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The Use of Thee Standardized Outcome Measures to assess Improvement in a Man with Peripheral Neuropathy: A Case Study

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Abstract

   Background: Diabetes Mellitus (DM) has become more prevalent in the United States population. Complications due to DM include chronic hyperglycemia if the disease is not managed appropriately and can lead to peripheral neuropathy. Diminished sensation, proprioception, and kinesthesia are all resultants of peripheral neuropathy that can cause persons to feel off balanced and at an increased risk of falls. Evaluation of balance and gait are important areas for Physical Therapists to look at to appropriately determine patient deficits due to peripheral neuropathy. **Purpose:** This case study looks at three useful outcome measures that can help to establish a baseline and monitor improvements in this patient population over time. **Outcomes:** The three outcome measures used include the Berg Balance Scale (BBS), the Functional Gait Assessment (FGA), and the Activities- specific Balance Confidence Scale (ABC Scale) to measure improvement in physical therapy interventions in an elderly man with peripheral neuropathy over 6 visits. Upon discharge the patient had improved on all outcome measures, self-reported a decrease in fear of falling, and improved awareness of his deficits. **Discussion:** Physical Therapists can help patients with patients with peripheral neuropathy to teach compensations, improve strength and range of motion, and educate patients on the effects of decreased sensation and their risk of increased falls. The use of outcome measures to track improvement can be useful in developing meaningful treatments to improve a patient's quality of life and help achieve their goals.

Introduction

      Peripheral neuropathy is a common complication of diabetes mellitus (DM). Epidemiology studies have shown that diabetes mellitus affects 26 million people in the United States and of those 26 million, 30-50% will develop peripheral neuropathy.[1,2,3] Peripheral neuropathy is defined as "a symmetrical, length-dependent sensorimotor polyneuropathy attributable to metabolic and micro-vessel alterations as a result of chronic hyperglycemia exposure and cardiovascular risk covariates."[1] DM Type II is due to decreased sensitivity to insulin, which causes hyperglycemia (increased glucose present in the blood). Chronic hyperglycemia can cause an increase in various metabolic factors, creating an increase in oxidative stress, Protein Kinase C, and advanced glycation end products (AGE).[1,2] In addition, chronic hyperglycemia causes a decrease in nerve blood flow and endothelial function which can lead to peripheral nerve damage, especially in the distal extremities. Peripheral nerve damage can lead to loss of sensation, muscle weakness, and slowed muscular contractile properties; all which may cause impaired balance or gait and lead to injury, wounds, or amputation.[1] This decreased sensation in the distal extremities puts this patient population at a greater risk of falls. Falls among this population may lead to loss of independence, hospitalization, a decrease in quality of life, and increased risk of death due to fracture and poor wound healing.[2]

      Physical Therapy, balance training, and moderate exercise have shown increased compensation for balance deficits, increased blood flow to distal extremities, and improved muscular performance with decreased muscular weakness.[2,3] Moderate exercise has been shown to help reverse these effects and prevent peripheral neuropathy by increasing nitric oxide production and improving cardiovascular function.[1,2,3] Additionally, balance and gait training, closed kinetic chain exercise, and aerobic exercise have all demonstrated a decrease in the effects of peripheral neuropathy and reduce the risk of falls in patients with DM. However, predicting the risk of falls in this population upon physical therapy evaluation is challenging due to the lack of validated outcome measures specific to peripheral neuropathy.

      There are currently no standardized outcome measures with prediction outcomes that are specific to patients with peripheral neuropathy. Some have been researched, but results are inconclusive and none provide a minimal detectable change (MDC) among this population. Many outcome measures have been studied in community dwelling older adults, patients with Parkinson's Disease, and vestibular dysfunction, but none indicate validity and reliability in the peripheral neuropathy population. The purpose of this study was to examine the use of three commonly used outcome measures that predict fall risk in the elderly or patients with neurological deficits, as an outcome assessment in a patient with peripheral neuropathy through an episode of physical therapy intervention. The Berg Balance Scale, Functional Gait Assessment, and Activities-specific Balance Confidence Scale were used to assess fall risk and track improvement over 6 visits. Care was targeted at improving balance, cardiovascular fitness, gait mechanics, education on DM, peripheral neuropathy, and adaptive compensations to reduce risk of future falls.

Case Description and Outcomes

    Mr. G was an 89-year-old male who presented to physical therapy at the Ann Arbor Veterans Affairs Hospital with complaints of increased instability and increased fear of falling. Upon subjective evaluation, Mr. G did not report a fall within the last 6 months but did report several near falls, slips or trips. Along with Mr. G's reported fear of falling, he also disclosed that he had Type II Diabetes Mellitus and history of bladder and liver cancer with secondary neuropathy in his feet which he was unable to attribute to DM or cancer treatments. Mr. G presented to Physical Therapy wearing diabetic shoes and socks and reported checking his feet daily for skin breakdown, wounds, and maceration. Throughout the course of his physical therapy treatment, he attended the Preventing Amputees in Veterans Everywhere (PAVE) clinic where he was assessed and screened for increasing numbness and desensitization of his feet. He was also issued a new pair of diabetic shoes during his time of

treatment.

During Mr. G's evaluation, he was assessed for strength, range of motion, gait and balance. Mr. G also answered the Activities- specific Balance Confidence (ABC) Scale about his confidence in everyday activities and fear of falling. Mr. G displayed range of motion and strength within normal limits of daily activities. Mr. G was assessed for balance and gait utilizing the Berg Balance Scale (BBS) and Functional Gait Assessment (FGA). Mr. G scored 44/56 on the BBS which indicated that he was at a high risk of falls. Additionally, Mr. G scored 16/ 30 on the FGA which also indicates a high risk of falls in the elderly. On the ABC Scale, Mr. G rated his fear of falling at 31% which was predictive of future falls. Mr. G expressed that his goal for physical therapy was to decrease his fear of falling and improve his balance. His physical therapy goals included the following: "Within 8-12 weeks, patient will demonstrate the following: patient will score 47 or greater on the Berg Balance Scale to reduce risk of falls; patient will be independent with HEP; patient will report improved ABC Scale by 15% or greater (46% or greater); and patient will score 19 or greater on FGA to reduce risk of falls."

Mr. G was seen for a total of 6 visits including his evaluation and discharge visit over a period of 7 weeks. Interventions throughout his treatment were focused on balance and complex gait practice along with general strength exercises and promoting a daily walking program. Each visit was structured around performing balance exercises including Rhomberg and Sharpened Rhomberg stance on Airex foam with eyes open and closed, double limb stance on a Dynadisc, and single leg balance on static ground, all with light to no upper extremity support as tolerated. Complex gait included slalom gait through cones, side stepping, retro gait, changes in speed, and stepping over various height objects and compliant surfaces. Additionally, Mr. G would perform the NuStep recumbent stepping machine for 10-15 minutes and encouraged to maintain 75-85 steps per minute at a workload between 3 and 5 for improved cardiovascular endurance.

The patient was also provided a home exercise program for lower extremity and core strengthening, improved single leg stance balance, and improved lower extremity joint range of motion which included: Rhomberg stance up to two minutes, single leg balance up to one minute, standing hip abduction, flexion, and extension, bridging, wall slides, side steps, monster walks and mini squats. Initially, Mr. G used a red Theraband for the standing hip exercises, side steps and monster walks and progressed to green and blue Theraband for increased resistance. Additionally, hamstring and gastro-soleus stretches were added to his program to improve muscle length bilaterally.

The patient was successful with balance, gait training, and global lower extremity strength training in Physical Therapy based on improved endurance and tolerance to exercise, gait mechanics, and manual muscle testing. Upon discharge, Mr. G scored 49/56 on the Berg Balance Scale which placed him at a low to moderate risk of falls. The FGA was also reassessed on Mr. G's final visit. He scored 21/30 which also placed him in the moderate risk of falls category. Additionally, the ABCs was also given on discharge and Mr. G rated himself at 78% which predicted a decrease in fall risk. A comparison between evaluation and discharge values with the minimal detectible change (MDC) are displayed in Table 1. Overall, Mr. G met and exceeded his therapy goals, improved his balance and ability to negotiate complex environments, and increased his confidence as a community ambulator.

Table 1: Comparison between evaluation and discharge of outcome measures.

Outcome Measure	Evaluation	Discharge	MDC*
Berg Balance Scale (BBS)	44/56	49/56	8

Functional Gait Assessment (FGA)	16/30	21/30	4.2
Activities- specific Balance Confidence Scale (ABC Scale)	31%	78%	11%

MDCs provided for older, community-dwelling adults.

Balance and Fall Risk Assessments

The Berg Balance Scale (BBS) and Activities –specific Balance Confidence Scale (ABC Scale) have been the most researched outcome tools for relevance for patients with peripheral neuropathy secondary to diabetes mellitus (DM) to predict risk of falling.   The BBS has not been determined to be valid for the peripheral neuropathy population, but research has started to explore this outcome tool. The BBS is a fourteen-item functional balance test that increases in balance difficulty beginning with seated balance and progressing to single limb stance. Its score depicts the patient's ability to control postural balance. Each item on the test is scored on a 0-4 scale (0 is an inability to complete, 4 indicates independence with the task). The patient may score a max of 56 points, scores less than 46 indicate a high risk of falls, and the minimal detectable change (MDC) is 8 points.[4]

In a study done by Bragadin et. al, the BBS was shown to be more sensitive at identifying balance impairment than the Tinetti Balance Scale in patients with peripheral neuropathy.[5] Another study done by Dixon et. al showed that the BBS may be an appropriate tool to assess risk of falls in the peripheral neuropathy population due to its challenges to the visual and somatosensory systems.[6] The group also concluded that there is a need to develop an outcome measures tool that is specific to the DM peripheral neuropathy population.

The FGA is a ten-item gait analysis scored on a zero to three-point scale (zero indicates severe impairment, a three indicates normal ambulation). The test examines gait speed, change in gait speed, gait with head turns, stepping over objects, retro gait, and stairs. The highest score a patient can achieve is 30 and the test may be performed with or without an assistive device. A score of 22 or less indicates a severe risk of falls with an MDC of 4.2.[4]

The Functional Gait Assessment (FGA) has very little research associated with predicting falls in the DM peripheral neuropathy population. However, the FGA has been validated as a tool to predict postural instability in independent community-dwelling older adults.[7] A study done by Ludlow and Beninato found that the FGA is a reliable tool to use in comparison to the Dynamic Gait Index (DGI) due to the decreased risk of experiencing a ceiling effect.[8] They examined each item on the FGA in an elderly population and concluded, "the results suggest that the FGA is a measure of walking balance ability that is clinically appropriate for older adults with balance impairments."[8] However, the group stated that their data should not be generalized to all patient groups with balance impairments.

The ABC Scale is a 16- item questionnaire that inquiries "How confident are you that you will not lose your balance or become unsteady when you…". The patient is asked to rate their confidence on a 0 -100 scale (0 being no confidence, 100 being confident). The overall score is calculated by adding up all the items and dividing by 16; if a patient fails to answer a question the test is scored out of the number answered. Patients that score 67 or less are at greater risk of falls and the MDC is an 11-point increase.[4]

The ABC Scale has been tested in community-dwelling older adults. This outcome measure has been highly correlated with predicting a risk of falls due to a person's confidence on their ability to maintain their balance in sixteen different situations. One study found that the lower a person's confidence was, the more likely they were to fall and vice versa.[9] Although the ABC Scale is not

validated for patients with DN peripheral neuropathy, it may still be reliable outcome tool to help predict falls.

Interventions and Compensations

Methods to develop compensations and treat the deficits caused by peripheral neuropathy were suggested as strength training, stretching and functional balance training programs. In a study done by Quigley, functional balance training, which involved strengthening, coordination, multi-tasking, hand-eye coordination, visual-perceptual conflict, and compensatory exercises, lead to improved plantarflexor power and decreases in step width and variability.[10] This was in comparison to Tai Chi, which demonstrated a faster Timed Up and Go and increased stride length in gait. The study concluded that both Tai Chi and functional balance training are appropriate to improve balance and functional mobility in older populations.[10]

Sartor et. al also did a study utilizing the ABC Scale and comparing the effects of functional training, strengthening, and stretching versus a physical therapy care on biomechanics of gait and foot function in the diabetic population.[11] They found that the group that performed functional balance training, strengthening, and stretching had an improvement in foot and ankle range of motion, improved single-leg stance time, functional reach, tandem stance time, and higher ABC Scale scores compared to the usual care group. They concluded that multi-faceted care showed greater improvements in postural compensations, balance and confidence.[11]

Another study done looked at patients with chemotherapy-induced peripheral neuropathy (CIPN) and the use of a closed kinetic chain exercise program and utilized the BBS as an outcome measure to define improvements in balance.[12] Although this study looked at patients with chemo-induced peripheral neuropathy, it can still be applied to this patient due to his extensive history of cancer and chemotherapy. Closed kinetic chain exercises were shown to decrease the severity of CIPN and dynamic balance. The treatment was administered 15 times within three weeks and included ankle range of motion, heel/ toe raises on one leg and bilaterally, inversion and eversion at the ankle, wall slides, and single leg balance. The program also demonstrated that the patient's BBS improved from baseline.[12]

Discussion

As diabetes mellitus continues to become a more common diagnosis, it is important to understand the complications of the disease and how Physical Therapists can best serve this patient population. Peripheral neuropathy diminishes the sensory nerves of the distal extremities and can slowly progress to affect the larger motor and autonomic nerves.[11] Due to the decreased sensory input, patients with peripheral neuropathy have difficulty with detecting thermal changes, painful stimuli, positional changes, and vibrations. This loss of sensation, especially in the feet, can lead to an increased risk of falls and feeling off balanced.

There are multiple standardized outcome measures that predict risk of falls in the community-dwelling elderly population. Studies selected in a systematic review have utilized the BBS, Dynamic Gait Index (DGI) and ABC Scale for predicting falls in this population, however, they have not studied the validity and reliability to determine a MDC in this population.[6,13] A combination of various outcome measures produces a more dynamic and accurate prediction of falls in the elderly with peripheral neuropathy. Although multiple studies utilized the Dynamic Gait Index, it has a ceiling effect that may be more easily achieved in community dwelling adults.[13] The FGA was created to reduce the ceiling effect; this was the clinical reasoning to utilize this outcome measure for this specific patient. The battery of tests that were selected for this specific patient were chosen to thoroughly assess gait dysfunction, balance deficits, and determine patient confidence in his own abilities.[14]

Additionally, research supports that exercise and balance training can be effective in treating deficits caused by peripheral neuropathy.[11] The addition of strength training and stretching, especially to improve ankle dorsiflexor and plantarflexor range of motion and strength was used to improve ankle strategies for compensation.[11] Functional balance training, including the use of compliant surfaces, and single leg support can all be incorporated to improve balance and confidence in high risk of falls patients. Gait training has also translated to development in confidence with walking on uneven ground, negotiate crowded areas, and increase community ambulation.[14,15]

Mr. G improved following treatment, had no adverse events, and demonstrated improvement on all three evaluations of fall risk. The case provides evidence that functional balance, therapeutic exercise, and gait training may be an effective treatment for patients at risk of falling and that the provided outcome measures may be appropriate for assessment of deficits. Utilizing standardized outcome measures can help to guide a patient's plan of care and determine specific deficits due to peripheral neuropathy. Research has shown that the Berg Balance Scale is an effective tool to determine dynamic balance in community dwelling adults at risk of falls. The ABC Scale also has been shown to be a useful outcome measure to help determine a patient's confidence and fear of falling. Additionally, the FGA has some emerging evidence that demonstrates that it is preferred over the DGI due to its assessment of gait in functional daily activities. Although no one measure has been shown to be superior to another, all three may be used in combination to provide a comprehensive understanding of a patient's dynamic balance, gait, and confidence of the two. Further research is warranted to demonstrate validity of these outcome measures in the peripheral neuropathy population and determine minimal detectable changes. The development of a single outcome measure that provides a comprehensive view of balance and gait may also be a further area of study and development to aid in physical therapy evaluations.

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