

# CASE STUDY

## Effects of Dynamic Balance Training and Progressive Ambulation on Functional Mobility in an Individual with Vaccine-Associated Guillain-Barre Syndrome: A Case Report.

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### ABSTRACT

**Introduction:** Guillain-Barré Syndrome (GBS) is an immune-mediated neurological condition characterized by rapidly ascending motor paralysis and sensory deficit. This case report provides an example of the functional mobility gains following outpatient physical therapy with a patient diagnosed with GBS. **Case Description:** Patient was a 52-year-old male diagnosed with GBS following an episode of pneumonia, who received an influenza vaccine during his hospital admission. With intensive inpatient physical therapy, home health services, and outpatient physical therapy, the patient returned to being independent in ambulation and activities of daily living. **Outcomes:** Patient participated in progressive gait and balance training with one hour sessions three-times per week. After 12 weeks of outpatient physical therapy, the patient significantly improved scores on the Dynamic Gait Index (DGI) and Timed-Up-And-Go (TUG), all of which coincided with improvements in fall risk and level of ambulation. **Discussion:** Physical therapy was beneficial in improving this patient's functional mobility and is an important factor in returning a patient to their previous level of function. Continued research is needed to further provide evidence supporting outpatient physical therapy in this patient population.

### Introduction

Guillain-Barré Syndrome (GBS), or acute inflammatory demyelinating polyneuropathy, is the most common cause of rapidly developing paralysis and sensory deficit<sup>1</sup>. The typical GBS presentation includes symmetrical progressive ascending

motor weakness, distal sensory impairments, and areflexia<sup>2</sup>. This immune-mediated disease occurs as antibody-activated macrophages circulating within the central nervous system target and strip Schwann cell myelination, causing decreased nerve conduction velocity and possible axonal degeneration<sup>1</sup>. The medical diagnosis of

GBS is based on clinical presentation, elevated protein in the cerebrospinal fluid with a normal white blood cell count, and abnormal electromyographic and nerve conduction velocity studies<sup>2</sup>. Severity of the disease is reduced with plasmapheresis treatment and high dose intravenous immunoglobulin doses. Plasmapheresis should occur 4 weeks after onset of symptoms in nonambulatory adults and 2 weeks after onset in ambulatory adults, or when respiratory function decreases quickly<sup>1</sup>. A study by Kannan and colleagues found that forced vital capacity (FVC) was less than 15 mL/kg in patients with GBS who required mechanical ventilation at admission, compared to those whose FVC was greater than 20 mL/kg who did not require ventilation<sup>3</sup>.

The onset of GBS typically occurs within one to two weeks following a viral infection, such as Haemophilus influenzae, Epstein-Barr virus, cytomegalovirus, or Campylobacter jejuni<sup>4</sup>. The development of GBS has also been associated with influenza vaccinations<sup>1</sup>. The relative risk of developing GBS is 52% higher within six weeks of immunization for an influenza illness<sup>5</sup>. Following the 1976 influenza vaccination campaign, a four- to eight-fold increase in GBS occurred within 6 weeks of immunization, thus resulting in a suspension of the vaccination program<sup>5,6</sup>. In one study by Kwong and colleagues<sup>6</sup>, 2,831 patients were hospitalized for GBS between 1993 and 2009 in Canada. Of those patients, 330 cases were preceded by the influenza vaccine and 1,109 cases were preceded by influenza illness within 42 weeks of admission. Admission for GBS occurred most frequently within three weeks of vaccination and during the first week after an influenza-coded healthcare encounter. The vaccination-associated group largely consisted of individuals 65 years and older and were most frequently diagnosed in October and November. Primarily, 18-64-

year-old individuals constituted the illness-associated group and were commonly diagnosed in January and March<sup>6</sup>.

Typically-occurring GBS time from onset to most severe symptoms occurs within 4 weeks. Paresthesia initially begins in the toes, followed by distal to proximal lower extremity weakness which can occur within hours or days of symptom onset. Weakness then ascends from distal to proximal upper extremity muscles, and to trunk and facial muscles<sup>1</sup>. GBS can become severe and require the patient to undergo intubation and mechanical ventilation once pulmonary function is compromised, and coughing and swallowing become difficult<sup>1,2</sup>. Neck and bulbar weakness and decreased forced vital capacity have been shown to correlate with a need for mechanical ventilation<sup>3</sup>. In cases where the preganglionic fibers of the autonomic nervous system become demyelinated, autonomic changes such as abnormalities in heart rhythm, tachycardia, blood pressure, or vasomotor symptoms can occur<sup>1</sup>.

Negative prognostic factors include onset of GBS at an older age, prolonged time before recovery begins, requiring mechanical ventilation, and axonal degeneration<sup>1</sup>. The main causes of death in patients diagnosed with GBS include pneumonia, sepsis, acute respiratory distress syndrome, autonomic dysfunction, and pulmonary embolism<sup>7</sup>. The mortality rate in patients who require mechanical ventilation may be as high as 20-38%<sup>8</sup>. After symptoms reach peak severity, a static phase occurs within two to four weeks before recovery begins proximally to distally. Although complete or near-complete recovery occurs in the majority of patients<sup>2</sup>, Khan and Amatya found that, despite improved functional mobility, 16% of patients continued to report moderate to severe impacts of GBS on work, family, and social activities up to 14 years after onset<sup>10</sup>. According to one

study, patients with paraparesis had better outcomes in ambulation without an assistive device, less cranial nerve involvement, and less respiratory failure compared to patients with quadriparesis<sup>9</sup>.

The main goal in rehabilitation for patients with GBS is improving activity limitations so as to return to their prior level of activity and participation in personal and environmental contexts<sup>10</sup>. Physical therapy interventions should be initiated early in the disease process, with the goal of maintaining range of motion until active exercising can be initiated as strength returns<sup>1</sup>. Secondary impairments as a result of bed rest can also occur in severe GBS cases, such as orthostatic hypotension, loss of muscle mass, decreased joint range of motion, and decreased balance and proprioception<sup>11</sup>. Residual sensory and motor impairments may be present, including neuropathic pain, foot drop requiring ankle-foot orthoses, and gait abnormalities requiring assistive devices<sup>10</sup>.

To date, however, there is little evidence documenting the impact of outpatient physical therapy services on patients with GBS. Thus, the purpose of this case report is to examine the effects of outpatient physical therapy interventions on improving safety and functional mobility in a patient diagnosed with severe GBS.

## **Case Description**

### ***Patient description***

The patient was a 52-year-old male diagnosed with acute respiratory failure secondary to GBS, along with acute kidney injury, who was previously independent in all aspects of functional mobility with an unremarkable medical history. He was initially admitted to the hospital with pneumonia and was given an influenza vaccination. Within 24 hours after

discharge, the patient experienced a rapid decrease in upper and lower extremity strength, impairing his ability to ambulate and causing him to require use of a power wheelchair for mobility in his home and community. The patient also required use of a hospital bed placed on the first floor of his home, as he was unable to climb stairs to reach second-floor bedroom. He was then re-admitted to the hospital and diagnosed with severe GBS, experiencing progressive functional deterioration and requiring intubation. Following discharge, the patient received inpatient and home health physical therapy. Approximately four months after diagnosis of GBS, the patient began participating in outpatient physical therapy. His impairments at the initial outpatient examination included gait deficits, impaired static and dynamic standing balance, decreased bilateral ankle range of motion, decreased bilateral lower extremity strength, decreased activity tolerance and endurance, and impaired coordination. The patient's goal was to be able to ambulate with a single point cane or least restrictive device at discharge after 12 weeks of outpatient therapy.

### ***Examination procedures***

Joint integrity and range of motion influences the kinematics of gait and may contribute to gait abnormalities if range of motion is limited. Ankle dorsiflexion range of at least 10 degrees<sup>12</sup> is important in allowing heel strike during initial contact, the anterior advancement of the tibia during the loading response phase, and transitioning from midstance to terminal stance phases<sup>14</sup>. Therefore, measuring ankle range of motion is recommended when evaluating a previously non-ambulatory patient and determining appropriate bracing and/or use of assistive devices.

Due to the progressive nature of acute GBS and muscle weakness being the most

common clinical presentation, measuring muscle strength periodically is important in assessing progress and guiding physical therapy interventions<sup>15</sup>. The physical therapist determined that manual muscle testing would be appropriate to conduct for the examination of lower extremity strength of the following muscle actions: hip flexion and extension, hip abduction and adduction, hip external/internal rotation, knee flexion and extension, ankle dorsiflexion and plantarflexion, ankle inversion and eversion, and toe extension and flexion.

Sensory disturbances have been shown to impact static and dynamic standing balance in populations with decreased sensation associated with neurological conditions<sup>16</sup>. The somatosensory system is responsible for influencing body position and movement by responding to external inputs from the support surface and environment<sup>16</sup>. One study compared plantar surface sensation and duration of single limb stance in individuals with multiple sclerosis (MS) and individuals with no neurological condition. Decreased sensation and single limb stance duration were significantly correlated in the MS group, with single limb stance duration being significantly lower when compared to the group with no neurological conditions<sup>17</sup>. Similar to results found with the MS population, these sensory disturbances associated with GBS may influence standing balance as well. Standing balance has a direct influence on safety with ambulation, and can be assessed with various outcome measures.

At initial examination, the physical therapist determined that the Timed Up-and-Go (TUG) was appropriate to perform to examine the risk of falling. The TUG has been shown to have excellent test-retest reliability in determining fall risk in individuals with neurological conditions such as Parkinson's disease and stroke<sup>18,19,20</sup>. Also, the Dynamic Gait Index (DGI) is an

outcome measure that assesses an individual's ability to modify dynamic balance while performing tasks similar to those required with community ambulation and has also been shown to have excellent test-retest reliability in individuals with the above neurological conditions<sup>19,21</sup>. Examination and interventions during outpatient physical therapy were provided by a third-year physical therapy student and supervised by a licensed physical therapist with three years of experience treating patients with neurological conditions.

### **Initial Findings**

The patient presented to his outpatient physical therapy examination in a lightweight manual wheelchair with bilateral non-articulating standard semi-solid posterior ankle-foot orthoses. Bilateral upper extremity active range of motion was within functional limits, while bilateral ankle dorsiflexion passive range of motion was limited to neutral. Manual muscle testing was performed with bilateral upper extremity strength within functional limits. Lower extremity strength was limited and is presented in table 1. Sensory appreciation to light touch was impaired throughout the bilateral lower extremities, with the patient reporting constant hypersensitivity.

The patient required supervision for sit-to-stand transitions and minimal to moderate assistance for a stand pivot transfer. The patient completed the TUG in 63 seconds using a standard two-wheeled rolling walker and bilateral AFOs with contact guard assistance (CGA) to maintain neutral pelvic position. Verbal cueing for widening his base of support and decreasing shoulder shrug was also required. The patient also demonstrated decreased endurance when compared to his prior level of function, being able to ambulate approximately 25 meters with a rolling walker with CGA before requiring a seated rest break. During

both swing and stance phases of gait, the therapist observed decreased contact of the posterior ankle and foot on both AFO uprights, causing increased bilateral plantarflexion and steppage gait. An orthotic referral was recommended for the addition of an ankle strap to maintain proper foot contact with the AFO and decrease gait abnormalities. In addition to the ankle strap, the therapist recommended articulation of the AFO to allow for improved dorsiflexion range and facilitate the appropriate ankle rocker with ambulation.

The patient scored 16/24 on the DGI during the tenth session, with bilateral AFOs donned and no assistive device, indicating the patient was at risk for falls<sup>21</sup>. The patient demonstrated mild gait deviation and deficits in balance with changing speed, performing head turns and pivoting, as well as use of stairs on the DGI. Comfortable gait speed with the above bracing and two single point canes was 0.41 m/s, indicating the patient was a limited community ambulator<sup>22</sup>.

The patient presented with decreased strength, difficulty with ambulation, decreased range of motion, and decreased functional mobility after being diagnosed with GBS. Goals included in the patient's initial plan of care consisted of ambulation with the least restrictive assistive device in home and community settings, decreased falls risk via examination using the TUG and DGI, being independent in a floor-to-chair transfer, and to be able to step over four-inch threshold to simulate stepping in and out of shower.

## **Interventions**

The patient experienced tightness in his hip flexors after being non-ambulatory and utilizing his power wheelchair for mobility for several months. Prolonged positioning in flexion with primary use of a wheelchair

caused tightness in the iliopsoas muscle, which can limit hip extension in midstance and terminal stance of gait, as well as cause excessive anterior pelvic tilt<sup>23</sup>. The therapist determined that manual therapy was appropriate to improve soft tissue mobility of the iliopsoas muscle. In order to improve ankle dorsiflexion range of motion, anterior to posterior talocrural joint mobilizations were performed as well as incorporated into a home exercise program. During the acute phase of the disorder, physical therapy focuses on stretching and range of motion exercises as re-innervation is occurring, which can last up to several weeks for re-myelination to complete<sup>24, 25</sup>. This patient was in the recovery phase, therefore strengthening exercises were initiated. Core strengthening was also initiated to improve upright posture and trunk control during ambulation and functional activities<sup>26</sup>. Core exercises were initiated with supine pelvic tilts with abdominal bracing; then the exercises progressed to more challenging tasks including emphasizing stability in developmental and functional positions, such as quadruped, half-kneeling, and kneeling. Lower extremity strengthening was also performed and included exercises such as the leg press, heel raises, hamstring curls, and resisted knee extension, beginning with three sets of ten repetitions. The patient progressed his strengthening home exercise program by performing these exercises at the community gym.

Gait training is an important intervention for allowing return to the patient's prior level of function. Initially, the patient required the use of a standard rolling walker for improved stability, however eventually progressed to single point canes by week 3, and subsequently no assistive device. The patient began gait training on smooth, level surfaces; then he progressed to uneven outdoor terrain for practice with ambulation in the community setting by week 4<sup>16</sup>. Proprioceptive neuromuscular facilitation<sup>27</sup>

was performed in weeks 1-4 to achieve full range and strength of pelvic anterior elevation and posterior depression for both stance and swing phases of gait, with forward weight shifts to improve reciprocal gait kinematics.

To improve safety and independence with ambulation and standing tasks, it is important to assess and provide interventions for static and dynamic standing balance<sup>28</sup>. Static balance on stable surfaces was addressed initially, with progression to static balance on unstable surfaces with external challenges, such as perturbations, ball toss, and functional reaching tasks by week 3. Dynamic balance is essential in home and community ambulation, and was the focus of the patient's latter stages of treatment after week 5. Similar to static balance, interventions began on stable surfaces and progressed to unstable surfaces, as well as incorporation of functional tasks such as maintaining balance while performing head turns, pivots, and changing speeds. Activities to improve static and dynamic balance included single limb stance with cone taps on stable and foam surfaces, static stance on rocker and BAPS boards, walking forwards/backwards/laterally/pivoting with ball toss, and stepping over obstacles. As the patient's strength improved, balance activities were performed without the bilateral AFOs with the focus of improvement of the ankle strategy so as to return the patient to his prior level of function. Ankle strategy aids in maintaining static balance in standing and requires normal ankle range of motion and proprioception. In a study by Park and colleagues, patients with chronic stroke participated in a general physical therapy program with a focus on ankle proprioceptive control training. At the end of six weeks, significant improvements were found in ankle dorsiflexor strength, TUG scores, gait cadence and reciprocal pattern<sup>29</sup>.

## **Post-intervention Findings**

The patient participated in 24, 1-hour sessions of physical therapy over a period of twelve weeks. Ankle dorsiflexion range improved following manual therapy and joint mobilization, furthermore, balance activities incorporating the ankle strategy also improved ankle range of motion and strength. After several treatment sessions, strength was reassessed and is presented in table 2. Although strength was not formally assessed at discharge, his bilateral lower extremity strength visually improved with improvements in gait and balance activities.

The dramatic improvements experienced by the patient over the 12 weeks of outpatient physical therapy can be seen in Table 3. With outpatient physical therapy, he advanced from using a rolling walker to two single point canes, and eventually did not require an assistive device for ambulation. Ambulation distance increased from 25 meters with a rolling walker with CGA to at least 580 meters with no assistive device or bracing and he was independent on even and uneven terrain at the end of treatment. Bilateral foot slap was present initially when ambulating without use of the AFOs; however at discharge the patient was able to ambulate safely without bracing. At discharge, the patient was independent in transfers and could ascend and descend several flights of stairs reciprocally, independently with use of one handrail. The patient reported being able to bathe safely without the use of his shower chair and had returned to sleeping in his regular bed on the second floor of his home. His lower extremity strength had improved enough to allow him to be able to drive a manual-transmission car.

Dynamic balance assessed with the DGI improved from 16/24 on the tenth visit to 22/24, indicating he was no longer at a risk

for falls<sup>21</sup>. He was able to perform the TUG in 8 seconds independently, which was a significant improvement from his initial score of 63 seconds with a rolling walker.

	<b>Left Lower Extremity</b>	<b>Right Lower Extremity</b>
<b>Hip Flexion</b>	4-/5	3+/5
<b>Hip Extension</b>	3+/5	3/5
<b>Hip Abduction</b>	4-/5	4/5
<b>Hip Adduction</b>	2+/5	2+/5
<b>Hip External Rotation</b>	4/5	4/5
<b>Hip Internal Rotation</b>	4/5	4-/5
<b>Knee Flexion</b>	3-/5	2+/5
<b>Knee Extension</b>	3+/5	5/5
<b>Ankle Dorsiflexion</b>	2-/5	2-/5
<b>Ankle Plantarflexion</b>	3-/5	2/5
<b>Ankle Inversion</b>	2+/5	2+/5
<b>Ankle Eversion</b>	2+/5	2+/5
<b>Toe Extension</b>	1/5	1/5
<b>Toe Flexion</b>	2/5	2/5

**Table 1. Bilateral Lower Extremity Strength with Manual Muscle Testing at Initial Examination.**

	<b>Left Lower Extremity</b>	<b>Right Lower Extremity</b>
<b>Hip Flexion</b>	4+/5	4/5
<b>Hip Abduction</b>	4+/5	4+/5
<b>Knee Flexion</b>	4/5	4/5
<b>Knee Extension</b>	4+/5	5/5
<b>Ankle Dorsiflexion</b>	2-/5	2/5
<b>Ankle Plantarflexion</b>	4+/5	4/5
<b>Ankle Inversion</b>	4/5	4-/5
<b>Ankle Eversion</b>	3+/5	3/5

**Table 2. Bilateral Lower Extremity Strength Grossly Assessed During Session 4.**



<b>Measure</b>	<b>Initial Examination - Visit 1</b>	<b>Visit 10</b>	<b>Discharge Examination – Visit 24</b>
<b>Transfers: Independence from bed to chair</b>	<b>Minimal-moderate assistance</b>	<b>Supervision</b>	<b>Independent</b>
<b>Gait: Independence</b>	<b>Contact-guard assistance</b>	<b>Contact-guard assistance</b>	<b>Independent</b>
<b>Gait: Assistive Devices</b>	<b>Rolling walker</b>	<b>2 single-point canes</b>	<b>None</b>
<b>Gait: Orthotics</b>	<b>Bilateral AFOs</b>	<b>Bilateral AFOs</b>	<b>None</b>
<b>Gait: Maximal Distance</b>	<b>25 meters</b>	<b>500 feet</b>	<b>1900 feet</b>
<b>Stairs: Independence</b>	<b>Dependent</b>	<b>Supervision with 1 handrail, non-reciprocal</b>	<b>Independent with 1 handrail, reciprocal</b>
<b>Timed Up &amp; Go</b>	<b>63</b>	<b>10</b>	<b>8</b>
<b>Dynamic Gait Index</b>	<b>N/A</b>	<b>16/24</b>	<b>22/24</b>

**Table 3. Progress Noted Throughout Outpatient Physical Therapy.**

## Discussion

The patient experienced dramatic improvements in ambulation and dynamic balance, and ultimately independence with decreased falls risk after participating in 12 weeks of outpatient physical therapy. This is evidenced in part by the fact that the time required to perform the Timed Up and Go Test decreased from 63 to 8 seconds. No studies have been conducted that have identified a minimal detectable change (MDC) or a minimal clinically important difference (MCID) for this measure in patients with GBS. However, the minimal detectable change for patients with chronic stroke is 2.9 seconds<sup>18</sup> and for patients with Parkinson's Disease is between 3.5 and 11 seconds<sup>19,20</sup>. All of these threshold values are well below the 55 second drop in TUG time experienced by our patient.

In reference to the DGI, no other MDCs or MCIDs have been identified for patients with GBS. However, for community-dwelling older adults undergoing a 16-week exercise program, the MCID for the DGI is 1.90<sup>30</sup>. This is appreciably lower than the six point increase in the DGI that our patient experienced. The outcome measures used in this case report indicate that our patient improved dramatically in his gait, dynamic balance, and activities independence.

Khan and colleagues conducted a study that compared levels of functional independence in subjects who were greater than one year status post diagnosis of GBS who participated in high-intensity versus low-intensity rehabilitation<sup>13</sup>. The high-intensity treatment group received multidisciplinary (speech, occupational, psychology, social, and physical) outpatient therapy of 30 minute sessions up to three times a week focusing on strengthening, endurance, and gait training, while the control group participated in a home-based walking and stretching program. At the end of the

twelve-week study, the treatment group demonstrated significantly improved levels of independence in mobility/transfers and locomotion, while the control group reported increased deterioration in function compared to the treatment group. While the outcomes were positive for the patients in the study by Khan et al (2011)<sup>13</sup> as well as in this case report, there were some differences noted. Khan et al provided multidisciplinary rehabilitation to their subjects while the patient in this case report only received physical therapy. Furthermore, the subjects in the study by Khan et al were between 1 year and 11.6 years post-onset, while the patient in this case report was only four months post-onset. Nevertheless, outpatient physical therapy has been shown to be beneficial in improving independence and functional mobility in patients with GBS as evidenced by these studies.

In a separate article, Khan and Amatya (2012)<sup>10</sup> conducted a systematic review that examined the benefits of physical therapy for patients with GBS. Studies included in this review focused on various interventions including strengthening, gait training, and endurance in inpatient and outpatient rehabilitation, as well as multidisciplinary rehabilitation. These investigators found 'satisfactory' evidence for physical therapy in reducing fatigue, increasing function, and improving quality of life. The paucity of studies available for review limited these investigators from indicating that there was 'good' evidence for the efficacy of physical therapy for patients with GBS<sup>10</sup>.

In addition to improving outcomes, rehabilitation was also found to be beneficial in reducing mortality in patients diagnosed with GBS<sup>7</sup>. Inokuchi and colleagues<sup>5</sup> performed a retrospective database search of 3,835 patients to compare the effects of rehabilitation on hospital mortality. Patients who received rehabilitation during their hospital stay were more likely to have

required ventilation within five days of admission and had a significantly higher prevalence of chronic cardiac disease, diabetes mellitus, cancer, pneumonia, and arrhythmia. Nevertheless, the rehabilitation group demonstrated significantly lower 30- and 90-day hospital mortality rates, despite their greater severity of illness compared to the non-rehabilitation group<sup>7</sup>.

Although literature on physical therapy with patients diagnosed with GBS is limited, outcomes from this case and the references provided demonstrate the benefits of physical therapy interventions in patients with this rapidly evolving disease. Despite recovery from GBS typically being favorable, physical therapy intervention may be the most important treatment in returning patients to their prior level of function<sup>31</sup>. This claim is supported by this case report in which a patient with subacute GBS received no other rehabilitative or medical intervention other than outpatient physical therapy and yet experienced a dramatic improvement in gait, dynamic balance, and independence with functional activities. types of treatment in the acute care setting and the therapists understanding of their role in the management of the wound is essential to have the most efficient and favorable outcome for the patient.

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