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Using a Symptom-Based Approach to Gait Progression in a Patient with Lateral Medullary Syndrome: A Case Report

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Abstract:
Background: Descriptions of treatments are sparsely cited in the literature when using a symptom-based approach to physical therapy after a lateral medullary stroke. However, there are many treatment options available for gait progression in the inpatient rehabilitation setting whether the patient is having a good or bad day (referring to symptoms). **Case Description:** The patient was a 53-year old male who suffered posterior circulation strokes (later named Lateral Medullary Syndrome) and had a 30-day stay on an inpatient rehabilitation unit. **Outcome Measures:** FIM scores were used to evaluate progress from initial evaluation to discharge. Daily subjective reports were also used to monitor and direct treatments. **Discussion:** Many interventions may be utilized in the inpatient rehabilitation setting to address gait along with other functional activities. A patient's rehabilitation journey following lateral medullary syndrome is their own and should not be compared too closely to another's. Post-stroke physical rehabilitation is not a linear progression, and requires flexibility in treatment decision making, often daily.

Keywords: Physical Therapy; inpatient rehabilitation; lateral medullary syndrome; posterior circulation strokes; post-stroke gait progression

Introduction

Strokes are the third leading cause of death in the United States (US), behind heart disease and cancer; and they are the leading cause of serious, long-term disability. 15 million people worldwide suffer from a stroke per year, and an average of 795,000 of those are in the US alone. Of those 15 million, 5 million result in death (over 140,000 of those deaths in the US), and 5 million are permanently disabled. Having high blood pressure is the greatest risk factor for stroke, and the risk of having a stroke in those who smoke is double that of non-smokers.[14] The two most basic types of stroke are ischemic and hemorrhagic. Ischemic strokes occur when a cerebral vessel becomes obstructed. Ischemic strokes account for 87% of all strokes. A hemorrhagic stroke occurs when a blood vessel that supplies the brain ruptures.[18]

Lateral medullary syndrome is a term given to an ischemic stroke which is produced by infarction of a specific region of the brain, the lateral medulla, lying posterior to the inferior olivary nucleus. Traditionally lateral medullary syndrome was thought to be attributed to the occlusion of the posterior inferior cerebellar artery (PICA). However, more recent evidence has found that lateral medullary syndrome could more often be the result of a vertebral artery occlusion from atherothrombosis.[12]

Based on the complexity of the functional anatomy within the medulla many areas may be affected post-medullary stroke, such as the vestibular nuclei, spinothalamic tract, descending sympathetic tract, utricular nucleus, olivocerebellar fibers, spinocerebellar fibers, restiform body, inferior cerebellum, tracts and nucleus of cranial nerves V, IX and X, nucleus solitarius, tractus solitarius, cuneate and gracile nuclei.[11] With a large number of regions involved, there are numerous possible signs and symptoms. These symptoms, among others, may include: vertigo, nystagmus, sensory changes, limb ataxia, miosis, ptosis, hoarseness, dysphagia, palate and vocal cord paralysis, changes in vision, falling to one side, and loss of taste, among others. See table 1 below for a listing of possible regions and their associated symptoms.[11]

Table 1. Symptoms manifestation often found in lateral medullary syndrome vs. patient presentation

Areas symptoms are derived from	Symptoms	Patient presentation
Vestibular nuclei	Vertigo, nystagmus, oscillopsia, vomiting	Vertigo, oscillopsia, vomiting
Spinothalamic tract	Contralateral, or less often, ipsilateral impairment of pain and thermal sensation	Ipsilateral impairment of pain and thermal sensation
Descending sympathetic tract	Ipsilateral Horner syndrome, miosis, ptosis, decreased sweating	Ipsilateral ptosis, decreased sweating
Issuing fibers of 9th and 10th nerves	Hoarseness, dysphagia, hiccups, ipsilateral paralysis of palate and vocal cords, decreased gag reflex	Hoarseness, initial dysphagia, intractable hiccups
Utricular nucleus	Vertical diplopia and illusion of tilting of vision and rotation of vertical meridian	Diplopia
Olivocerebellar, spinocerebellar fibers, restiform body, inferior cerebellum	Ipsilateral ataxia of limbs, falling or toppling to ipsilateral side, sense of lateropulsion	Ipsilateral ataxia of limbs, lateropulsion
Descending tract and nucleus of 5th	Pain, burning and impaired sensation over ipsilateral ½ of face	Unclear – patient did not state
Nucleus and tractus solitarius	Loss of taste	Not present
Cuneate and gracile nuclei (rare)	Numbness of ipsilateral limbs	Decreased to absent sensation on ipsilateral limbs and trunk

*Note: Table adapted from Ropper, et al.[11]

In addition to the many signs and symptoms that can occur following a lateral medullary stroke, the patient's health history, medications used, and size and regions involved in the stroke are factors that influence the initial presentation to physical therapy and progress throughout treatment. For these reasons, there is limited research as to the overall treatment plan and daily physical therapy interventions for a patient in the inpatient rehabilitation setting recovering from a lateral medullary stroke.[13] No two strokes will present the same, rehabilitate the same, or have the same outcomes. Therefore, no physical therapy rehabilitation plan will, or should, look the same. Therefore, the purpose of this case report is to highlight the challenges and triumphs associated with one individual's inpatient rehabilitation journey and how we used a symptom-based approach in the progression of gait.

Case Description

The subject of this case report is a 53-year-old male with a past medical history of smoking, hypertension, hyperlipidemia and type II diabetes. Late one morning the patient was taken to the emergency department (ED) by his wife after they both became concerned due to him experiencing a headache, leaning to the left as he was walking, and the feeling of left arm numbness. The patient vocalized upon arriving at the ED that he had been having on-and-off headaches for the last month. The headaches would start behind his left eye and spread around the cranium. The headache he had when he arrived at the ED was of similar presentation to the ones he had experienced in the prior month. However, the lateral lean while ambulating and left arm numbness was new and worrisome to the patient, and his wife.

The patient was admitted to the intensive care unit (ICU) and had magnetic resonance imaging (MRI) of the head and neck. The imaging revealed the patient had a few small areas of increased signal on diffusion weighted imaging involving the left parietal occipital lobes indicating acute/subacute infarcts and mild chronic microangiopathy, most pronounced in the left posterior watershed region. The neurologist in the ICU diagnosed this patient with "posterior circulation strokes". The patient remained in ICU for eight days. For the first several days in ICU his stroke presentation worsened; he exhibited failed swallow tests, hoarseness in his voice, extreme dizziness and nausea with any movement (especially of his head), intractable hiccups, diplopia, inability to find or maintain midline orientation, inability to ambulate without maximum assistance, ataxic limbs on the left side, and he had further sensory changes to his left side. After becoming medically stable he was transferred to an inpatient rehabilitation unit (IRU). For this patient, the majority of his therapy hours were spent in physical or occupational therapy, rather than speech therapy.

Initial Examination

Upon admission to IRU, a physical therapy examination was completed and functional independence measure (FIM) scores were collected. During the initial examination the patient was able to follow commands appropriately and demonstrated no cognitive impairments; his speech was quiet and hoarse, and hiccups remained constant throughout. He reported feeling "pins, needles, and tingling" in his left upper extremity, a diminished sense of light touch along with an altered perception of sharp/dull and differences in temperature. The diminished sensation was also present on the left side of his trunk. Light touch and sharp/dull was intact in bilateral lower extremities along with the right upper extremity. The patient's proprioception and kinesthetic awareness were affected on the left side in both the upper and lower extremities, and he demonstrated ataxic movements. Impairment in coordination was observed while he was unable to complete rapid, alternating movements of the hands and feet. The patient expressed great frustration with his inability to control his limbs as he wanted. He often stated, "I know what I need to be able to do- I'm telling my body to do it, and it just won't listen". Overall the patient revealed good muscle strength (grossly 5/5), except for slight decrease in strength in the left triceps and biceps (4/5). Along with the frustration of not having control of his limbs as he wished, he expressed extreme annoyance with his hiccups.

Mobility and transfer tasks were assessed during the initial examination (see table 2 for more specific assist levels during certain tasks). The patient was requiring stand by assist (SBA) for transfers

in bed/to side of bed, minimum assist (minA, up to 25%) for transfers to chair and standing, moderate assist (modA, up to 50%) for standing, and max assist (maxA, up to 75%) while walking 5 feet without an assistive device. During all mobility tasks patient became very fatigued, nauseated, and dizzy. He was unable to complete more complex mobility tasks such as side-stepping, retrograde walking, gait on a curb, or stair climbing, all due to safety concerns. He stated that he was unaware that he was falling to the left side until the point where he needed assistance to regain balance and upright posture. The goals set at the end of the initial examination were that the patient would be independent in all transfers, modified independent in ambulation (relying on an assistive device) and that he would require only supervision on the stairs. The patient's FIM scores were assessed and can be found in table 3. The FIM scores upon initial evaluation indicated that a majority of functional mobility tasks were requiring maximal-total support. When asking the patient about individual goals he listed four: he wanted to be able to complete transfers independently, not have to use a wheelchair at home, get rid of his hiccups, and eventually get back to work.

Clinical Impression I

From the initial evaluation, several areas were identified in which would be focused on in the first weeks of rehabilitation: tonal abnormalities, poor balance, left-sided limb ataxia, gait abnormalities, mal-adapted perception of midline orientation, poor postural control and impairments in the vestibular and visual systems that were causing nausea, vomiting, and vertigo with poor tolerance for head movement and change in positions. All these areas of disabilities were leading to the inability of the patient to ambulate without maximal assist or sitting and standing without minimum to moderate assist upon admission to the IRU. For this case report the focus will be on discussing the changing interventions concentrating on functional movements and gait, although daily the interventions targeted all aspects of the problem list from above. The interventions were dependent on the day-to-day presentation of the patient, which we are referring to as interventions guided by a symptoms-based approach.

Every morning as the physical therapist arrived in the patient's room before treatment sessions the patient stated whether he was having a "good" day or "bad" day. The patient considered a "good" day one in which he could tolerate upright activities before and during breakfast; no emesis before the morning physical therapy session; and lower levels of headache pain, dizziness, and nausea. When the patient would state he was having a "bad" day, he would refer to this as higher levels of dizziness, nausea, vomiting, fatigue, and more assistance needed for morning ADLs and transfers. See figure 2 to see the progression of his daily subjective status over a month of rehabilitation. This is a representation of a non-linear subjective and symptom intensity presentation post-stroke during inpatient rehabilitation physical therapy. This patient's good days aligned with high-level treatment days, in which interventions were progressed. His bad days associated with his low-level treatment days. On low-level treatment days the interventions were not progressed, but rather taken "back to the basics" or more passive treatment approaches were utilized. Even the days in which our patient was unable to stand or sit without emesis, there were still treatment options in the supine or side-lying positions which could be completed and contributed to his overall goals and progression in physical therapy. See table 4 for some of the interventions that were utilized on the lower-level treatment days. It was shared with the physical therapist by the patient and his wife that for the last 10-15 years the patient struggled with extreme motion-sickness. He stated that he was unable to be a passenger in a car without getting sick, ride on a boat, and couldn't ride on any carnival or amusement park rides. This could be a contributing factor to the sickness the patient experienced post-stroke.

Components of Gait

Individuals without underlying impairments, who have not suffered a stroke, learn how to walk over several years, which becomes more of an automatic task, rather than a conscious (step by step) one. However, a large number of systems and areas of the brain influence posture and gait: the cerebral cortex, cerebellum, basal ganglia, subthalamic locomotor region, midbrain, and spinal cord with segmental reflexes.[15] When one or more of these systems are affected after stroke, it causes the

patient to have to consciously focus on the walking task, or in a sense, re-learn the task so it once again becomes automatic.[10]

Although gait is a complex subject matter, the requirements for upright walking can be reduced to antigravity support of the body (verticality), stepping, maintenance of equilibrium, and a means of propulsion.[6] Verticality is a concept that is used in human sensory systems for postural orientation. It refers to a position (or posture) perpendicular to the horizontal plane. Three different sensory systems regulate upright posture; the vestibular, visual and somatosensory systems. When there is damage to the central integrating system [of sensory information] or disturbance of the central or peripheral vestibular system, it can cause an abnormal perception of the body's posture, or orientation in space.[9] Patients with brainstem or medullary stroke may present with a large ipsilateral bias in their subjective postural vertical which causes them to fall towards the direction of their lesion (ipsilesional).[9] This ipsilesional bias has been termed as lateropulsion and is a common symptom after lateral medullary stroke. The exact region affected to produce this phenomenon is not well understood but may involve the restiform body, olivocerebellar area, rubrocerebellar areas,[2] lateral vestibulospinal tract or the dorsal spinal cerebellar tract.[17] The lateral vestibulospinal tract has a part in control of vestibulospinal postural control, whereas the dorsal spinal cerebellar tract plays a part in ascending proprioceptive information.[17]

Equilibrium must also be maintained while stepping occurs. Stepping, which is a reflex present at birth, requires descending control from the caudal midbrain tegmentum and pontine reticular formation; controlling gait mechanics through the reticulospinal, vestibulospinal, and tectospinal pathways.[11] Equilibrium is necessary to maintain a vertical posture as the center of gravity shifts slightly side to side and forward as walking occurs. Equilibrium also occurs through the righting and postural reflexes, with the vestibulocerebellar tract being a large proponent.[11]

Stepping is not as simple as it sounds, however. When one has difficulty with inter- and intra-limb coordination it is termed limb ataxia and can be a common symptom after cerebellar, medullary or the generalized posterior circulation strokes diagnosis.[16] Limb ataxia can contribute to ataxic gait; which is a compensatory gait pattern characterized by slow walking speeds, irregular steps, difficulties with limb coordination and reduced postural stability.[5] Ataxic gait occurs when the central nervous system is unable to optimally complete motor learning, or process both the motor commands (efferent) and sensory feedback (afferent)[8] while timing the muscle activation and coordination,[8,3] not allowing the limb movements, or walking task to be automatic. The lack of automatic control will mean that the patient will present with highly variable motor performance on a daily basis, especially if they are fatigued, unwell, or distracted.[5] Our patient was a wonderful example of this.

Although there is not a large variety of research addressing the overall physical therapy treatment of lateral medullary strokes, there is research pertaining to certain aspects or deficits after the stroke. Common treatments found in the literature for limb ataxia include: weighting of the torso or limbs, supported suspended treadmill walking, direct feedback of the visual system, noninvasive brain stimulation for neuromodulation, balance-based torso weighting (BBTW), and generalized strengthening and core stability training.[7] Weighting of the torso is somewhat common, but the mechanism in its success has not been well established. It may involve an increase in somaesthetic contributions to movement control (including postural control) and a mechanical reduction in the severity of multi-segment coordination disorders.[7] Despite the varied approaches available, there is consensus at least that balance is a priority.

Interventions Progressing Gait: Week One

Week one was heavily focused on slow, purposeful movements. The first goal at hand in gait progression was the patient achieving antigravity support of the body (or achieving verticality). Due to the patient's display of ipsilesional lateropulsion and left-sided limb ataxia, we started the patient with basic functional tasks such as short sitting in a chair or mat table without the use of upper extremity support. We also worked on static standing with an appropriate base of support, and many pre-gait activities (see table 5 for examples). Using the visual system for instant feedback on body position is a

useful tactic after a stroke. However, when attempting to use a mirror the patient's vertigo caused increased dizziness and often instant emesis. Therefore, the usage of a mirror for self-feedback was not an option in week one.

To address verticality, with the patient short sitting on the mat table, from the patient's posterior we provided superior to inferior pressure on the top of his shoulder to give deep proprioceptive input and a sense of grounding. At this time the patient focused on a spot on the wall in front of him and was instructed to attempt to maintain his upright posture (not falling to his left side), as the therapist gradually lessened the pressure on his shoulders. This same principle was completed in a static stand. When the patient could achieve a short sitting position for 30 seconds without physical assist we progressed to the next intervention.

To address static standing without falling to his left, the patient stood leaning against a wall on his right side. This served as instant tactile feedback. When the patient could no longer feel the wall on his right shoulder, it would cue him that he was beginning to fall to his left. The patient completed pre-gait activities both beside the mat table and the wall. During the interventions the patient was challenged by with progression of the activity or decreasing assist from the physical therapist. When the patient was able to demonstrate ability to short sit for 30 seconds, stand at the wall or mat table without lateropulsion or loss of balance, and ability to complete pre-gait activities with assist, we progressed to assisted over-ground walking.

Over-ground walking began with the patient completing short distance ambulation (10 feet) with his right side to the wall, or ambulation around a high-low mat table. The mat table was to his right side (contralesional), and the physical therapist was to his left (ipsilesional, and to the side of lateropulsion). The patient utilized his right hand to stabilize himself during ambulation, and the physical therapist provided maximal support for safety, assisted in weight shifts, and verbally cued the patient to keep him focused on the walking task. Cues were given to the patient such as "push your knee forward, sky your toes, slowly move your foot to the target, and keep a wide base".

Week one was also the introduction of stabilization and strengthening exercises that were completed in supine and side-lying positions. Mat exercises were focused on the transverse abdominus, quadriceps, hamstrings, and gluteus medius, among other muscle groups. These exercises allowed multiple options on low-level treatment days and also gave our patient safe exercise options to complete independently (or with assist of his wife), outside of physical therapy sessions. Low-level treatment days or portions of sessions in which the patient could not tolerate any active movements without nausea or emesis, we completed manual passive stretching on tight musculature (ipsilesional side especially), and soft tissue mobilization on trigger point areas.

Interventions Progressing Gait: Week two

In week two we continued to progress the patient's pre-gait activities while incorporating upper extremity involvement. He advanced to weight shifting with upper extremity stacking activities at diagonals (emphasizing right weight shift) and marching/step-ups onto a six-inch box. In order to increase muscle recruitment and multiple muscle groups for tasks, the patient began to use the shuttle machine for bilateral and single leg presses. In order for the patient to carry over the large muscle recruitment and reciprocal patterning into a functional task we directly challenged the patient with ascending and descending 4 stairs after using the shuttle. Although requiring heavy assistance, the patient was pleasantly surprised that he could navigate the stairs. This appeared to be a boost of confidence he needed, as he became even more motivated to continue progressing his gait and was more confident in the possibility of doing so.

A few days into week two, our patient demonstrated the ability to walk around the high low mat with light contact assist for safety. Therefore, week two brought the beginning of utilizing other means over-ground walking. Using a tray table on wheels the patient maintained right forearm placement on the tray table while ambulating in a straight line, with the assist of the therapist on his left side. This, like leaning into the wall, allowed for a constant tactile cue to overcompensate and lean to the right, rather than allowing lateropulsion, falling to the left. The therapist then took the place of the tray table, assisting the

patient during ambulation on his contralesional side rather than ipsilesional. He was given verbal and tactile cues to lean into the therapist. When the patient began demonstrating lateropulsion, the therapist would assist at the patient's waist and pull him to his right. The patient had lower levels of dizziness, nausea, and vomiting, which allowed for these progressions in gait. However, due to the higher intensity of intervention and decreased assistance, the patient more quickly fatigued, and some sessions ended with the focus on mat exercises, manual therapy techniques, stretching or family education.

At the latter half of week two the patient had suddenly begun requiring increased assistance during transfers, while standing, and during ambulation. He was unable to tolerate any upright activities on day 14, stating that even trying to sit or stand instantly caused an increase in headache, dizziness, and emesis. He was then sent for an MRI, which showed an extension of edema around sites of stroke, not an extension of the strokes themselves. The neurologist at the IRU then changed his medical diagnosis to "lateral medullary syndrome". As a result, his medications were changed, and he was able to continue with therapy the following day (start of week three).

Interventions Progressing Gait: Week three

The beginning of week three was focused on interventions bringing it "back to the basics" with many low-level treatment sessions as the patient was recovering from the increased edema around the stroke sites. Some low-level treatment sessions were more heavily focused on the NuStep, where the movements were predictable, and the patient was upright. Mat exercises on the highest-symptom days were sometimes too aggressive causing emesis due to vertigo symptoms with horizontal positioning and with position changes. As the sessions passed and symptoms began to ease, we worked with the patient on executing transfers slowly, sitting without the use of upper extremities while maintaining midline, along with static standing.

On day seventeen the patient had great improvement in his nausea and emesis, thus we were able to resume the progression of his rehabilitation, specifically gait. He was able to decrease his level of assist without any abrupt losses in balance when ambulating around the mat table and walking in a straight line with his therapist to his right. We then moved on to using an overhead track and harness system; the Solo-Step. The patient worked very hard during this new-to-him intervention, and he found it to be quite challenging. He did not have the tactile cues from the wall, mat table, or therapist. It was a safe place for him to feel himself falling to his left side while walking. He was over-recruiting during ambulation in the Solo-Step, but just in a short 20-minute span, he was able to make great improvements in his ambulation, which then carried over to walking with minimal assist from the therapist once out of the Solo-Step harness. After such a productive day, the patient reached a level of fatigue that brought us back to the utilization of mat exercises, seated exercises, and very slow, purposeful movements into varying positions, working on independence in bed mobility and transfers. With continuation of over-ground walking with and without an assistive device and in the Solo-Step, the end of week three was focused on increasing the distance of ambulation. At the beginning of week two the patient was walking no more than 60 feet in one bout. By the end of week three, he had worked up to almost 100 feet of walking without taking a seated rest break.

Interventions Progressing Gait: Week four

Week four was the first time, since admission to acute care, that the patient subjectively stated that he had more good days than bad which resulted in a week of great progression. Pre-gait activities took up less time, and we were able to focus on developmental sequencing tactics such as quadruped position, crawling, and tall kneeling. This was very difficult for our patient. However, after completing these tasks, he demonstrated improvement in his reciprocal patterning and coupling with upper extremity movements during ambulation. The Solo-Step continued to be used during week four with the progression of walking over and around items on the floor. The patient continued to display in his base of support left leg adduction and right leg abduction during standing and gait activities, which contributed to falling to his left. Therefore, the physical therapist placed an elastic band around the

patient's ankles, which provided cues for him to keep a wide base of support. Due to his vertigo and dizziness symptoms lessening we were also able to use tape cues and cones on the floor for step length and width. All of these activities with much repetition brought within-session improvement in gait, with less physical assistance needed from the physical therapist.

The patient was showing increased tolerance for a longer duration of upright tasks and gait, so early in week four, the patient was placed in a suspended treadmill and completed 2-minute bouts of fast speed walking (2.5-3.0mph). To address the patient's lack of arm swing we stood behind the patient and completed a reciprocal arm swing while he was ambulating. The patient was then cued to continue with the arm swing, purposefully over-accentuating. The patient stated this felt very unnatural. However, while the patient was ambulating with the over-accentuated arm swing, he showed decreased lateral deviations and reduced physical assist necessary. We continued to provide less physical support during over-ground walking and allowed the patient and his wife more practice with her providing the physical assist, or with the patient utilizing an assistive device with his wife supervising. We were able to continue progressing complex gait with retrograde walking, side-stepping, stepping over items, ambulating on uneven surfaces, navigating steps regularly, and further challenging balance. By the end of week four, the patient was able to ambulate 300 feet with contact guard assist from the therapist, and standby assist when using a front wheeled walker (which he would utilize once discharged).

Outcomes

The functional independence measure (FIM) was the only standardized outcome measure that was used in this case report due to the patient's high variability in performance with his fluctuating daily presentation of symptoms. His success in his 30-day stay at IRU was not only measured by the FIM, however. The achievement was also demonstrated through the changing level of assist necessary during various mobility tasks (table 2), subjective report of headache and nausea level (figure 2), and distance of ambulation without a rest break (figure 3). The minimal clinically importance difference (MCID) for FIM scores is 22 points for total FIM score, 17 points for the motor subscale, and 3 points for the cognitive subscale.[1,4] The motor subscale includes: eating, grooming, bathing, dressing (upper and lower body), toileting bladder management, bowel management, transfers (bed/chair/wheelchair), toilet transfers, bath/shower transfers, walking (or using wheelchair), and stairs.[4] Each motor item is scored on a point scale from 1 (completely dependent) to 7 (completely independent). The higher the score, the more independent the patient is in performing the motor task. The total score for the motor subscale is a value between 13-91.[4] In the IRU setting the physical therapist collects the FIM scores for bed/chair/wheelchair transfers, walking/wheelchair assistance and distance and stair navigation. The occupational therapist collects scores the remaining mobility items in the motor subscale. Due to the physical therapist only collecting a portion of the FIM scores, those are the scores in which we will take into consideration for this case report subject. The total FIM points that were collected (from a physical therapy standpoint) could range from 5-30. Although the MCID is not stated for only a portion of the motor subset, our patient had a 16-point increase from time of initial evaluation to discharge. The MCID for the whole motor subscale (including items scored by occupational therapist) is 17 points.[1,4] The patient's 16-point improvement in this small portion of the motor subscale allowed us to believe that he had made a significant change in his independence level during his treatment. The patient's FIM scores for motor tasks can be found in table 3.

Figure 1. Timeline of events from emergency depart visit to discharge from inpatient rehabilitation

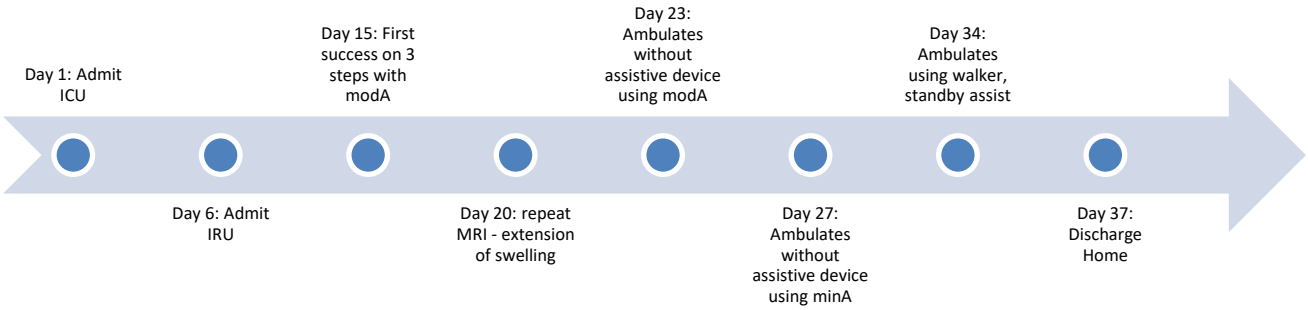
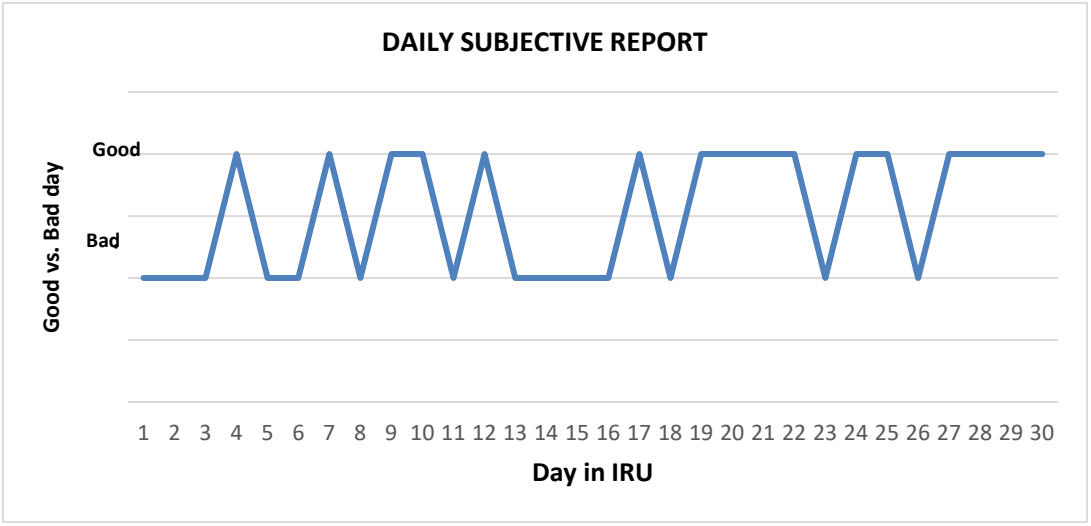


Figure 2. Daily morning verbal report from patient on whether he was having a good day or bad day



*Note: A “bad” day is one in which the patient had nausea and emesis prior to and/or during morning physical therapy session. These “bad” days also correlated to low-level treatment days

Table 2. Patient's level of assist necessary during various mobility tasks at initial evaluation, 2 weeks and 4 weeks (discharge)

Mobility task	Initial evaluation	Week 2 evaluation	Discharge evaluation
Rolling	Independent with use of bed rail	Independent	Independent
Supine to sit	SBA with use of bed rail	Supervision	Independent
Sit to supine	Supervision	Supervision	Independent
Sitting balance	ModA	SBA	Supervision
Bed to chair transfer	MinA with PSPT	SBA with PSPT	Supervision with SPT
Sit to stand	LCA	Close SBA	SBA
Standing balance	ModA	LCA	SBA
Gait on level	5' with maxA	100' with ModA	310' with LCA or supervision with AD
Complex gait	Unable	ModA	LCA with AD
Gait on curb	Unable	ModA	SBA with AD
Gait on stairs	Unable	ModA	MinA with 1 railing
Wheelchair skills	Independent	Independent	Independent

*Note: Abbreviations – Stand by assist (SBA), moderate assist (ModA), partial stand pivot transfer (PSPT), stand pivot transfer (SPT), light contact assist (LCA), maximum assist (MaxA), minimum assist (MinA).

Table 3. Functional independence measure (FIM) scores for patient upon initial evaluation, goals set at time of admission, and at discharge evaluation.

Category	Initial	Goal	Discharge
Bed/wc/chair transfer	4	6	5
Walk	1	6	5
Walking distance	1	3	3
Distance in wheelchair	3	3	3
Stairs	unsafe	6	4

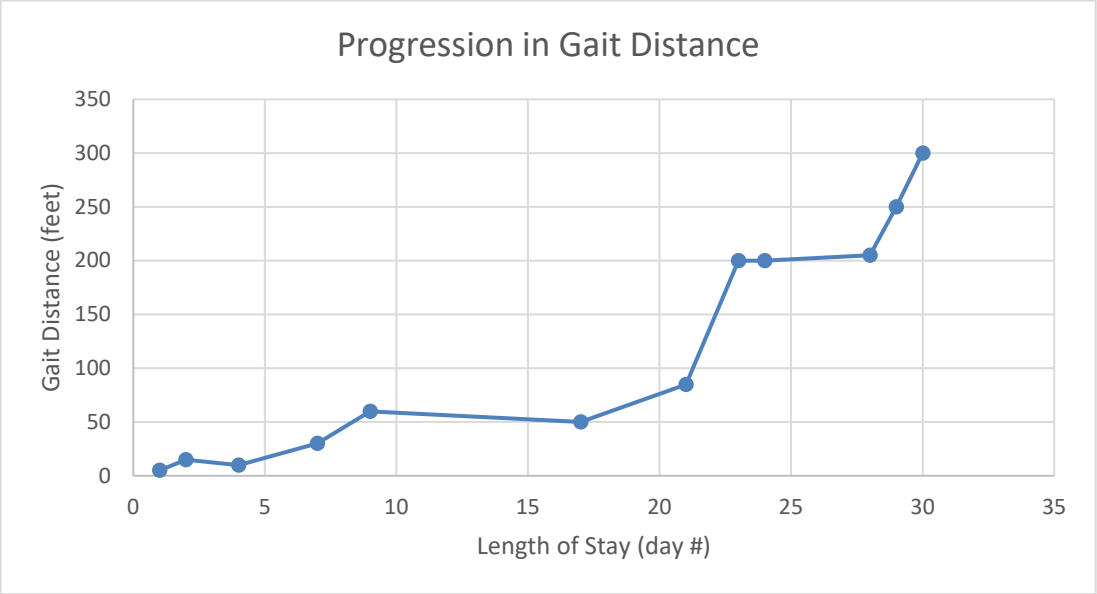
about the FIM you may visit U.S. Department of Human Services website.

Table 4. List of exercises completed during various interventions

Intervention Group	Exercises
Mat exercises	Transverse abdominus activation Gluteal sets Quadricep sets Heel slides Straight leg raises Sidelying hip abduction Gluteal bridges
Manual therapy techniques	STM trapezius STM sternocleidomastoid Suboccipital release Quadrutus lumborum STM
Stretching	Lower trunk rotation Upper trapezius Levator scapulae Quadratus Lumborum Piriformis Gluteus medius Gastroc/soleus complex
Pre-gait activities	Wide base of support weight shifts Romberg stance weight shifts Dorsiflexion/heel strike training Stepping training One foot on box (single limb stance) Plantarflexion/push off training
Mat pre-gait/developmental activities	Static quadruped Quadruped crawling Static tall kneel Tall kneel walking Static half kneel Half kneel with reaching
Balance activities	Static standing (EO/EC) Standing feet together (EO/EC) One foot on box Romberg (EO/EC) Single-limb stance (EO/EC) Standing on uneven surfaces Half foam roll Airex pad Dino-disc Bosu-ball Uneven surfaces (EC)
Activities for reciprocal patterning and muscle recruitment	NuStep machine Shuttle machine Pre-gait activities

*Note: This is not an all-inclusive chart of exercises or interventions utilized during the 30-day admission. Abbreviations: Eyes open (EO), eyes closed (EC)

Figure 3. Progression in gait distance over IRU admission



*Note: Assistive device used, or physical assistance necessary did not remain constant during the collection of gait distance. Rather, collected as the patient was progressing.

Discussion

A stroke can occur in any area of the brain.[14] The region of the brain that is affected can help to guide physical therapy treatments. Although it is important to target physical therapy interventions based on the brain region in which the stroke occurred, it needs to be kept in mind that an MRI report stating the stroke location is not all-telling and should not completely guide the physical therapy plan. It is likely that symptoms observed during physical therapy sessions will arise from damage to more than one region of the brain.[11] Thus, using a symptom-based approach in selection of interventions and gait progression rather than a medical diagnosis of stroke location has the opportunity to lead to better functional mobility for a patient post-stroke.

When using a symptom-based approach in physical therapy it is vital to collect a daily subjective report from the patient, not just assume how the patient is feeling, and what symptoms they are or are not experiencing. Our patient gave a daily subjective report on his symptoms relating to his nausea, emesis occurrence and vertigo symtpoms. This assisted us in choosing daily interventions. However, other tools might have been able to better measure his variability in symptoms beyond his subjective statements. The dizziness handicap inventory is one example; or collecting a subjective nausea score while completing a functional task such as bed mobility or stand pivot transfer. Assessing one of these possible measures before the start of each treatment session could have been beneficial. Along with collecting daily subjective reports it is important to provide patient-centered care and give the opportunity to the patient and their family to discuss the personal goals they have set.

The subject of this case report was highly motivated throughout his treatment at the IRU and pushed through many physical therapy sessions despite dizziness, hiccups, headaches, nausea, and vomiting. The patient's wife stayed with him during the 30-days and was very encouraging throughout. She attended nearly all therapy sessions, and was able to complete a lot of hands on assist and family training before discharge. The patient had shared his goals with the physical therapist upon admission to IRU. He had the goal of returning home with occasional assistance from his family. He wanted to be able to walk around the house using a walker, and did not want to have to rely on a wheelchair for mobility. He wanted to be able to complete all his ADLs without any assistance, and desired his wife to

not have to overly assist him on the stairs, as he did not want her to get hurt. Therefore, our interventions targeted what our patient desired – near independence in functional mobility and improvement in walking. This case report provides physical therapists additional "evidence" when progressing gait in a patient who experienced a lateral medullary stroke.

Gait progression after stroke involves many compoenents of physical therapy while targeting many systems within the body. Hopefully, with much of the physical therapy treatment in the inpatient rehabilitation setting focused on gait progression, the patient will discharge from the IRU with the ability of gait to be more of an automatic task, rather than a conscious step-by-step one. In order to re-learn a more natural gait pattern, high-intensity practice of necessary skills is required, with many repetitions, minimal rest breaks, and consistently challenging the patient to progress in the ambulation activities.[5] This is the reason our physical therapy sessions were repetitive in pre-gait activities, over-ground walking, and progression of gait in many different forms. The patient's symptoms and mobility performance presented differently daily based on his level of fatigue, nausea, dizziness/vertigo, visual disturbances, among others. His daily treatment plans and interventions were determined using a symptoms-based approach. On the days in the which our patient could tolerate more, interventions and gait progression was progressed, which we considered a high-level treatment day. The days in which the patient was very sick or could tolerate little, more passive and low-level active interventions were completed, considered a low-level treatment day.

During gait training many factors were a part of our clinical decision making process as to whether it was time to progress gait or continue with the current intervention or form of over-ground walking. Generally, when the patient was able to complete the pre-gait or ambulation task with light contact or minimal assist, that is when the patient was further challenged by progressing the gait, removing a level of assist, or choosing a different form of over-ground walking. With each new gait task came many, many repetitions. This was a welcomed challenge for our patient, as well as encouraging for him to see his progress within one session.

FIM scores were collected, however, additonal standardized tests or outcome assessments were not utilized often during our patient's stay. We had concerns that standardized tests to track balance (such as the Berg Balance Test) or ambulation (such as the six-minute walk test) would not be an accurate representation of the patient's progress over time- as his symptoms and assistance level varied daily. Further, declines in functional test scores on a daily or weekly basis may have been discouraging to our patient, as he was already frustrated with how difficult mobility tasks were. However, refelcting back, we could have utilized standardized tests if done so in a manner that would have allowed an accurate representation of mobility, as well as an encouragment to our patient. One option could have been to administer the standardized test on a high-level treatment day when symptoms were not as bothersome or detremental to our patient's functional mobility. However, even without standardized tests scores we were able to show the patient that he was making progress by the documented assist levels per treatment session, along with how he was improving in his gait distance on a weekly basis. Although the patient's day to day progression in functional mobility and gait was by no means linear, at the end of his 30-day stay he had a great improvement in his FIM scores, confidence, functional mobility, and quality of life when compared to his admission to IRU.

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