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Subacute Physical Rehabilitation For A Young Adult With A Hypoxic Brain Injury Resulting In Severe Myoclonic Movements And Ataxia: A Case Report

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The patient's mother signed all informed consent allowing the use of medical information, photo and video footage for this report and received information on the institution's policies regarding the Health Insurance Portability and Accountability Act (HIPAA).

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Key Words: Hypoxic Brain Injury, Ataxia, Myoclonic Movements, Physical Therapy Interventions

Abstract

Background and Purpose: An acquired brain injury is an injury to the brain that is not hereditary, congenital, degenerative in nature or induced by birth. Hypoxic/anoxic ischemic brain injuries (HIBI) result from global lack of oxygen to the brain from events such as drowning, choking, and cardiac or respiratory arrest. Limited research has been done regarding physical therapy (PT) interventions to improve functional mobility, gait, and tolerance to activity in an inpatient rehabilitation facility (IRF) with this patient population. Thus, the purpose of this case report is to provide PT interventions that were utilized in an IRF setting for a patient who experienced a HIBI resulting in severe ataxia and myoclonic movements.

Case Description: The patient was a 28-year-old male who experienced a choking incident resulting in severe ataxia and myoclonic tremors secondary to an HIBI. The patient received 25 days of skilled therapy in an IRF totaling 3 hours per day to address limitations in bed mobility, coordination, transfer ability, and gait.

Outcomes: After 25 days of PT services, the patient's functional mobility improved as measured by level of assistance required for each functional task and distance ambulated. Within the IRF, a modified Functional Independence Measure (FIM) scoring was utilized to assess physical assistance provided to the patient regardless of assistive device used, distance ambulated, and environment set-up.

Discussion: This case report demonstrated improvements in level of assistance to perform functional mobility that can be accomplished through intensive and consistent PT interventions. However, there is limited research in the area of HIBIs, therefore, more research is required to provide the PT practice with objective assessment tools to better track patient progress.

Introduction / Background and Purpose

An acquired brain injury is an injury to the brain that is not hereditary, congenital, degenerative in nature or induced by birth.[1] Such injury results in neuronal activity changes which can drastically affect an individual's presentation. Acquired brain injuries are classified as traumatic or non-traumatic brain injury. Traumatic brain injuries (TBI) include concussion, contusion, coup-contrecoup, diffuse axonal, and penetrating injuries.[1] Non-traumatic brain injuries include brain tumors, stroke, infectious disease, neurotoxic poisoning, and hypoxic/anoxic injuries.[1] Hypoxic/anoxic brain injuries result from global lack of oxygen to the brain from events such as drowning, choking, and cardiac or respiratory arrest.[1]

The brain requires a high metabolic demand which makes it more susceptible to damage when deprived of oxygen.[2] The extent of brain tissue damage can be correlated with the duration of hypoxia. Five minutes without oxygen causes irreversible damage to the cerebral cortex.[3] Fifteen minutes without oxygen supply to the brain can result in up to 95% of brain tissue damage.[2] Brain tissue damage can result in various presentations of physical and cognitive deficits. Certain areas of the brain have more devastating effects as they have a higher metabolic activity and increased utilization of oxygen such as the basal ganglia.[4] The oxygen demand that these structures require expand their vulnerability to hypoxic ischemic brain injuries (HIBI).[4] Anoxic brain injuries involving infarcts of the basal ganglia can result in involuntary movement disorders such as myoclonic jerks, ataxia, and akinetic-rigid movements as well as difficulties in learning new motor skills.[4]

Ataxic gait is characterized by decreased speed of ambulation, irregular stepping pattern, difficulties with inter- and intra-limb coordination, and impaired postural stability, all of which contribute to an increased risk of falls.[5] Studies suggest that various physical therapy (PT) interventions can improve ataxic gait including dynamic balance training, individualized balance programs, personalized interventions targeting independence in activities of daily living (IADLs), and customized gait training.[5] There is very limited research on PT interventions to employ when attempting to improve functional mobility, gait, and tolerance to activity in an adult who experienced severe ataxia and myoclonic tremors secondary to an hypoxic ischemic brain injury. Thus, the purpose of this case report was to provide the physical therapy interventions utilized in an inpatient rehabilitation hospital setting for a patient who experienced a hypoxic ischemic brain injury resulting in severe ataxia and myoclonic movements.

Patient History and Systems Review

The patient was a 28-year-old male who was living in a neurorestorative assisted-living facility where he was completely independent with activities of daily living (ADLs) at baseline. He required supervision for impaired frontal lobe functioning, such as impulse control and judgment, due to a TBI resulting secondary to a severe seizure when he was 19-years-old. Prior to his injury in 2009, he had no significant past medical history and was working in the field of masonry. Since his TBI, he had acquired a significant medical history including an unspecified neurodegenerative disorder, epilepsy, abdominal and lower extremity thromboses, and Factor V Leiden gene mutation. Other pertinent personal history included tobacco dependence and daily use of marijuana. Just over one month prior to the initial evaluation within the IRF, he experienced a witnessed choking episode with respiratory arrest leading to cardiac arrest. He was brought to an acute care hospital's intensive care unit (ICU) where he was intubated. Therapeutic hypothermia protocol was initiated for poor rating on the Glasgow Coma Scale (GCS) following

the return of spontaneous circulation. Therapeutic hypothermia protocol is a cooling of an individual's core temperature to prevent further cell death within the brain. A magnetic resonance image (MRI) was taken demonstrating bilateral acute globus pallidus, nuclei of the basal ganglia, infarcts consistent with a hypoxic ischemic brain injury. One month after his initial choking incident he was medically stabilized and transferred to an inpatient rehabilitation facility (IRF) to benefit from a comprehensive multidisciplinary rehabilitation program to improve overall function to ideally return to his baseline level of independence. See Appendix 1 for detailed medication list once admitted into the IRF. A summary of significant findings upon the initial evaluation (IE) within the IRF can be found in Table 1.

Examination – Tests and Measures

At the IRF, his course of treatment was complicated by severe myoclonic tremors with intentional movement, spastic tetraparesis, positive screen for methicillin-resistant staphylococcus aureus (MRSA), urinary tract infection, and behavioral difficulties. He also experienced dystonia of his larynx which limited his ability to communicate effectively. His diagnosis upon admission was hypoxic ischemic encephalopathy (HIE). During the PT initial evaluation, the patient was unable to perform formal manual muscle testing (MMT) secondary to initiation tremors, ataxia and dyskinetic movements. As a result of his inability to perform formal MMT, his strength was assessed via observation. The patient was observed to have grossly 3-/5 (less than full range of motion against gravity) strength bilaterally. According to a study performed by Fan et al,[6] the reliability of the MMT for ICU survivors and simulated patient populations is adequate to excellent; the interrater reliability for lower extremity was 0.66-1.0.

Both his trunk and bilateral lower extremity (BLE) were hypertonic. Therefore, the Modified Ashworth Scale (see Appendix 2) was applied to quantitatively assess his tone. A detailed objective assessment of his bilateral lower extremity tone was performed (see Table 2).

Mehrholz et al,[7] determined that test-retest reliability was adequate for the brain injury population when performing measurement of the hip, knee and ankle (kappa =0.47-0.62). Sensation, including light touch, deep pressure and localization, and proprioception were all intact. Bilateral lower extremity coordination measured by heel-to-shin sliding motions, were severely impaired. The Functional Independence Measure (FIM) was utilized during the remainder of the initial evaluation. See Appendix 3 & 4 for a detailed description of the FIM scoring. The FIM was performed at this facility to provide healthcare providers with a template to measure the amount of assistance required to perform meaningful tasks relating to mobility. The physical therapists within this setting were responsible for assessing the level of assistance required for bed mobility, transferring technique, ambulation, wheelchair mobility, ascending/descending stairs, and the cognitive assessment. For this patient, a modified form of the FIM was utilized to assess the amount of physical assistance provided to the patient regardless of assistance device used, distance ambulated, or the environmental set-up. Detailed descriptions of the patient's FIM scores can be found in Table 3. Donaghy and Wass[8] determined the interrater reliability of the FIM for brain injury populations is excellent; 0.85 for total FIM scores, 0.92 for FIM Motor, and 0.69 for FIM Cognitive.

At the time of the initial evaluation, various impairments and limitations were identified. The patient's impairments included abnormal tone, bed mobility deficits, ataxic gait, balance deficits, diminished coordination/proprioception, decreased activity tolerance, decreased strength, deficits in transitional movement and transfer ability, and wheelchair mobility deficits. Additionally, this patient presented with the following cognitive limitations; impaired cognitive ability, decreased knowledge of condition, decreased knowledge of equipment use, impaired judgement/safety awareness, and social interaction deficits. Potential barriers to a safe discharge included a

complicated medical history, the severity of his deficits, and the time that had passed since the onset of his condition.

Clinical Impression: Evaluation, Diagnosis, Prognosis

Following the initial evaluation, it was determined that he was an appropriate patient for an intensive rehabilitation program consisting of services from various disciplines such as PT, occupational therapy (OT), and speech therapy (ST); totaling three hours of therapy per day. The patient remained an appropriate candidate for this case report because he was able to participate in the sub-acute PT interventions that were implemented to improve his balance and mobility despite his recent hypoxic ischemic brain injury. The patient's primary medical diagnosis was hypoxic ischemic encephalopathy complicated by myoclonus (ICD-10-P91.60). The primary PT diagnoses were impaired mobility and balance (ICD-10-R26.9) and ataxia following nontraumatic cerebral infarct (ICD-10-I69.393).

Based on the evaluation of the patient, it was anticipated the patient would be discharged to a group home that provided caregiver assistance for ADLs and functional mobility. His prognosis overall remained unclear due to the severity of his deficits and lack of research involving adult hypoxic brain injuries resulting in severe ataxia and myoclonic movements. However, the main goal expressed by him and his family was to eventually return to the neurorestorative group home he was previously living at.

Ultimately, the recommended PT interventions included balance training to improve balance deficits and diminished coordination/proprioception; basic ADL training; bed mobility training and transfer training; body weight supported treadmill training to improve his ataxic gait; gait training to improve his gait kinematics and activity tolerance; manual therapy to improve his abnormal tone; neuromuscular reeducation and therapeutic exercises for strength; posture/body mechanics training; stair training; wheelchair assessment and management; equipment/orthotic

assessment and training; pain management; patient and caregiver education; and home assessment/modification. Due to lack of research involving adult hypoxic brain injuries, all anticipated interventions were chosen based on the supervising clinical instructor's clinical experience and expertise.

Due to his functional mobility impairments, the short-term goals for this patient focused on improving his ability to perform the following tasks bed mobility, transfers, ambulation, wheelchair management, and balance. For detailed descriptions of short-term goals see Table 4. The patient's long-term goals involved higher level tasks and mastering the functional ability of his short-term goals consistently long with the addition of transitional movements and ambulation. For detailed descriptions of long-term goals for mobility see Table 5. In order to address his cognitive limitations, long-term cognitive goals were developed which included attaining the level of supervision/standby for comprehension, expression, and social interaction; and only requiring minimal prompting for problem solving and memory.

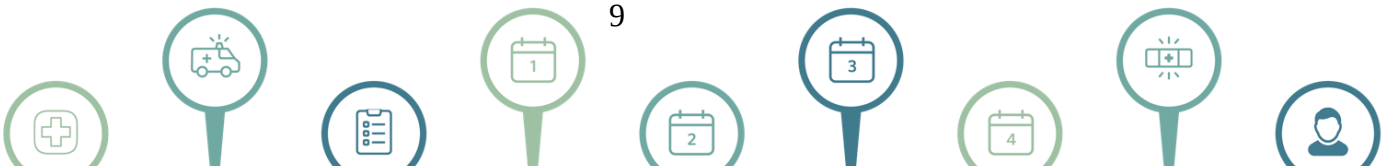
Intervention and Plan of Care

Overall, this patient required a comprehensive interprofessional team consisting of various healthcare providers such as physical therapists, occupational therapists, speech-language pathologists, the lead physician, licensed nurse practitioners, rehabilitation certified registered nurses, certified nursing assistance, and a neurobehavioral psychologist. Team meetings occurred weekly with the previously stated care providers present for each meeting. These meetings fostered a collaborative environment to ensure quality care. During team meetings, each specialty discussed pertinent information, barriers to discharge, and the plan of care. Once admitted into the IRF, the patient received three hours of therapy each day, for five days per week. Skilled therapy services were distributed evenly between physical therapy, occupational therapy, and speech therapy. Furthermore, each form of therapy would focus on specific areas

which needed improvement. PT focused on transfer training, transitional movements, coordination and gait training. OT would focus on personal hygiene, dressing, and upper extremity interventions. ST aimed to improve his communication ability and his independence with eating and drinking. Specific PT interventions along with description, frequency, and purpose statement are located in Table 6.

Although, many of the interventions were determined appropriate by the clinical instructor on the basis of clinical experience; Beaulieu et al[9] found the most utilized treatment activities performed by PT, OT, and ST in an acute rehabilitation hospital of patients with TBIs were transitional movements, therapeutic exercise and gait training. In order to be discharged to another facility, he would have to perform specific mobility tasks, therefore our treatment and interventions focused on those specific areas to allow a proper and safe discharge. Early stage rehabilitation focused on reducing level of assistance when performing bed mobility, transfers, and wheelchair mobility and improving coordination. Late stage rehabilitation focused on transitional movements and gait training. Interventions progressed based on the patient's ability to perform each task and level of assistance required to safely accomplish the task.

Unavoidable variables, such as timing of medication, level of fatigue, time of day when PT session was performed, and personal care requirements during PT session, affected the clinical decision making for daily intervention selection. The patient was compliant with PT treatments and his willingness to participate greatly improved if he could listen to music during the treatment sessions. McCulloch,[10] determined that the integration of music into an intervention improved ability when performing cognitive dual-tasks. The decision to incorporate music into each treatment session was based upon this research along with the patient's devotion to rock-n-roll music. The incorporation of music not only enhanced his drive to increase the distance of



ambulation, but also it improved his overall outlook on his rehabilitation process.

Timeline

Outcomes

After completing 25 days of inpatient rehabilitation, the patient improved overall by having less assistance required to perform tasks such as bed mobility, transfer training, functional mobility and gait training. Progressively, he was able to meet all of his short-term goals throughout this time in the IRF. Meaningful improvements were made in the level of assistance required for each activity. His independence with bed mobility such as rolling, moving from a supine to a seated position, and vice versa improved from maximal assistance to minimal assistance. Transfer training such as squat pivot and stand pivot transfers improved from total assistance to moderate assistance. His ability to perform transitional movements such as moving from a seated to a standing position and vice versa improved from total assistance to minimal assistance. Gait training improved from a maximum level of assistance from 2 therapists and a close wheelchair follow to minimum assistance of one with a wheelchair follow, the distance of ambulation per treatment session also improved from 2 feet on his IE to ~1,500 feet. Table 6 provides a detailed description of the activities performed and purpose of each task, as well as

specifics regarding the fluctuations in level of assistance required for each week of therapy.

The patient's tolerance to activity was subjectively assessed based on the visual cues of fatigue such as increased ataxia, knee buckling, and the patients self-reported level of exhaustion. The patient experienced complications which resulted in him being sent to an acute hospital to receive a percutaneous endoscopic gastrostomy (PEG) tube for optimal nutritional support. He was expected to return to the IRF within 72 hours, therefore, no objective measures were performed prior to his last treatment session. Unfortunately, the patient experienced unforeseen complications at the acute care hospital that ultimately resulted in his passing.

Discussion

This case demonstrated the intended purpose by providing PT interventions that were utilized to improve functional mobility in a 28-year-old patient post-ischemic hypoxic brain injury within an IRF setting. Due to the limited research on adults with severe ataxia and myoclonic tremors secondary to an ischemic hypoxic brain injury, clinician experience was employed most often and was critical for this patient's plan of care and interventions choice. Consistent with the studies summarized by Kelly and Shenley[5], the patient showed marked improvements in his ataxic gait through the incorporation of an individualized balance program, personalized interventions targeting independence with ADLs, and a customized gait training program. The severity of this patient's impairments made it difficult to select any pre-existing outcome measures because he was unable to perform the tasks required of them. This case report could be a valuable contribution to the PT practice concerning interventions when treating a patient with severe ataxia and myoclonic tremors.

Improvements in functional mobility such as bed mobility, transitional movements, performing transfers, gait, and tolerance to therapy were noted throughout the first 20 days of

therapy; the last few days of treatment were increasingly difficult due to significant fluctuations in his medical status. Factors that may have positively influenced his outcomes were the consistency of therapeutic interventions, gradual progression of interventions, perceived motivation, and family support. The patient's progress may have been limited by medication adjustments, a witnessed fall, fluctuations in functional mobility, pain, and emotional barriers which occasionally decreased his ability to fully participate in therapeutic interventions. Regrettably, the patient experienced unforeseen complications at the acute care hospital, which ultimately lead to his passing roughly one week after his last treatment session at the IRF. However, the improvements made through PT prior to the onset of complications were consistent and should be considered relevant when treating this patient population.

Since there is such limited research for this unique patient population, it would be valuable to have future case reports written involving the area of adult hypoxic or anoxic brain injuries. A beneficial contribution to this case report as well as the PT practice in general, would be the development of assessment tools to objectively evaluate the progress or fall-risk for this patient population.

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Tables and Figures

Table 1: Systems Review

Systems Review	
Cardiovascular/ Pulmonary	Pulse: 2+; Normal Capillary Refill: less than 2 seconds; Normal Heart rhythm: Regular Respirations: unlabored and regular, no cough Breath sounds (LUL*, RUL*, RML*, LLL*, RLL*): clear BMI: 23.94 kg/m^2 Blood Pressure: 114/80 mmHg* Heart Rate: 66 bpm* Respiratory Rate: 20 br/min* Oxygen Saturation: 97% Oral Temperature: 97.6 degrees F
Musculoskeletal	LE* overall active range of motion: within functional limits bilaterally

	LE overall passive range of motion: within functional limits bilaterally
Neuromuscular	LE tone assessment: Trunk, and bilateral lower extremity were hypertonic.
Integumentary	No wounds or incisions
Communication	Verbal communication: impaired, dysarthric Auditory communication: needs facilitation of communication skills Notes: easily distracted, requires repetition, cueing, and reduction of background noise.
Affect, Cognition, Language, Learning Style	Language: English Following complex commands: impaired Able to comprehend basic information Health literacy: Basic Safety and judgement: impaired Learning style: combination of written, verbal, and demonstration. Education must be provided to caregiver. Insight Education: incomplete awareness of current limitations/deficits.

*LUL= left upper lobe, RUL= right upper lobe, RML= right middle lobe, LLL= left lower lobe, RLL= right lower lobe, LE= lower extremity, mmHg= millimeters of mercury, bpm= beats per minute, br/min= breaths per minute

Table 2: Detailed tone assessment of bilateral lower extremities upon initial evaluation

Specific muscle groups assessed	Modified Ashworth Score (see Appendix 2)
Bilateral hip flexors	1+
Bilateral hip adductors	2
Bilateral knee flexors	2
Bilateral ankle plantarflexors	3

Table 3: Tests and measures performed on initial evaluation

Tests & Measures	Initial Evaluation Results
Sensation Testing (light touch, proprioception measured at great toe, deep pressure and localization)	Intact throughout bilaterally
Trunk and lower extremity tone	hypertonic
Observational strength assessment	Less than full range of motion against gravity
FIM* Rolling left	4: minimal assistance
FIM Rolling right	3: moderate assistance
FIM Supine to sit	3: moderate assistance
FIM Sit to supine	4: minimal assistance
FIM Sit to stand	1: total assistance
FIM Stand to sit	2: maximum assistance
FIM Stand-pivot transfer	1: total assistance requiring 2-person assistance
FIM Ambulation	1: total assistance requiring 2-person assistance for a distance of 1 foot
FIM Wheelchair mobility	1: total assistance for a distance of 10 feet

FIM Stairs	0: does not occur
FIM Comprehension functional status (auditory)	5: standby prompting
FIM Expression functional status (verbal)	1: total assistance
FIM Social interaction	5: standby prompting
FIM Problem solving	1: total assistance
FIM Memory	3: moderate assistance

*FIM= Functional Independence Measure

Table 4. Short-term goals

Bed Mobility	Transfers	Ambulation	Wheelchair Management	Balance
1. The patient will perform supine to sit task with minimal assistance from the physical therapist. 2. The patient will perform sit to supine task with supervision and/or set-up of equipment from the physical therapist.	1. The patient will perform a sit to sit transfer with maximal assistance from the physical therapist.	1. The patient will ambulate on level surfaces for a distance of 10 feet using parallel bars with maximal assistance from the physical therapist.	1. The patient will perform manual wheelchair propulsion on level surfaces for 100 feet with moderate assistance from the physical therapist.	1. The patient will maintain a position of unsupported long sit while performing dynamic sitting balance tasks with minimal assistance from the physical therapist to improve independence with transfers.

Table 5. Long-term goals

Level of Assistance	Independent	Modified Independent	Minimal Assistance
Tasks	Rolling left and right	Sit to supine	Sit to stand
		Supine to sit	Stand to sit
		Propelling a manual wheelchair 150 feet with 2 turns	Stand pivot transfers
			Walking 150 feet with 2 turns

359 **Table 6: Physical therapy interventions**

Interventions & Purpose	Frequency	Assistance Provided	Week 1	Week 2	Week 3	Week 4
Bed Mobility: Focus to improve independence with self-care, LE* dressing, and transfers.	5 days per week, multiple times throughout each session.	(A)* required for trunk force production to overcome posterior boas, eccentric control of lowering trunk, and management of BLE*. VCs* to slow pace to reduce intensity of myoclonic tremors and improve fluidity of task.	(Mod A* - Max A*) Supine ←→ sit with HOB* 30° elevation and use of rails. Supine ←→ sit with HOB at 0° elevation and use of rails.	(Mod A - Max A) Supine ←→ sit with HOB at 0° elevation and use of rails.	(Min A* – Mod A) Supine ←→ sit with HOB at 0° elevation and use of rails. Rolling left ←→ right with HOB at 0°.	(Min A – Max A) Supine ←→ sit with HOB at 0° elevation and use of rails. Rolling left ←→ right with HOB at 0°.
Transfer Training: Focus on improving independence with transfers, improving coordination and sequencing of steps.	5 days per week, multiple times throughout each session.	(A) required by 1-person to facilitate lift off, and control descent. (A) required for coordination of patient's LE and stability throughout the transfer. 2-person (A) required to set-up and stabilize WC*. VCs to initiate the pt* to provide self-compression by wrapping arms across chest tightly to reduce myoclonic tremors.	(Total A – Max A) Attempt slide-board transfer (unsuccessful due to safety concerns) Tall squat pivot transfer from EOB*←→WC. Stand pivot transfer from EOB←→WC.	(Total A - Mod A) Tall squat pivot transfer from EOB←→WC. Stand pivot transfer from EOB←→WC.	(Max A – Mod A) Tall squat pivot transfer from EOB←→WC. Stand pivot transfer from EOB←→WC.	(Max A – Mod A) Tall squat pivot transfer from EOB←→WC. Stand pivot transfer from EOB←→WC.
Transitional Movement: Focus on improving independence with transfers, LE strength, and functional mobility for ADLs*.	5 days per week, multiple times through each session	(A) required to produce power for lift-off, and control descent. (A) to maintain full upright position. When performing in parallel bars or at a walker with padded forearm support (atlas walker); additional (A) was required for placing his hands on the device.	(Total A*- Max A) Sit←→stand within parallel bars.	(Total A- Max A) Sit←→stand with Atlas walker. Sit←→stand without UE* support.	(Max A- Mod A) Sit ←→ stand with Atlas walker. Sit ←→ stand without UE support.	(Max A- Min A) Sit ←→ stand with Atlas walker. Sit ←→ stand without UE support.
Static Standing & Sitting Balance: Focus on increasing activity tolerance, core strengthening, promote weight-bearing, and overall stability	~ 3 times per week, throughout sessions.	(A) required for compression and joint approximation to reduce the myoclonic tremors. (A) for steadying.	(Min A) Static sitting balance on EOB with BUE* support.	(Mod A- Min A) Static sitting balance on EOB without BUE support.	(Mod A- Min A) Static sitting balance on EOB without BUE support. Static standing balance with BUE support on Atlas	(Min A) Static sitting balance on EOB without BUE support. Static standing balance with BUE support on atlas walker.

					walker.	
Coordination: Utilizing Frenkel's exercise progression (See Appendix 5); focus on improving coordination and control of ataxic movements.	~ 2 times per week	(A) required to perform exercises in gravity eliminated position.	(Min A) Performed Frenkel's exercises #1-3 supine.	(Min A – SPV*) Performed Frenkel's exercises #1-5 supine.	(Min A - SPV) Performed Frenkel's exercises #1-7 supine.	(Min A - SPV) Performed Frenkel's exercises #1-7 supine.
Functional Mobility: Focus on improving cardiovascular endurance, LE strength, and coordination.	~ 3-4 times per week	(A) required for advancement of WC, directional changes, and to navigate through doorways.	(Mod A - Min A) Propulsion of WC using BLE for a distance of ~50-100 ft*.	(Min A) Propulsion of WC using BLE for a distance of ~75-100 ft.	(Min A) Propulsion of WC using BLE for a distance of ~50-100 ft.	(Min A) Propulsion of WC using BLE for a distance of ~50-100 ft.
Gait Training: (with rock-n-roll music) Focus on improving cardiovascular endurance, reducing tremors, promoting WB*, coordination of movements, improving ability to perform cognitive dual-tasks, and improving independence with ADLs	~ 5 times per week, multiple trials each session. (beginning at 2nd week)	(A) required for overall stability, compression of forearms onto atlas walker †, navigation/steadying of atlas walker. Additional person's (A) for close WC follow. Throughout patient was total A (according to FIM guidelines) because he required a WC follow based on fluctuations in level of fatigue which resulted in increased ataxia and buckling of knees. The level of (A) stated in each week is the level provided to the pt in a range from the highest level of (A) required that week to the lowest level of (A).	N/A	(Max A of 2 + WC follow) Ambulation within parallel bars. Ambulation with a therapist on each side providing HHA* and support at the waist. Ambulation with utilization of atlas walker. Cognitive dual-task of listening to music with occasional verbalization of lyrics	(Mod A – Min A of 2; Max A –Mod A of 1 + WC follow) Ambulation with utilization of atlas walker. Cognitive dual-task of listening to music with more frequent verbalization of lyrics	(Mod A – Min A of 1 + WC follow) Ambulation with utilization of atlas walker. Cognitive dual-task of listening to music with more frequent verbalization of lyrics

*(A)= assistance, Min A= minimal assistance (0-24%), Mod A= moderate assistance (25-49%), Max A= maximum assistance (50%-74%), Total A (75-100% or 2-person required), SPV = supervision/set-up, pt = patient, BLE= bilateral lower extremities, LE= lower extremity, BUE= bilateral upper extremities, UE= upper extremity, HOB= head of bed, EOB= edge of bed, VCs= verbal cues, WC= wheelchair, WB= weight-bearing, HHA= hand held assistance, ADLs= activities of daily living, ft= feet

† Similar models can be found through: Leckey Assistive Technology Products 9C Ballinderry Road Lisburn, BT28 2SA United Kingdom

Appendices

Appendix 1: Active medication list at IRF during initial evaluation

Medication	Condition the Medication is Being Prescribed For[12]	Dosage
Clonazepam	A sedative commonly used to treat seizures, panic disorder, and anxiety.	1mg tablet taken orally once every 12 hours
Docusate 10mg/mL oral liquid	A stool softener to reduce straining.	100mg/10mL taken orally BID*
Levetiracetam 500mg/5mL oral solution	An anticonvulsant commonly used to treat seizure disorders, and as an adjunct to myoclonic seizures.	1,500mg/15mL taken orally every 12 hours
Multivitamin	As a supplement to daily nutritional intake.	Tablet taken orally once daily
Nicotine 21mg/24hr	Assistance with smoking cessation.	Transderm ER* film one patch daily
Oxybutynin 5mg	A urinary antispasmodic commonly used to treat symptoms of bladder instability associated with voiding in patients with bladder dysfunction usually associated with a neurological cause.	Tablet taken orally once every 12 hours
Rivaroxaban 10mg tablet	An anticoagulant commonly used to treat and prevent occurrence of a DVT*, and other conditions associated with an increased blood clotting ability.	20mg, 2 tablets taken orally after dinner
Senna 8.8mg/5mL oral syrup	A laxative commonly used to treat occasional constipation by producing/stimulating bowel movements.	17.6mg/10mL PRN* taken orally QHS*
Acetaminophen 325mg tablet	An analgesic and antipyretic commonly used to reduce a fever and relieve of pain.	650mg, 2 tablets taken orally every 6 hours
Baclofen 5mg	A muscle relaxant commonly used to treat muscle spasticity associated with certain neurological conditions.	10mg taken orally every 8 hours

*BID= "bis in die" meaning twice daily, ER= extended release, DVT= deep vein thrombosis, PRN= "pro re nata" meaning take as needed, QHS= "quaque hora somni" meaning taken before bedtime

Appendix 2: Modified Ashworth Scale:

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

Appendix 3: Functional Impairment Measurement (Motor):

	Transfer: Bed, Chair, Wheelchair	Locomotion: Walk/Wheelchair	Stairs
0: Does not occur	Activity did not occur due to safety, medical limitation or refusal.	Activity did not occur due to safety, medical limitation or refusal.	Activity did not occur due to safety, medical condition, refusal.
1: Total Assist	Patient performs less than 25% of transfers on and off a bed to a wheelchair (WC). Requires helper to perform all tasks, the patient uses a mechanical lift or patient requires 2 helpers.	Patient travels a distance less than 50 feet or requires 2 helpers for any distance.	Ascends and descends fewer than 4 stairs. Performs less than 25% of effort or requires 2 helpers for any number of stairs.
2: Max Assist	Patient performs 25% - 49% of the transfer. Requires assistance both to stand and to lower to a sit.	Patient travels a distance of 50 ft to 149 ft or helper needed to assist with ambulation, wheelchair, for safety, supervision, verbal cues or to carry equipment (such as oxygen).	Ascends and descends 4-11 stairs. Performs 25% - 100% of the effort OR Ascends and descends 12-14 stairs. Performs 25% - 49% of the effort.
3: Moderate Assist	Patient performs 50% - 74% of the transfer. Requires lifting for part of the transfer, either to bring patient to stand or to help lower the patient to sit, requires helper to assist with two limbs.	Patient travels a distance of 150 feet or more. Performs 50%-74% of walking or wheelchair task.	Ascends and descends 12-14 stairs. Performs 50%-74% of the effort.
4: Minimum Assist	Patient performs 75% - 100% of the transfer. Requires touching, steadying or contact guard assistance. Requires assistance with one limb.	Patient travels a distance of 150 feet or more. Performs 75% or more of walking or wheelchair task.	Ascends and descends 12-14 stairs. Performs 75% or more of the effort. Touching, contact guard assist or steadying assist.
5: Supervision, Standby Assist	Requires cueing, coaxing, supervision, or set up of device. Requires setup of wheelchair (locking brakes, moving leg rests or placing sliding board).	Patient travels a distance of 150 feet or more. Requires set-up, verbal cues, supervision, coaxing or to carry equipment (i.e. O2).	Ascends and descends 12-14 stairs with standby assist, cueing, coaxing, supervision and/or helper carries oxygen tank.
5: (Household Exception)	--	Patient travels a distance of 50 ft to 149 ft with no helper needed. Ambulates or uses wheelchair independently for short distances.	Ascends and descends 4-11 stairs independently. No helper needed.
6: Modified Independent	Patient raises the head of the bed to transfer. (no assistance) Requires the use of bed rails, arm rests, grab bars, a sliding board, walker, or a cane to complete transfer, takes 3 times longer than usual.	Patient travels a distance of 150 feet or more. Ambulates with a device. Operates a manual or motorized wheelchair independently. Can negotiate a 3% grade, over carpet, around corners and over door sills.	Ascends and descends 12-14 stairs with an assistive device, handrail and/or orthosis or protheses.
7: Independent	Transfers safely and independently. If transferring to/from a wheelchair, patient must manage all parts independently and not use arm rests during transfer.	Patient travels a distance of 150 feet or more. Ambulates independently *Not used for wheelchair mobility.	Ascends and descends 12-14 stairs safely and independently. No hand rails used.

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378 Appendix 4: Functional Impairment Measurement (Cognitive)

	Comprehension	Expression	Social Interaction	Problem Solving	Memory
1: Total Assist	Patient does not respond appropriately, consistently or reliably <25% of the time.	Patient expresses basic needs/ideas <25% of the time or does not express needs appropriately or consistently despite prompting.	May require restraints or alarms or 1:1 supervision for safety 75% or more of the day. Patient acts appropriately with staff less than 25% of the time.	Requires direction nearly all of the time. May need restraint for safety. 1:1 staff.	Manages the 3 R's (recognize people frequently encountered, remember daily routine, execute requests without being reminded) less than 25% of the time or not at all.
2: Maximum Direction/ Prompting	Patient understands basic needs/ideas 25%-49% of time. Patient only understands simple words or commonly spoken expressions ("Hello, how are you?") or gestures (waving)	Patient expresses basic needs/ideas 25%-49% of the time, is only able to express single words or gestures, or needs prompting > than half the time.	Interacts appropriately 25%-49% of the time.	Solves routine problems 25%-49% of the time, requiring assistance to initiate, plan, or complete simple daily activities.	Manages the 3 R's 25%-49% of the time. Remembers 1/3 unrelated tasks.
3: Moderate Direction/ Prompting	Understands basic needs/ideas 50%-74% of the time. Patient may need parts of sentences repeated due to lack of understanding or hearing loss.	Patient expresses basic needs/ideas 50%-74% of the time. Repeats parts of sentences or phrases.	Interacts appropriately 50%-74% of the time.	Solves routine problems 50%-74% of the time.	Manages the 3 R's 50%-74% of the time. Remembers 2/3 unrelated tasks.
4: Minimum Direction/ Prompting	Understands basic needs/ideas 75%-90% of time; may need single words repeated due to lack of understanding or hearing loss.	Patient expresses basic needs/ideas 75%-90% of the time. May repeat single words.	Interacts appropriately 75%-90% of the time. Requires supervision under unfamiliar situations.	Solves routine problems 75%-90% of the time.	Manages the 3 R's 75%-90% of the time.
5: Standby Prompting/ Supervision/ Setup	Requires prompting less than 10% of the time for routine/basic information. May need to stress particular words or phrases, repetition, or provide visual or gestural cues or helper puts in hearing aid.	Patient requires prompting less than 10% of the time to express complex or abstract ideas. Patient expresses basic daily needs/ideas.	Requires supervision under unfamiliar situations <10% of the time. Requires cueing and coaxing to participate. Staff prompts less than 10% of the time.	Requires supervision in unfamiliar situations <10% of the time. Requires cueing and coaxing to participate. Staff prompts less than 10% of the time.	Requires cueing, repetition, or reminders under unfamiliar situations. Staff prompts less than 10% of the time.
6: Modified Independence	Comprehends complex information with additional time, or has mild difficulty but self corrects. If primary mode is visual: corrective lenses are a device. If primary mode is auditory: a hearing aid is a device. An interpreter is not considered a device.	Patient may need extra time or a device such as a communication board or a computer device or system. Patient self corrects. Mild difficulty managing own device.	Requires medication (must receive medication consistently not ordered as needed). Has mild difficulty with behavior or participation but self corrects.	Required extra time. Patient self corrects. Mild difficult, recognizes problems, initiates steps to solve and able to carry out sequence of steps to solve with only mild difficulty.	Employs a memory device independently or requires extra time. Patient self corrects. Mild difficulty.
7: Complete Independence	Comprehends complex information without a device, prompts, cues, or assistance of any kind.	Patient clearly and fluently expresses complex or abstract ideas and information.	Interacts with others appropriately 100% of the time. Controls temper. Accepts criticism and is aware of impact.	Consistently demonstrates the 5 required steps to manage complex problems.	Manages the 3 R's without assistance 100% of the time. Remembers 3/3 unrelated tasks.

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381 **Appendix 5: Frenkel's Exercises for Ataxic Conditions[11]**

	Exercises While Laying Down	**Exercises While Sitting**	**Exercises While Standing**
Description of Starting Position	Lie on a bed or mat with a smooth surface along which the feet may be moved easily. The patient's head should be raised on a pillow to be able to watch every movement.	Sit on a chair with feet flat on the floor.	Stand erect with feet 4 to 6 inches apart.
Exercise #1	Bend one leg at the hip and knee, sliding your heel along the bed. Straighten the hip and knee to return to the sitting position. Repeat with the other leg.	Mark time, raising just the heel. Then progress to alternately lifting the entire foot and placing the foot firmly on the floor upon a traced foot print.	Walk sideways beginning with half steps to the right. Perform this exercise to a counted cadence: At one, shift the weight to the left foot, at two, place the right foot 12 inches to the right; at three, shift the weight to the right foot; at four, bring the left foot over to the right. Repeat exercise with half steps to the left. The size of the step taken to right or left may be varied.
Exercise #2	Bend one leg at the hip and knee as in #1. Then slide your leg out to the side leaving your heel on the bed. Slide your leg back to the center and straighten your hip and knee to return to the starting position. Repeat with the other leg.	Make two cross marks on the floor with chalk. Alternately glide the foot over the marked cross: forward, backward, left and right.	Walk forward between two parallel line 14 inches apart placing the right foot just inside the right line, and the left foot just inside the left line. Emphasize correct placement. Rest after 10 steps.
Exercise #3	Bend one leg at the hip and knee with the heel raised from the bed. Straighten your leg to return to the starting position. Repeat with the other leg.	Learn to rise from the chair, at two, bend trunk forward; at three, rise by straightening the hips and knees and then the trunk. Reverse the procedure to sit down.	Walk forward placing each foot on a footprint traced on the floor. Foot prints should be parallel and 2 inches from a center line. Practice with quarter steps, half steps, three-quarter steps, and full steps.
Exercise #4	Bend and straighten one leg at the hip and knee sliding your heel along the bed stopping at any point of command. Repeat with the other leg.	--	Turn to the right. At one, raise the right toe and rotate the right foot outward, pivoting on the heel; at two, raise the left heel and pivot the left leg inward on the toes; at three, completing the full turn, and then repeat to the left.
Exercise #5	Bend the hip and knee of one leg and place that heel on the opposite knee. Then slide you heel down the shin to the ankle and back up to the knee. Return to the starting position and repeat with the other leg.	--	Walk up and down the stairs one step at a time. Place the right foot on one step and bring the left up beside it. Later practice walking up the stairs placing one foot on each step. At first use the railing, then as balance improves, dispense with the railing.
Exercise #6	Bend both hips and knees sliding heels on the bed keeping your ankles together. Straighten both legs to return to starting position.	--	--
Exercise #7	Bend one leg at the hip and knee while straightening the other in a bicycling motion.	--	--

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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.	3-4
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.	4-5
6. **Clinical Findings** – Relevant physical examination (PE) and other clinical findings	5-6
7. **Timeline** – Relevant data from this episode of care organized as a timeline (figure or table).	9
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.	6-8
9. **Therapeutic Intervention** a. Types of intervention (pharmacologic, surgical, preventive). b. Administration of intervention (dosage, strength, duration). c. Changes in the interventions with explanations.	8-9
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.	9-10
11. **Discussion** a. Strengths and limitations in your approach to this case. b. Discussion of the relevant medical literature. c. The rationale for your conclusions. d. The primary "take-away" lessons from this case report.	10-11
12. **Patient Perspective** – The patient can share their perspective on their case.	N/A
13. **Informed Consent** – The patient should give informed consent.	1