3x) Rolling (3x)	Supine⇆ sit for paretic and non-paretic side (3x) Rolling (3x)
Proprioceptive Neuromuscular Facilitation (PNF)	D1 and D2 FL/EXT rhythmic initiation of R LE (3x5)	D1 and D2 FL/EXT rhythmic initiation of R LE (3x5)	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic	D1 and D2 FL/EXT rhythmic

			initiation of R LE (2x5)	initiation of R LE (2x5) D1 and D2 rhythmic initiation of scapula and pelvis	initiation of R LE (1x5) D1 and D2 rhythmic initiation of scapula and pelvis	initiation of R LE (1x5)
LE Strengthening **Core strengthening**		Supine isometric hip ADD (maintaining hook lying position for 10s x 3) Modified sit ups (3x5)	Hip FL/EXT in sidelying with slip sheet under leg (3x5) Knee FL/EXT in sidelying with slip sheet under leg (3x5) Modified sit ups (3x5)	Hip FL/EXT in sidelying with slip sheet under leg (3x5) Knee FL/EXT in sidelying with slip sheet under leg (3x5) Bridges (3x5) Trunk twists (3x10)	Bridges (2x10) Trunk twists (3x10)	
Overground Gait Training (OGT)	Weight shifts in // bars (UE support)	Walking in // bars (5ft x 2→ 10ftx2) Weight shifts with HW Repetitive stepping in // bars	Repetitive stepping w HW Walk 10ft x 2 w HW MAX VC's and tactile cues for swing through phase of R LE, sequencing of step pattern	Walk 50ft x 2 w HW MOD VC's for sequencing step pattern, increasing step length Trialed platform step w HW	Walk 100ft x 2 w HW Ascend/descend two platform steps w HW	Walk 200ft SUP/TOUCH A with HW Ascend/descend two platform steps with HW

			ACE wrap implemented on R LE for increased ankle dorsiflexion			
Body Weight Supported Treadmill Training (BWSTT)				25% BWS at 1.0mph for 1min x 2 bouts	25% BWS at 1.0mph for 1min x 2 bouts	

PRN = as needed; UE = upper extremity; BOS = base of support; HW = hemiwalker; PRN = as needed; FL/EXT = flexion/extension; R LE = right lower extremity; MAX VC's = maximum verbal cues; MOD VC's = moderate verbal cues; SUP/TOUCH A= supervision/touch assistance; BWS = body weight support

Figure 1: Dorsiflex Assist Wrap[27]

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450 **APPENDICES**
451 **Appendix 1: Function in Sitting Test[12]**

FUNCTION IN SITTING TEST (FIST) RESULTS

FIST Test Item ½ femur on surface, hips & knees flexed to 90° ◊ Used step/stool for positioning & foot support	**Date:**	**Date:**	**Date:**
Randomly Administered Once: **Anterior Nudge**: superior sternum			
Randomly Administered Once: **Posterior Nudge**: between scapular spines			
Randomly Administered Once: **Lateral Nudge**: to dominant side at acromion			
Static sitting: 30 seconds			
Sitting, shake 'no': left and right			
Sitting, eyes closed: 30 seconds			
Sitting, lift foot: dominant side, lift foot 1 inch twice			
Pick up object from behind: object at midline, hands breadth posterior			
Forward reach: use dominant arm, must complete full motion			
Lateral reach: use dominant arm, clear opposite ischial tuberosity			
Pick up object from floor: from between feet			
Posterior scooting: move backwards 2 inches **Anterior scooting**: move forward 2 inches			
Lateral scooting: move to dominant side 2 inches			
TOTAL	/ 56	/ 56	/ 56
Administered by: **Notes/comments:**			

Scoring Key:
4 = **Independent** (completes task independently & successfully)
3 = **Verbal cues/increased time** (completes task independently & successfully and only needs more time/cues)
2 = **Upper extremity support** (must use UE for support or assistance to complete successfully)
1 = **Needs assistance** (unable to complete w/o physical assist; document level: min, mod, max)
0 = **Dependent** (requires complete physical assist; unable to complete successfully even w/physical assist)

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460 **Appendix 2: Barthel Index[15]**

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):	_____

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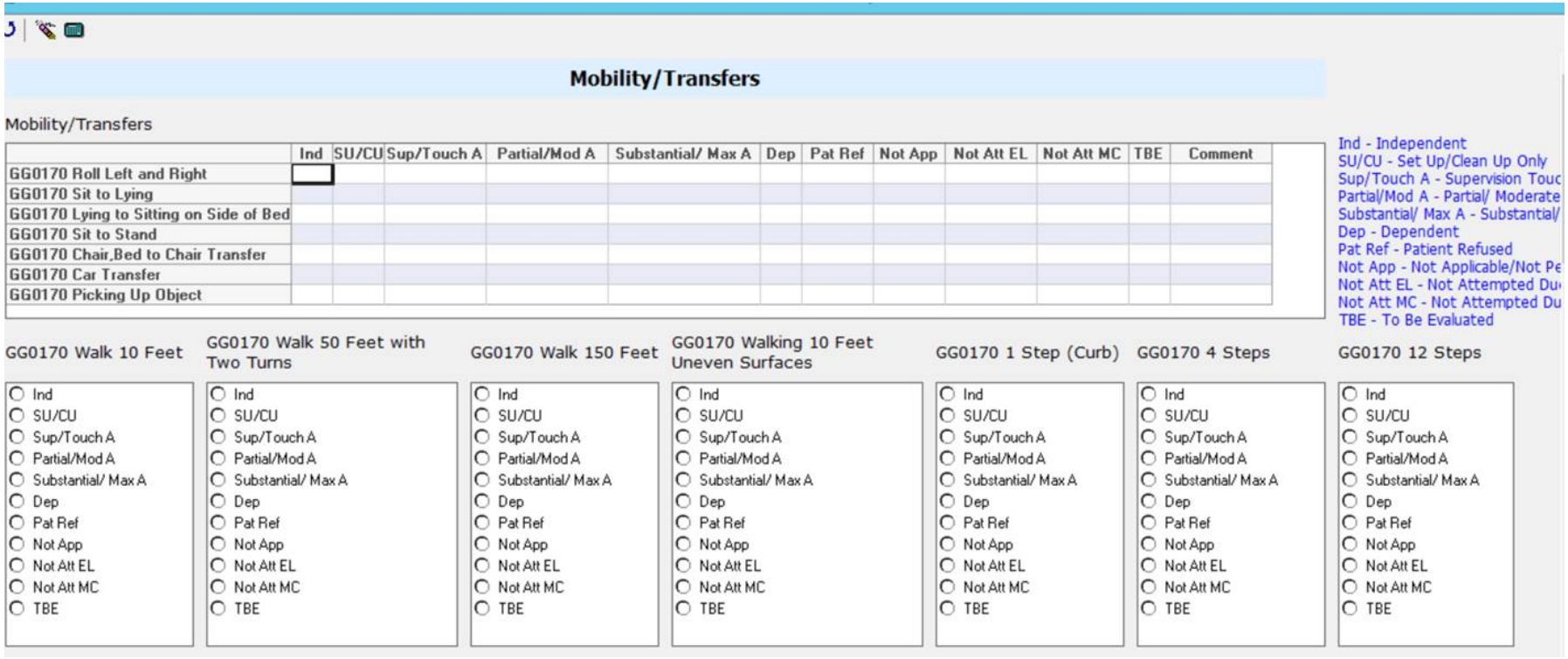
Appendix 3: Encompass Health Rehabilitation Functional Abilities Scale



Mobility/Transfers

Mobility/Transfers

	Ind	SU/CU	Sup/Touch A	Partial/Mod A	Substantial/ Max A	Dep	Pat Ref	Not App	Not Att EL	Not Att MC	TBE	Comment
GG0170 Roll Left and Right												
GG0170 Sit to Lying												
GG0170 Lying to Sitting on Side of Bed												
GG0170 Sit to Stand												
GG0170 Chair,Bed to Chair Transfer												
GG0170 Car Transfer												
GG0170 Picking Up Object												

Ind - Independent
SU/CU - Set Up/Clean Up Only
Sup/Touch A - Supervision Touc
Partial/Mod A - Partial/ Moderate
Substantial/ Max A - Substantial/
Dep - Dependent
Pat Ref - Patient Refused
Not App - Not Applicable/Not Pe
Not Att EL - Not Attempted Du
Not Att MC - Not Attempted Du
TBE - To Be Evaluated

GG0170 Walk 10 Feet	GG0170 Walk 50 Feet with Two Turns	GG0170 Walk 150 Feet	GG0170 Walking 10 Feet Uneven Surfaces	GG0170 1 Step (Curb)	GG0170 4 Steps	GG0170 12 Steps
Ind	Ind	Ind	Ind	Ind	Ind	Ind
SU/CU	SU/CU	SU/CU	SU/CU	SU/CU	SU/CU	SU/CU
Sup/Touch A	Sup/Touch A	Sup/Touch A	Sup/Touch A	Sup/Touch A	Sup/Touch A	Sup/Touch A
Partial/Mod A	Partial/Mod A	Partial/Mod A	Partial/Mod A	Partial/Mod A	Partial/Mod A	Partial/Mod A
Substantial/ Max A	Substantial/ Max A	Substantial/ Max A	Substantial/ Max A	Substantial/ Max A	Substantial/ Max A	Substantial/ Max A
Dep	Dep	Dep	Dep	Dep	Dep	Dep
Pat Ref	Pat Ref	Pat Ref	Pat Ref	Pat Ref	Pat Ref	Pat Ref
Not App	Not App	Not App	Not App	Not App	Not App	Not App
Not Att EL	Not Att EL	Not Att EL	Not Att EL	Not Att EL	Not Att EL	Not Att EL
Not Att MC	Not Att MC	Not Att MC	Not Att MC	Not Att MC	Not Att MC	Not Att MC
TBE	TBE	TBE	TBE	TBE	TBE	TBE

INDEP = independent; SU/CU= set up/clean up only; Sup/Touch A= supervision/touch assistance; Partial/MOD A= moderate assistance; Substantial/MAX A= maximum assistance; DEP= dependent; Pat Ref= patient refused; Not App= Not Applicable; Not Att EL= not attempted due to environmental living situation; Not Att MC= not attempted due to medical concern; TBE= to be evaluated

Appendix 4: Lower Extremity D1 and D1 Flexion Extension PNF Pattern Videos[25,26]

https://youtu.be/c7qx1r6adb4

https://youtu.be/-MYCNj-5cDk

CARE checklist

CARE Content Area	Page
1. **Title** – The area of focus and "case report" should appear in the title	1
2. **Key Words** – Two to five key words that identify topics in this case report	1
3. **Abstract** – (structure or unstructured) a. Introduction – What is unique and why is it important? b. The patient's main concerns and important clinical findings. c. The main diagnoses, interventions, and outcomes. d. Conclusion—What are one or more "take-away" lessons?	2
4. **Introduction** – Briefly summarize why this case is unique with medical literature references.	3
5. **Patient Information** a. De-identified demographic and other patient information. b. Main concerns and symptoms of the patient. c. Medical, family, and psychosocial history including genetic information. d. Relevant past interventions and their outcomes.	5
6. **Clinical Findings** – Relevant physical examination (PE) and other clinical findings	6
7. **Timeline** – Relevant data from this episode of care organized as a timeline (figure or table).	12
8. **Diagnostic Assessment** a. Diagnostic methods (PE, laboratory testing, imaging, surveys). b. Diagnostic challenges. c. Diagnostic reasoning including differential diagnosis. d. Prognostic characteristics when applicable.	7
9. **Therapeutic Intervention** a. Types of intervention (pharmacologic, surgical, preventive). b. Administration of intervention (dosage, strength, duration). c. Changes in the interventions with explanations.	8
10. **Follow-up and Outcomes** a. Clinician and patient-assessed outcomes when appropriate. b. Important follow-up diagnostic and other test results. c. Intervention adherence and tolerability (how was this assessed)? d. Adverse and unanticipated events.	13
11. **Discussion** a. Strengths and limitations in your approach to this case. b. Discussion of the relevant medical literature.	14

c. The rationale for your conclusions. d. The primary "take-away" lessons from this case report.	
12. **Patient Perspective** – The patient can share their perspective on their case.	6
13. **Informed Consent** – The patient should give informed consent.	5