BALANCE AND VESTIBULAR REHABILITATION QUALITY IMPROVEMENT

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Quality improvement (QI) in healthcare aims for higher performance. Nonetheless, QI and guidelines implementation focus mostly on assessing the processes and less attention is given to the effect on clinical outcomes. This project examined the adherence of physical therapists to the clinical decision rules (CDRs) in balance and vestibular rehabilitation and its effect on clinical outcomes. We hypnotized that physical therapists would be more adherent to the CDRs after the QI interventions. Also, we hypothesized that persons with balance and vestibular disorders who were treated in adherence to the CDRs would have better scores on the clinical outcomes.

Eighteen physical therapists were randomly assigned to the intervention or wait-listed groups. Both groups received the QI interventions at different time points. The main outcome was the adherence to the CDRs. Four hundred fifty-four patients' evaluation forms had complete follow-up data and were classified as either being adherent or non-adherent to the CDRs. The clinical outcomes were the Activities-specific Balance Confidence scale (ABC), the Dizziness Handicap Inventory (DHI), and the Global Rating of Change (GRC).

The change in adherence rates after the QI interventions was 9% and 12% for the intervention and wait-listed groups, respectively. There was a significant within group effect ($p=0.008$), but the between groups difference was not significant ($p=0.8$). The interaction effect was not significant ($p=0.6$). The change in the ABC score was 14 and 9 for adherent and non-adherent forms, respectively. For the ABC, there was a significant change within groups ($p=<0.001$) and the change was not significant between groups ($p=0.8$). The change in the DHI

score was -16 for adherent forms and -17 for non-adherent forms. The change within and between groups for the DHI was not significant (p=0.6 and 0.7, respectively). Median GRC score was +5 for adherent forms and +4.5 for non-adherent forms. The difference in the GRC scores between adherent and non-adherent forms was not significant.

This QI project showed enhancement in adherence to the CDRs in both groups. There was no additional benefit in the clinical outcomes for adherent evaluation forms.

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PREFACE

I would like to express my gratefulness to my family who encouraged and supported me. I would like to acknowledge the members of my committee Dr. Susan Whitney, Dr. Patrick Sparto, Dr. Gregory Marchetti, Dr. Anthony Delitto, and Dr. Joseph Furman for their limitless guidance and support. This project would have been impossible without the support I got form my committee.

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1.0 INTRODUCTION

In the United States, the level of adherence of healthcare to quality standards is unknown.[1,2] Quality can be described as evidence-based practice and best practice.[3] Unexplained disparity in clinical care plays a role in medical error and lack of quality of healthcare.[4]

Reason[5] described medical error as the failure to plan healthcare to achieve a desired goal, or failure to adhere to a planned care. However, when a medical error occurs, it is necessary to know how and why it occurred, not who made that error.[6]

Avoidable medical errors and adverse events are a leading cause of death in the United States, and approximately cause death to 44,000-98,000 and injuries to 1,000,000 citizens each year.[7] Studies have shown improvements in care from quality improvement projects in numerous health care aspects.[8-13] However, many studies reported that the quality improvement initiatives in the US and Canada ranged from failure to 50% success.[14-18]

1.1 STATEMENT OF THE PROBLEM

Quality of health care in the United States is substandard, taking into consideration the expense of health care.[19-22] Clinical practice does not always reflect research findings and clinical guidelines.[23-26] In many countries, including the US, 30-40% of patients do not receive evidence-based interventions, and around 25% of patients receive unnecessary care.[27,28] Research findings

demonstrate a lack in providing recommended preventive acute or chronic care to Americans.[2,19,20,29] Quality improvement initiatives were developed to address the poor use of evidence and to establish standardized care.[30]

1.2 PURPOSE OF THE STUDY

The impetus of this project was to determine if quality care was being provided to persons with balance and vestibular disorders via compliance with the minimum data set (MDS) and adherence to the clinical decision rules (CDRs). This quality improvement project aimed at assuring that physical therapists at UPMC Centers for Rehab Services (CRS) who were treating patients presenting with balance and vestibular disorders were providing their clients with standardized care. This project should have led to improvements in care provided for persons with balance and vestibular disorders in the UPMC Centers for Rehab Services system.

1.3 DEFINITION OF TERMS

The definition of terms used in our project was important to assure shared meaning of these terms. These terms are:

Minimum data set (MDS): a set of key indicators that are mandatory to be completed regularly in order to obtain enough health related information about patients, and to be able to set a plan of care. They allow for comparison across individual clinicians and settings as well.[31]

Clinical decision rules (CDRs): are clinical decision rules that are based on evidence based practice and consensus among experts.[32]

Compliance: the completion of the minimal data set (MDS) included on the agreed-upon balance and vestibular evaluation form.

Adherence: the consistency by which clinicians use clinical decision rules (CDRs) during the initial evaluation.

Compliance reminders: emails that are sent to the physical therapists to remind them about missing items in the MDS.

Adherence reminders: emails that are sent to the physical therapists to remind them that they are not adherent to the CDRs.

2.0 BACKGROUND AND SIGNIFICANCE

2.1 EPIDEMIOLOGY OF BALANCE AND VESTIBULAR DISORDERS

Between 2001 and 2004, approximately 70 million Americans older than 40 years have complained of vestibular dysfunction.[33] Vestibular disorders may affect the person's activities of daily living (ADL) and health related quality of life (QOL).[34-36] In a survey, around 80% of persons with vertigo reported that their daily activities were interrupted, affected sick leave, and/or they had to seek medical consultation.[37] Based on their own rating, persons with vestibular disorders consider themselves as functionally disabled in many skills that impact their QOL.[38,39]

Balance and vestibular disorders signs and symptoms include dizziness, vertigo, nausea and vomiting, imbalance, increased sway, nystagmus, oscillopsia or blurry vision, and disturbed spatial information processing.[40-50] Dizziness and vertigo are the most common symptoms reported globally.[33,51-53] In a general population, between 20% to 35% of people reported dizziness to their physician or via a national health survey.[37,51] Complaints of dizziness are common in the US and represent more than 8 million medical visits per year.[54] Dizziness is a general term used to describe symptoms such as light-headedness, off-balance, and vertigo.[54]

However, 54% of persons with dizziness presenting in primary care are classified as having vertigo.[55] Vertigo is the spinning sensation usually described by persons with an inner ear problem.[54,55] Persons with vestibular disorders may present with imbalance in walking, standing, and sitting.[56]

Nausea and vomiting are among the most reported complaints by individuals with vestibular dysfunction.[42] In a recent study, the most common diagnosis for chronic nausea and vomiting among 248 subjects was a chronic vestibular disorder (26%); the investigators recommended the consideration of vestibular disorders diagnosis for persons with chronic nausea and/or vomiting.[43] In a study by Mendal and others[57], nausea was found to be the second most-frequent symptom, following dizziness, described by persons with vestibular disorders. Individuals with vestibular dysfunction also frequently complain of headache.[57] Neuhauser and colleagues[37] found that 80% of 243 subjects who were diagnosed with vestibular vertigo reported a history of headache.

Blurred vision is also among the main complaints of persons with vestibular impairment.[58] Blurry vision is a term used by individuals with vestibular disorders to describe oscillopsia.[59,60] Oscillopsia is the word used to describe the illusionary movement of visual field.[59] In one study, 33% of persons with bilateral vestibular disorders reported oscillopsia; it was the second most frequently reported symptom after unsteadiness.[61]

Space and motion discomfort is characterized by increased distress in some situations that demand visual, somatosensory, and vestibular information to maintain balance.[40,41,62,63] These situations include supermarkets, moving crowds, heights, vibrating or moving floors, spiral stairs, and repetitive geometric wall patterns.[40,41,62,63] Persons with balance and vestibular disorders may experience space and motion discomfort when they are in such situations.[40,41,62,63]

2.2 BALANCE AND VESTIBULAR REHABILITATION

Vestibular rehabilitation was found to be effective in reducing the level of functional disability and improving ADL in persons with vestibular disorders.[39,64-67] A recent study revealed possible structural cortical plasticity in persons with a peripheral vestibulo-cochlear lesion who underwent surgical intervention to remove an acoustic neuroma.[68] Subjects in this study received physical therapy intervention in the hospital after the surgery.[68] These findings suggest vestibular functional improvement as a result of central vestibular compensation.[68]

The effectiveness of vestibular rehabilitation appears to depend on the type of vestibular disorder.[66] Persons with benign paroxysmal positional vertigo (BPPV) can improve the most and may have complete recovery by canalith repositioning procedures as part of vestibular rehabilitation.[66,69,70] In addition, persons with peripheral vestibular disorders can have good recovery in terms of balance and quality of life.[64,67] However, persons with central vestibular disorders seldom have a complete recovery but can have significant functional improvement.[66,71]

2.3 QUALITY IMPROVEMENT

Variation in practice is one of the leading causes of healthcare inadequacies.[72] Therefore, improvement in processes and outcome of care can be seen when that variation decreases.[72] Variations in practice can be remediated by the use of practice guidelines and quality improvement initiatives.[72] To illustrate the variation of care we will summarize the findings of a cross-sectional survey on physical therapy for 588 persons with chronic back pain.[73] Among

treatment that has support for effectiveness, exercise instruction was received the most (75%) and spinal manipulation (10%).[73] However, among treatment that has ambiguous support for effectiveness, heat treatment was received 51%, cold pack 41%, and electrical stimulation 31%.[73] Moreover, among treatment that has no support of effectiveness in chronic low back pain conditions, a corset or brace was received 24%, and traction was received 7%.[73] Quality improvement in healthcare aims at detecting the variation in care and targeting for a higher level of performance.[74] Improvement in healthcare should not only focus on establishing evidence based intervention, but rather should focus on implementing these evidence-based practices into everyday care.[75] Loeb[76] stated that "Health care quality measurement is at least 250 years old. While the names and faces of the measures and those who measure it have changed, the intent of such measurement, i.e. obtaining data and information bearing clinical outcomes, has not changed over the years, and nor have the challenges associated with the measurement of quality in health care".

Quality itself is defined as doing the right thing in the right manner while measuring to ensure excellent results; it is an ongoing process that has no beginning or end.[77]

Definitions of quality improvement:

- Quality improvement is the continuous organized process of using quality quantifiers to detect problems and to apply plans to enhance the quality of care that is usually carried out within particular organizations i.e. a group practice or a hospital. It aims at detecting the reasons for differences in the procedures and outcomes of care and to attempt continuously for better performance.[78]

- Quality improvement is a movement that aims to enhance the quality of care provided by specific organization.[79,80]

- Quality improvement is the collaborative and ongoing efforts to make the changes that will lead to better healthcare outcomes, better system performance, and better practitioner development.[81]

Quality improvement can offer an opportunity for leadership among clinicians, hospitals, or organizational levels of healthcare; it can also benefit professional societies, licensure, and certification boards.[4] Therefore, quality improvement programs should be a balance of regulatory requirements, teamwork, data management, and comparable indicators and results.[82]

Quality improvement effects on healthcare outcomes are ambiguous.[83] Under-use, overuse, and misuse of care are the quality issues that could harm patients in the American healthcare system and probably worldwide.[29] Many studies have shown advantages from the use of quality improvement approaches in many aspects of healthcare including: enhancing clinical outcomes[8-10], improving patient and provider satisfaction[11,12], and decreasing process variation and healthcare costs.[13] However, many studies reported that the quality improvement initiatives in the US and Canada were either not successful[18], report 20-40% success[17], or report less than 50% success.[15] Moreover, other studies have reported that initiatives had low to moderate successful results in achieving their aims.[14] In a quality improvement project for diabetes and coronary artery disease management, an electronic clinical decision support system was favored more than paper-based system by 71% of the participating physicians.[84] Moreover, 76% of physicians participating in the project thought that the quality of care was enhanced by the electronic reminder system.[84]

Quality Improvement Organizations (QIOs) are considered essential for Medicare's external quality review activity.[85] The QIOs began in the early 1970's as Professional Standards Review Organizations (PSROs) and this name was changed in 1983 to Peer Review

Organizations (PROs), and their job was to improve the performance of individual providers via an inspection approach.[85,86] Since this approach helped in improving care for few beneficiaries, the program was changed to target overall quality rather than individual quality and the name was changed to Quality Improvement Organizations in 2001.[87]

Lynn and colleagues[79] suggested that to achieve a successful quality improvement project, the quality improvement process should be part of the clinicians' daily practice. Clinicians should be engaged in the quality improvement, which will help them to gain more insight into process of care to understand it and improve it.[79] Quality improvement movements depend on collaborative efforts by practitioners, managers, and staff to enhance processes.[79] Management commitment, creating awareness of quality, training, employee participation, and quality criteria for performance evaluation are important factors that were found significantly correlated with successful quality improvement.[88]

Clinicians can be frustrated by quality improvement processes because their performance is being measured while not all decision-making in healthcare is covered by high standard evidence.[76] However, we hope that will not be the case in our project since the participating clinicians were involved in the process from the beginning, and they were also involved in the development of CDRs and developed consensus on these protocols.

Implementation of quality improvement can be a challenge.[89] The implementation issues may include organizational unwillingness to allow clinicians to develop care processes that meet their needs, the inability of clinicians to avoid personal biases and break traditional practice, and inability to receive administrative support.[89]

Quality improvement projects should be continuous and ongoing; it is not the type of research that ends by the end of data collection. The importance of the continuity part of quality

improvement is best illustrated by this example: a multifaceted intervention to improve physicians' management of depression in Sweden revealed decreases in suicide rates, however, after 3 years follow up, suicide rates returned to previous levels as physicians' management of depression had deteriorated. Thus, the authors recommended follow up and continuous education.[90,91]

Balance and vestibular testing and examination represent an important aspect of vestibular rehabilitation, as they help in determining the health status of individuals with vestibular disorders and assist in planning the appropriate interventions. These tests and measures can be the key indicators (or MDS) upon which quality can be measured. These indicators are commonly used for persons with balance and vestibular disorders, and they include description of falls, dizziness description, functional eye-head movements coordination testing, positional testing, and balance examination.

Description of falls:

Vestibular dysfunction impacts postural control and balance, which may lead to falls.[35,92-94] One or more falls are reported in 20-30% of older adults; these falls may cause serious injuries such as hip fracture, dislocation, and head trauma which can lead to disabilities.[95-98] Hence, older adults who fall frequently may feel less confident in their activities of daily living and be more dependent on others.[96,99] Therefore, older adults who have a history of one or more falls in the past 12 months should be evaluated for gait and balance.[100] Our group of experts agreed that when a patient reports one or more falls in the last six months he/she should be provided with education about falls as a clinical decision rule.

Dizziness description:

Specific movements can induce dizziness such as getting out of bed, rolling, and quick head movements; these items are among other items in the Dizziness Handicap Inventory (DHI).[101] When dizziness gets worse during these activities, it is highly suspected that the patient has BPPV, and a Dix-Hallpike maneuver should be performed to confirm this diagnosis.[102]

The Dizziness Handicap Inventory (DHI) is a 25-item questionnaire that was developed by Jacobson and Newman.[101] The DHI was designed to record the handicapping effect of dizziness in persons with vestibular disorders.[101] It is scored from 0 to 100, and lower scores indicate less handicap.[101] Whitney and others[103] determined the cut off scores as 0 - 30 (mild handicap), 31- 60 (moderate handicap), and 61 - 100 (severe handicap).

The DHI has good internal consistency for the total score ($\alpha = 0.89$), satisfactory internal consistency for subscales ($\alpha = 0.72 - 0.85$), and high test-retest reliability ($\alpha = 0.97$).[101] Discriminant validity was also established with a good relationship between DHI scores and the number of dizziness episodes.[92] The DHI was also found to be responsive to change as a measure in vestibular rehabilitation.[104] Our group of experts did not establish a clinical decision rule for DHI total or its sub-items.

Functional eye-head movements coordination testing:

The head thrust (HTT) is a test that was originally developed by Halmagyi and Curthoys to test the horizontal vestibulo-ocular reflex (VOR).[105] The VOR stabilizes gaze when the head is moving. Thus, a dysfunction of the VOR will cause visual disturbance.[106,107] The function of the VOR is to induce eye movements in equal magnitude and opposite direction of head movements in order to stabilize gaze.[47,107] The HTT assesses the function of the horizontal VOR in maintaining gaze during head movements by asking patients to fix their gaze on a target while

applying an unexpected head thrust by the examiner.[108] When eye movement derived by the VOR is insufficient, catch-up saccades present toward the unaffected side to re-fixate the eyes.[105]

The sensitivity of the HTT is between 63-72% and the specificity is between 64-78%, which were calculated by scleral search coil head impulse testing as a gold standard and has 100% of sensitivity and specificity in detecting the catch-up saccades with the scleral coil.[109] When the HTT is positive, physical therapists should provide gaze stability exercises and gait exercises (including static and dynamic balance exercises).[107,110] In line with evidence, our group of experts agreed that gaze stabilization exercises should be provided when HTT is positive as a clinical decision rule.

Another ocular motor test is dynamic visual acuity (DVA) that examines the function of the VOR during head movement (horizontally or vertically) by comparing visual acuity during head movement to head still (static) and indicating the amount of visual acuity loss when the head is being moved.[111-113] To perform the DVA test, the examiner takes note of the last line that the patient could correctly read on a Snellen chart while the patient's head is still, and compares it to what the patient could read correctly on the same chart when the patient's head is moving.[114] For vestibular impairment prediction, the sensitivity of horizontal DVA was 66.7% and specificity was 86.2%.[115] For vertical DVA, sensitivity was found to be 42.4% and specificity was 93.8%.[115] A drop of more than 2 lines is considered abnormal.[111] When the DVA is positive, physical therapists should consider optimizing gaze stability via adaptation and eye-head to target exercises.[116,117] Also, gait and balance training should be part of the treatment.[116,117] Our group of experts agreed that gaze stabilization exercises should be provided when the patient loses more than 2 lines on the DVA as a clinical decision rule

The convergence test is among the ocular motor tests, and it examines the ability of the eyes to perform binocular vision to see a single image when focusing on a near object.[118,119] Therefore, convergence insufficiency is the outward deviation of eyeball that is greater for near than far when persons look at a close object that can result in double vision.[118,119] In this test the examiner moves a target toward the patients' nose and records the distance from above the nose (between the eyes) to the target.[120,121] That distance is called the nearpoint of convergence (NPC), and it is recorded when patients report double vision of the target or when the examiner notices a deviation of eyeballs.[120,121] The cutoff value for NPC break is > 6 cm for children,[120] and > 5 cm for adults.[121] When convergence insufficiency presents, convergence exercises are indicated. These exercises may include pencil push-ups,[122] optometric vision therapy,[123] or office-based vision therapy/ orthoptics (the latter has been shown to be more effective than pencil push-ups alone).[124] Our group of experts agreed that when there is difficulty with vergence at 6 cm from the bridge of the patient's nose, the physical therapist should provide convergence exercises as a clinical decision rule.

Vestibulo-ocular reflex (VOR) cancellation is one of the ocular motor tests as well. VOR cancellation occurs when the head is rotated passively while the subject fixates his/her eyes on a target that is also rotating with them at the same speed and direction.[125,126] The VOR normally stabilizes the eyes when the head is moving. However, when the target is also rotating the VOR is cancelled and the eyes follow that target.[126] VOR cancellation examines the capability of central nervous system to cancel a vestibular command.[127] The test is considered positive when there is saccadic pursuit movement in combination with a breakthrough nystagmus.[127] A positive VOR cancellation test may indicate a central nervous system involvement. When the VOR cancellation test is positive and the central nervous system involvement is ruled-out, VOR

cancellation exercises should be provided.[127-129] Our group of experts agreed that when symptoms increase with VOR cancellation (while central vestibular dysfunction is ruled-out) the physical therapist should provide optokinetic training as a clinical decision rule.

Positional testing:

An important part of balance and vestibular testing is positional testing in which the head is moved into specific positions related to gravity to evoke benign paroxysmal positional vertigo (BPPV) symptoms.[130] BPPV is characterized by brief episodes of vertigo that occur with changes of head orientation.[130] These episodes usually last less than 1 minute and alter the patient's life as he/she often avoids these provocative head movements in order to minimize symptoms.[131] Positional testing was developed to evaluate the presence of BPPV, and among these positional tests are the Dix-Hallpike[132] test and the roll test.[133]

The Dix-Hallpike test is used to isolate the involvement of the posterior semicircular canal (PSCC), and the anterior (superior) semicircular canal (ASCC) via the characteristics of the nystagmus.[134] An up-beating torsional nystagmus indicates an involvement in the PSCC in the lowermost ear, however, a down-beating torsional nystagmus indicates a ASCC involvement in the uppermost ear.[131,134] When the lateral (horizontal) semicircular canal (LSCC) is involved, the Dix-Hallpike test should be negative and roll test should be performed.[131] The Dix-Hallpike has a sensitivity of 82% and specificity of 71% for predicting BPPV.[135] The inter-rater reliability of agreement in interpretation of The Dix-Hallpike test is 43 – 81%.[136]

The canalith repositioning procedure (CRP)[137] and the liberatory (also called Semont) maneuver[138] are the most effective interventions for PSCC-BPPV.[131,139] The CRP is also recommended for ASCC-BPPV.[140] Moreover, the forced positional procedure[141], prolonged forced maneuver[142], deep Dix-Hallpike maneuver[134], and head hanging maneuver[143] were

recommended for ASCC-BPPV. In line with evidence, our group of experts agreed that CRP should be provided when the Dix-Hallpick is positive as a clinical decision rule.

Another positional test is the roll test, which is used to diagnose the involvement of the LSCC.[131,144] A positive roll test will provoke either a geotropic or ageotropic nystagmus.[131,144] The geotropic type is more common and indicates that displaced otoconia are floating in the SCC (canalolithiasis), and it produces a strong horizontal nystagmus toward the lowermost ear (affected ear).[131,139,144] Also, the direction of horizontal beating changes when the patient is rolled to the other side to produce less strong nystagmus toward the lowermost ear (unaffected ear).[131,144] However, the less common type of LSCC involvement is the ageotropic in which the displaced otoconia are attached to the cupula (cupulolithiasis), and it produces a horizontal nystagmus beating toward the uppermost ear whether the patient is rolled to either his/her right or left sides.[131,139,144] In the ageotropic type, nystagmus is stronger when the affected ear is the uppermost.[144]

The roll maneuver[145] (also called Lempert maneuver and barbecue roll maneuver) is commonly used for the LSCC-BPPV.[131] Other maneuvers such as forced prolonged maneuver[141], Gufoni maneuver[146], Appiani maneuver[147], and Vannucchi-Asprella liberatory maneuver[148] are used for LSCC-BPPV as well.[131] Our group of experts agreed that with a positive roll test the physical therapist should provide a log roll maneuver as a clinical decision rule.

Balance examination:

The Clinical Test of Sensory Interaction and Balance (CTSIB) was developed originally by Shumway-Cook and Horak[149]; it consists of 6 conditions: (1) standing on a solid surface with eyes open, (2) standing on a solid surface with eyes closed, (3) standing on a solid surface with a visual conflict, (4) standing on a foam surface with eyes open, (5) standing on a foam surface

with eyes closed and (6) standing on a foam surface with visual conflict. Since no difference was found between conditions 2 and 3 and conditions 5 and 6[150], the CTSIB was modified to include 4 conditions.[151] The four conditions of the Modified Clinical Test of Sensory Interaction and Balance (mCTSIB) are: (1) standing on a solid surface with eyes open, (2) standing on a solid surface with eyes closed, (3) standing on a foam surface with eyes open, (4) standing on a foam surface with eyes closed.[151] Test-retest reliability of the CTSIB total score was $r = 0.75$ in older adults.[152] Also, test-retest and inter-rater reliability were $r = 0.99$ in normal young individuals.[150] Abnormal sway while standing with eyes closed on foam (mCTSIB) has 90% sensitivity and 95% specificity for identifying abnormalities in sway during standing with eyes closed on a sway-referenced platform during the Sensory Organization Test in persons with vestibular disorders.[153]

With a maximum of three trials for the original CTSIB, each condition is performed for 30 sec. The time should be stopped when: (a) the patient deviates from initial position, (b) the patient opens his/her eyes in the closed eyes condition, (c) the patient takes a step, or (d) the patient loses his/her balance or requires assistance to prevent falling.[149] The time is scored for each condition; if more than one trial is performed the average time of the trials for that condition is scored.[149] Trials should be performed until 30 sec is achieved or the three trials limit is reached.[149]

Vereeck and colleagues[154] tested 318 normal subjects between 30 – 80 years of age and they found that all subjects performed successfully in three conditions of this balance test: solid surface/eyes open, solid surface/eyes closed, and foam surface/eyes open. However, in the fourth condition (foam surface/eyes closed), all subjects performed normally except subjects in their 70's who had a mean score of 26 sec, and those in their 80's who had a mean score of 19.8 sec.

Cohen and colleagues[150] tested 39 subjects (22 normal / 17 vestibular disorders). Normal subjects were divided based on their age into three groups: group 1 (25 - 44 years), group 2 (45 - 64 years), and group 3 (65 - 84 years). The fourth group included persons with vestibular disorders (including BPPV, vestibular neuronitis, cupulolithiasis, labyrinthitis, and idiopathic vestibular disorders) and the age range was 30 to 87 years. All normal subjects performed solid surface/eyes open, solid surface/eyes closed, and foam surface/eyes open for the entire 30 sec trial. However, normal subjects between the ages of 60 - 84 had a mean score of 16 sec on foam surface/eyes closed. Normal subjects up to the age of 64 were able to stand in foam surface/eyes closed for the entire 30 sec. Subjects with vestibular disorders stood for 30 sec on solid surface/eyes open and solid surface/eyes closed, but had a mean of 26.5 sec on foam surface/eyes open and 14 sec on foam surface/eyes closed.[150]

Balance training can be effective for patients who fail to complete any condition of mCTSIB.[155] In line with evidence, our group of experts agreed that when the patient fails to complete any of the mCTSIB conditions, the physical therapist should provide exercises for static and/or dynamic standing balance as a clinical decision rule. The criteria they agreed-upon for mCTSIB failure are: stood <30 s after 3 attempts, movement of the hands, eye opening when their eyes are to be closed, or movement of the feet on the floor.

Another measure that is used to assess a patient's balance is the Activities-specific Balance Confidence scale (ABC). The ABC is a 16-item that quantifies the difficulty of activities and fear of falling in elderly individuals.[156] Items inquire about activities with different levels of difficulty, ranging from walking around the house to walking on icy sidewalks.[156] It is scored from 0% to 100%, and higher scores indicate a more confident individual.[156]

The sensitivity and specificity of the ABC for falls prediction in community-dwelling older adults were 84% and 87%, respectively.[157] It has a high internal consistency ($\alpha = 0.96$) and good test-retest reliability $r = 0.92$, $p < 0.001$.[156] The ABC has a strong correlation with the DHI $r = 0.64$, $p < 0.001$, which indicates convergent validity.[158] The cutoff score for the ABC is 67%.[157] Any patient who obtains a score lower than 67% should be considered at risk of falling and balance and gait training should be provided.[157] Our group of experts' clinical decision rule for the ABC was to provide education for patients with an ABC score less than 70% to increase their confidence. They decided to choose 70% instead of 67% to be more conservative.

Gait speed is also one of the balance indicators. Gait speed is a measure that can be used to detect falls risk, disability, functional changes, and overall health status.[159,160] Gait speed is timed while patients walk at their preferred speed over 8 feet, 4 m, 5 m, 6 m, or 10 m.[160-162] The 4 m distance for gait speed was deemed appropriate to be used by our group of experts. Gait speed has excellent test-retest reliability in healthy adults $r = 0.90$[163], healthy older adults $r = 0.96$[164] and in persons with vestibular disorders $r = 0.85$.[165] The cut-point for gait speed is 0.8 m/s for adverse health outcomes.[166,167] Scores lower than 0.8 m/s indicate poor health and function, therefore, balance and gait exercises should be provided when gait speed is lower than 0.8 m/s.[166,167] In line with evidence, our group of experts' clinical decision rules for gait speed was to provide an ambulation program for patients with gait speed less than 0.8 m/s.

The 4-item Dynamic Gait Index (DGI 4-Item) is also part of the balance examination. Marchetti and Whitney[168] developed the DGI-4 outcome measure, which assesses walking performance in persons with vestibular disorders. It is a short form of the original 8-item Dynamic Gait Index (DGI).[169] The DGI 4-Item has a sensitivity of 85% and specificity of 74% for identifying individuals with balance and vestibular disorders.[168] It also demonstrates high

internal consistency ($\alpha = 0.89$) and discriminant validity $r = 0.87$.[168] A cut-point of ≤ 9 indicates risk of falling and balance and gait training should be provided.[168] Our group of experts' clinical decision rules for DGI-4 was to provide an ambulation program for patients with a DGI-4 less than 12.

The last indicator is the 15-point Likert Global Rating of Change (GRC).[170] Jaeschke and colleagues developed the GRC outcome measure.[170] The global rating of change measures the change in health status from the patient's perspective.[170-172] The GRC outcome measure can help in determining if patients think that they are improving.[170-172] The GRC can assist in determining the validity of the clinical decision rules (CDRs).

The GRC is a 15-point score ranging from +7 (a very great deal better) to -7 (a very great deal worse), with 0 indicating no change.[170] Further, it was divided into three ranks of change: +1 to +3 or -1 to -3 which indicate small change, +4 and +5 or -4 and -5 which indicate moderate change, and finally, +6 and +7 or -6 and -7 which indicate large change.[170]

2.4 CLINICAL DECISION RULES IMPLEMENTATION

Clinical guidelines or clinical protocols are defined as a set of rules that affects clinical decision-making and provision of care.[173] One of the shortcomings of quality in healthcare is variation in practice.[72] Therefore, quality of healthcare can be improved through minimizing such variation.[72] Standardized care can reduce variation in care, reduce medical error, and improve quality of healthcare.[4,174] Thus, practice guidelines and decision rules are important remedies to solve the issue of variation in practice.[72]

Adherence to clinical guidelines and standards of care is associated with improvements in quality of care and clinical outcomes.[175] However, implementation of clinical decision rules can be the most important barrier to adherence of standardized care.[89] Clinical decision rules implementation issues may include lack of organizational and administrative support and clinicians' resistance to change their practice.[89]

Protocols and guidelines created by government agencies and medical societies are not utilized as much as when clinicians themselves create them.[89] Therefore, locally developed guidelines (developing standards by local consensus) can be more effective than national guidelines, mainly when combined with management monitoring such as reminders.[176]

2.5 CHANGING CLINICAL BEHAVIOR

Clinical behavior plays an important role in the quality of healthcare and in the process of guidelines implementation.[177,178] Behavioral intervention strategies that target clinical behavior include educational material dissemination[179], continuing medical education[180], and reminders.[181]

In a systematic review, Grimshaw et al[23] reported poor implementation effectiveness of behavioral intervention strategies. Moreover, interventions to change clinical performance have shown varied and limited effectiveness; however, combining intervention strategies or multifaceted interventions are more promising.[25,177]

Failure to change clinical behavior can decrease the chances of improvement in quality of healthcare.[182] Adherence to guidelines was found to be poor as a result of predominance of opinion over evidence.[76] When clinicians are not able to avoid personal biases and break traditional practice, they can disturb the processes of implementing standardized care and quality

improvement.[89] Therefore, knowing and planning for barriers to change may play an important role in the success of the attempt to change clinical behavior.[183,184] Also, preparing clinicians for change and involving them in the process of change can be helpful.[89,176] Administrative and organizational roles in implementing clinical behavioral change is as important as the clinicians role.[185] Administrative and organizational roles may include policy development, incentives, and monitoring of the quality improvement program.[89,176]

2.5.1 EDUCATIONAL TRAINING

Cantillon and Jones[186] summarized the findings of systematic reviews on continuing medical education and stated that continuing medical education (CME) could improve clinical performance and patient outcomes. They also found that clinicians' behavior could be changed through education that is related to clinical practice or the work they perform. Moreover, CME can show greater effectiveness when reminders accompany it. Other studies reported that a combination of interventions such as educational training and reminders is more effective in changing clinical behavior than individual intervention.[23,187]

Educational training was more effective than educational materials dissemination in terms of changing clinical behavior.[23,187] Also, no difference was found in the effectiveness between educational training and reminders in changing clinical behavior.[187] However, the increase in number of intervention strategies applied has no statistically significant association with changing clinical behavior.[23] Thus, we think that the type of intervention strategies that are combined can make the difference not only the number of strategies.

In continuing medical education (CME), e-learning is as effective as traditional learning in conveying knowledge to health care providers.[188-193] The use of internet-based CME has

increased from 2.7% to approximately 31% between 2001 and 2004.[194,195] E-learning is more convenient and cost-effective than traditional learning.[190,191,196] It is also associated with higher satisfaction and learning efficiency.[192,193,197] Marshall et al[196] suggested that e-learning is a promising method in changing clinical behavior, with 64.7% of participants in an on-line case discussion reporting a change in their clinical behavior compared to 30.8% in the control group who received no intervention. These reports were based on pre-post intervention surveys. Other studies have shown the same role of the e-learning method in changing clinical behavior.[190,198]

Carrying evidence-based medicine into practice may face many barriers at different levels.[199] Knowledge deficiency is an individual level barrier and a non-supporting system can be a problem at an organizational level.[199] The management support (CRS in our project) can play a very important role in changing the clinical behavior of therapists.[200] In this project we worked at both levels by educating the therapists and through the support we have from the CRS management team.

The main goal of this study was to implement and evaluate a quality improvement initiative for service provided to persons with balance and vestibular disorders in outpatient clinics that belong to the Centers for Rehab Services (CRS) in southwestern Pennsylvania. The process of fostering a quality improvement project involved development and implementation of clinical decision rules (CDRs) that established standardized care.

2.6 SPECIFIC AIMS AND HYPOTHESES

There were six aims to this project:

1. To develop and implement the CRS balance and vestibular evaluation form that included the minimal data set (MDS).
2. To develop and implement the CDRs.
3. To develop and deliver a continuing education program for balance and vestibular rehabilitation aimed at increasing the knowledge of participating physical therapists about the MDS and CDRs.
4. To measure the level of compliance to the MDS by participating physical therapists.
5. To measure the level of adherence to the CDRs during the initial evaluation by participating physical therapists before and after the behavioral interventions of interest are provided.
6. To compare the change in the score of outcome measures (ABC and DHI) and patient's perceived improvement based on the GRC between persons with balance and vestibular disorders who were treated according to the CDRs and those who were not.

Primary hypothesis:

We hypothesized that physical therapists in the intervention group, who received the educational training and adherence reminders earlier than the wait-listed group, would show greater adherence to the CDRs than the wait-listed group who would have not yet received the educational training and adherence reminders. Also, we hypothesized that physical therapists in the wait-listed group would show an increase in adherence to the CDRs when they were provided with the educational training and adherence reminders.

Secondary hypothesis:

We hypothesized that persons with balance and vestibular disorders who were treated according to the CDRs would benefit from balance and vestibular rehabilitation more than those who were not treated according to the CDRs, and that would be reflected in their scores on the ABC and DHI, and the GRC by comparing adherent and non-adherent clinical evaluation forms.

3.0 METHODS

This project was an attempt to standardize and improve care, and to determine if physical therapists were providing care to their patients with balance and vestibular disorders according to the best available evidence. In this quality improvement project, physical therapists completed a custom-made balance and vestibular form and a concussion form that had a number of indicators (minimal data set-MDS) including various tests and measures, and physical therapists decided during initial evaluation on a plan of care based on pre-determined clinical decision rules (CDRs). Also, physical therapists were to record three clinical outcome measures every two weeks.

Behavioral intervention strategies used in this study included:

- Dissemination of educational materials that covered the MDS and the CDRs.
- Sending reminders to any physical therapist who omitted an item on the MDS and/or did not adhere to the CDRs.
- Providing educational training that covered theoretical and practical aspects of the MDS and the CDRs.

We investigated how these intervention strategies changed clinical behavior of participating physical therapists.

3.1 DEVELOPMENT OF BALANCE AND VESTIBULAR FORM

Documentation in medical records enables agencies in healthcare to evaluate providers' performance.[78] In order to facilitate effective healthcare, documentation has to be consistent and complete.[201] Loeb[76] stated that "the central issue in performance measurement remains the absence of agreement with respect to what should be measured. Not everything in healthcare can or should be measured".

The current balance and vestibular form was developed initially by faculty members and graduate students from the physical therapy department within School of Health and Rehabilitation Sciences- University of Pittsburgh (Drs. Whitney and Sparto) and experienced physical therapists working at the Eye and Ear Institute- CRS (Drs. Mucha and Hinderliter). The balance and vestibular form went through over 10 modifications by physical therapists who attend the monthly CRS Neurological/ Vestibular physical therapist meeting at the Center for Sports Medicine clinic-South Side until the MDS was agreed upon by the CRS team. The final version of the evaluation form was reached after 13 months and it contained information about the patient's diagnosis, history, examination, and interventions.

The MDS in this project included (Appendix A shows the balance and vestibular evaluation form that included the MDS as bold, italicized, and boxed items):

- ICD-9 codes
- Current medical history
- Date of onset
- History of falls
- Symptoms of dizziness when: getting out of bed, moving head quickly, and rolling
- Dizziness Handicap Inventory (DHI)

- Head thrust test (HTT)

- Dynamic visual acuity (DVA)

- VOR cancellation

- Convergence

- Positional testing

- Balance test (mCTSIB)

- Gait speed

- Activity-specific balance confidence scale (ABC)

- 4-item dynamic gait index (DGI 4-item)

- Plan of care: it was a list of generic treatment categories[202] that served as intervention choices based on the examination findings and included:

  - Eye-head activities
  - Balance activities
  - Ambulation program
  - Canalith repositioning
  - Optokinetic training
  - Patient education

The concussion form was a similar version of the balance and vestibular form but dedicated for persons with concussion. (Appendix B shows the concussion evaluation form that included the MDS as bold, italicized, and boxed items)

The participating physical therapists developed a list of contraindications for almost each clinical test in the forms. These contraindications were deemed appropriate for not performing the test (Appendix C).

3.2 DEVELOPMENT OF CLINICAL DECISION RULES

For every examination within the evaluation form that was part of the MDS, a care decision was provided. Such decisions led either to additional examinations or to a specific treatment option. These decisions were based on the best available evidence and/or experienced physical therapist consensus. The development of the CDRs took place over more than 6 meetings involving physical therapists who attend the monthly CRS Neurological/ Vestibular physical therapist meeting at the Center for Sports Medicine clinic-South Side. (Appendix D)

3.3 INTERVENTIONS STRATEGIES

Three behavioral intervention strategies were used with the aim to improve the clinical behavior of physical therapists. These intervention strategies were:

1- Educational material dissemination: the educational material included information about how to complete the evaluation form, how to perform examinations on the form, contraindications to perform the examinations, how to choose the appropriate intervention based on the CDRs, and how to administer the ABC, DHI and the GRC. The educational material was disseminated via email.

2- Monitoring of compliance to MDS and adherence to CDRs: reminder emails were sent to any physical therapist who omitted one or more items in the MDS and/or when he/she had not

chosen the pre-determined treatment interventions, in the initial evaluation form, based on the group's established CDRs. Compliance referred to completing of all MDS items included in the evaluation form. Physical therapists were considered non-compliant when they have faxed an evaluation form with incomplete MDS. Adherence referred to consistency in implementation of the CDRs. Physical therapists were considered non-adherent if they did not follow the CDRs. Therefore, there were two types of reminders:

- Compliance reminders: reminders regarding the MDS.
- Adherence reminders: reminders regarding the CDRs.
- Physical therapists were given 2 weeks from sending the compliance reminders to complete the missing MDS or justify their decision
- Also, they were given 2 weeks from sending the adherence reminders to correct the treatment choice according to the CDRs or justify their decision

3- Educational training: this educational program was part of a quality improvement project (QI) that aimed at assuring that physical therapists who were working at the Centers for Rehab Services (CRS) and treated people with balance and vestibular disorders were providing their clients with the best available care.

Therapists often do not receive specialized training to practice vestibular rehabilitation (VR) and no certificate is mandatory for them to practice.[203] In an international survey, one of the recommendations was to develop standards for education in VR.[204]

The educational training consisted of 1.5 hours of training that covered theoretical information were videotaped and uploaded on the University of Pittsburgh's Mediasite for the physical therapists to review. A short test (Appendix E) was completed online upon completion of the educational training. In addition, a practical session (approximately 30 minutes) followed

by a competency test that covered the practical portion of the educational training was carried out in local clinical sites; the time and venue were announced in advance to participating physical therapists. Physical therapists received a continuing education certificate for 3 general CEUs upon successful completion of the theoretical and competency testing/ training that could be used for their CEU requirement for licensure renewal in Pennsylvania.

Evidence has shown that e-learning in continuing medical education is as effective as traditional learning[188-193], and thus we chose to use the media-site because the educational training would be the same for all the groups, and thus no difference in adherence could be claimed against differences in the educational program. Also, the Mediasite platform offered a more convenient method of education for everyone, taking into consideration that the participating physical therapists were busy and it could be difficult to find a time that fit everyone's schedule.

Outcome measures:

Clinical outcome measures are benchmarks that help in determining if the level of healthcare quality is accepted.[78] Three self-report outcome measures were used in this study as benchmarks of patients' improvement. Clients completed these measures every two weeks, and the most recent were used for analysis of patient self-perceived improvement. These three outcome measures included:

- *The Activities-specific Balance Confidence scale (ABC)*
- *The Dizziness Handicap Inventory (DHI)*
- *A 15-point Likert Global Rating of Change (GRC)*

3.4 RESEARCH DESIGN

Traditional designs, i.e. randomized controlled trials (RCT), depend on the ability to identify and measure confounders. However, little is known about confounders in quality improvement and how to measure these confounders.[81,205-207] Despite the practical and ethical challenges to apply RCT, they are the gold standard design to determine the effect of quality improvement projects as well as other areas.[30,208,209]

In this project, physical therapists who work at the CRS and treat people with balance and vestibular disorders were divided into two groups: an intervention group and a wait-listed (control) group.

Timeframe of the project:

At the beginning of the project, educational materials were disseminated to both groups via email. All physical therapists completed the balance and vestibular form or the concussion form for each patient at the initial visit; however, therapists were given the chance to complete the form in two visits if they were not able to complete it in the first visit. All physical therapist have been using the forms since they were approved on 11/29/2012. The physical therapists would choose the pre-determined treatment interventions in the evaluation form according to the protocol (CDRs). The three outcome measures (ABC, DHI and GRC) were administered every two weeks for each patient, and in case of patients who do not continue their treatment the most recent completed outcome measures were considered. Both groups received educational material 1 week before the start of the quality improvement project. Also, both groups received compliance reminders from the start of the study until the end of the study.

A compliance rate of 90-95% was deemed appropriate by the investigators to start the behavioral intervention in order to assure that enough information in the evaluation form was

being collected. Thus, compliance rate were monitored during the first couple of weeks. Once a compliance rate of 90-95% or more was reached on week 7, the intervention group started to receive the other two intervention strategies that include educational training and adherence reminders. The wait-listed group did not receive any other interventions at this stage except the dissemination of educational materials and compliance reminders. Four weeks after the intervention group received the behavioral intervention, week 12, the wait-listed group received the educational training and adherence reminders. Data collection of this project continued for a total of 16 weeks. A 2-week washout period at the end of the project was dedicated to send reminders and collect data (forms and follow-ups) from the 16-week period.

Physical therapists sample:

The clinicians sample consisted of physical therapists who worked at the Centers for Rehab Services (CRS) and treated people with balance and vestibular disorders.

Patients sample:

The patients sample in this study was persons presenting to CRS outpatient Neurological specialty clinics with balance and/or vestibular complaints and assigned one or more of ICD-9 codes (Appendix F) commonly used for persons with balance and vestibular disorders.

Randomization:

CRS facilities in southwestern Pennsylvania were divided into two groups. The two groups were counterbalanced in terms of the number of physical therapists in each facility, full-time vs. part-time physical therapists, and physical therapists who worked at more than one facility. After the counterbalanced groups were determined, one group was assigned to the intervention group and the other group was assigned as the wait-listed group via randomization.

Randomization process:

CRS facilities were clustered and matched into pairs of clusters according to the number of physical therapists in each facility, full-time vs. part-time physical therapists, and physical therapists who work at more than one facility. We chose to divide groups according to facilities instead of physical therapists to avoid cross-contamination of the behavioral interventions between physical therapists within each facility. A cluster contained one or more physical therapists that worked at one or more facilities. A matched pair of clusters was two clusters that had a similar number and characteristics of physical therapists. Therefore, cluster assignment provided an equal pair of clusters that were divided into two groups.

The two clusters in each matched pair were divided into two groups using randomization. At the beginning these two groups were called group number 1 and group number 2. In each matched pair of clusters, we randomly selected one cluster and flipped a coin for group assignment. Once all matched pairs were divided into the two groups, a coin was flipped to assign group number 1 to be either the intervention or wait-listed group. Once group was assigned be the intervention group, therefore, group two was assigned to be the wait-listed group. All of the physical therapists were blinded to their group assignment and to the difference between the two groups in term of intervention strategies.

3.5 DATA COLLECTION

Two honest brokers (data managers) were trained and completed the required certification through UPMC to be able to receive the faxed balance and vestibular and concussion evaluation forms plus to de-identify and extract the data. The 1st data manager was trained before the

project started and the other data manager was trained in the middle of the project to take over because the 1st data manager changed positions. The use of an honest broker was essential to this project in order to protect patients' information.

The evaluation form and the outcome measures were sent to a secure fax at the Eye and Ear Institute-UPMC to which the data manager had dedicated access. The data manager reviewed the faxed forms and data was inputted to an Excel spreadsheet.

Type of data collected:

Demographic information for physical therapists participating in the study was collected. A questionnaire was sent to all physical therapists and included: age, gender, highest earned degree, specialty certifications, whether he/she has attended a course in vestibular rehabilitation at Emory University, years of total experience, years of balance and vestibular experience, and whether he/she worked full-time or part-time. Also, demographic information was extracted from the evaluation forms that included patients' age, gender, and duration of symptoms.

The average percentage of compliance amongst each group was collected and categorized as compliant or non-compliant. An evaluation form was compliant if all MDS items were completed. The compliance for each physical therapist was averaged by dividing the number of compliant forms by the number of total forms from that physical therapist. Thus, it was possible to obtain group weekly averages of compliance rates.

The average percentage of adherence amongst each group was also collected. The adherence of physical therapists was dichotomized as adherent or non-adherent. Each evaluation forms was considered adherent if there was no "non-adherent" treatment category among the 6 treatment categories per evaluation form. Then adherent evaluation forms were averaged for

each physical therapist at each time point (pre/ post-behavioral intervention) to obtain average adherence rate for each physical therapist at each time point.

The type and count of reminders sent to each group were collected. The average score on outcome measures (ABC, DHI, and GRC) for adherent vs. non-adherent evaluation forms was calculated.

A post-hoc survey (Appendix G) regarding the project was sent to the participating physical therapists via email at the end of the project. The survey aimed to explore the value of the quality improvement project for the participating physical therapists. A website (www.surveymonkey.com) was utilized to host the survey.

The intention to treat (ITT) principle was used in this project when: the follow-up data were linked to the physical therapists who completed the initial evaluation and planed the care even if the follow-up sessions were provided by a different physical therapist, if there were missing outcome measures at discharge, the most recent outcome measure scores were considered as the discharge data, and if the physical therapist was assigned to a new clinic after the group assignment, he/she was analyzed within the original group assignment.

3.6 STATISTICAL ANALYSES

The baseline characteristics for physical therapists and persons with balance and vestibular disorders were compared using an independent t-test, Mann-Whitney U test, Chi square test, or Fisher's exact test.

A mixed-factor ANOVA was used to compare the average adherence between/within groups based on adherence rates before and after the behavioral intervention. Interactions

between the two groups after they had received the behavioral intervention were probed using results from the mixed-factor ANOVA.

Baseline and discharge of the ABC and DHI for adherent and non-adherent evaluation forms were analyzed using mixed-factor ANOVA. The Mann-Whitney U test was used to compare the change in GRC score between adherent and non-adherent evaluation forms. The significant level of p-value in this project was 0.05.

4.0 A QUALITY IMPROVEMENT PROJECT IN BALANCE AND VESTIBULAR REHABILITATION: A RANDOMIZED CONTROLLED TRIAL

4.1 INTRODUCTION

In the United States (US), the level of adherence of healthcare to quality standards is unknown.[1,2] In many countries, including the US, about 40% of patients do not receive evidence-based interventions, and around 25% of patients receive unnecessary care.[27,28] Under-use, overuse, and misuse of care are quality issues that could harm patients.[29]

Variation in practice is one of the leading causes of healthcare inadequacies; therefore, improvement in processes and outcome of care can be seen when that variation decreases.[72] Variations in practice can be remediated by the use of practice guidelines and quality improvement initiatives.[72] Improvement in healthcare should not focus only on establishing evidence-based intervention, but also should focus on implementing these evidence-based practices into everyday care.[75] Quality improvement is defined as a continuous organized process of using quality quantifiers to detect problems and to apply plans to enhance the quality of care.[78] Many studies have shown advantages from the use of quality improvement approaches in many aspects of healthcare including: improving patient and provider satisfaction and decreasing process variation and healthcare costs.[11-13] However, quality improvement effects on healthcare outcomes are ambiguous.[83] Several studies reported that the quality improvement initiatives in

the US and Canada were either not successful or reported less than 50% success.[14,15,18] Lynn and colleagues[79] suggested that to achieve a successful quality improvement project, the quality improvement process should be part of the clinicians' daily practice. Clinicians should be engaged in the quality improvement, which will help them to gain more insight into process of care, to understand it, and improve it.[79]

Clinical practice does not always reflect research findings and clinical guidelines.[23-26] Clinical guidelines are defined as a set of rules that affects clinical decision-making and provision of care.[173] Adherence to clinical guidelines is associated with improvements in quality of care.[175] Locally developed guidelines can be more effective than national guidelines, mainly when combined with management monitoring such as reminders.[176] Clinical behavior plays an important role in the quality of healthcare and in the process of guidelines implementation.[177,178] Failure to change clinical behavior can decrease the chances of improvement in quality of healthcare.[182] Behavioral intervention strategies that target clinical behavior include educational material dissemination[179], continuing medical education[180], and reminders.[181]

Between 2001 and 2004, approximately 70 million Americans older than 40 years complained of vestibular dysfunction.[33] Vestibular disorders may affect a person's activities of daily living (ADL) and health related quality of life (QOL).[34-36] Balance and vestibular rehabilitation was found to be effective in reducing the level of functional disability and improving ADL in persons with balance and vestibular disorders.[39,64-67]

The main goal of this study is to implement and evaluate a quality improvement initiative for service provided to persons with balance and vestibular disorders in outpatient clinics. We hypothesized that physical therapists in the intervention group, who received educational training and adherence reminders earlier than the wait-listed group, would show greater adherence to the

clinical decision rules (CDRs) than the wait-listed group. Also, we hypothesized that physical therapists in the wait-listed group would show a similar increase in adherence to the CDRs after they were provided with the educational training and adherence reminders, compared with the intervention group.

4.2 METHODS

In 2013, a 16-week quality improvement project was carried out among physical therapists employed by Centers for Rehab Services (CRS), which is a part of the University of Pittsburgh Medical Center (UPMC). The UPMC Quality Improvement subcommittee approved this project. The project involved development and implementation of a minimum data set (MDS) and CDRs that establish standardized care.

The minimum data set:

The MDS was developed through consensus from experienced physical therapists on the important indicators for balance and vestibular disorders. The MDS included: physical therapist selected codes of the International Classification of Diseases (ICD-9), current medical history, date of onset, history of falls, symptoms of dizziness when: 1) getting out of bed, 2) moving the head quickly, and 3) rolling in bed, the Dizziness Handicap Inventory[101] (DHI), the head thrust test[105] (HTT), dynamic visual acuity[113] (DVA), provocation of symptoms during vestibulo-ocular reflex (VOR) cancellation,[125] ocular convergence testing,[119] positional testing,[132,133] the Modified Clinical Test of Sensory Interaction and Balance (mCTSIB),[149,151] gait speed,[159] the Activity-specific Balance Confidence (ABC) scale,[156] the 4-item Dynamic Gait Index[168,169] (DGI 4-item), and the plan of care. The plan of care was a list of generic treatment categories[202] that served as

intervention choices based on the examination findings and included: eye-head coordination activities, balance activities, an ambulation program, the canalith repositioning maneuver, optokinetic training, and patient education. The MDS was highlighted in the forms used by physical therapists when they performed an initial evaluation for a client with dizziness or imbalance.

The clinical decision rules:

A clinical decision was provided for 10 out of the 16 items of the MDS. These decisions were based on the best available evidence and/or experienced physical therapist consensus (Table 1). Physical therapists were asked to check off the treatment interventions (plan of care) on the initial evaluation form according to the CDRs.

Physical therapists sample:

The sample consisted of physical therapists who were working at the Centers for Rehab Services (CRS) and who treated people with balance and vestibular disorders.

Patients sample:

The sample included patients who presented to the CRS outpatient neurological specialty clinics with balance and/or vestibular complaints. Patients were included based on one or more ICD-9 codes (i.e. 386.2, 781.2, 780.4, 850.9, and 386.11) commonly used for persons with balance and vestibular disorders. All participating physical therapists were asked to include consecutive patients with whom they utilized the balance and vestibular evaluation form or the concussion evaluation form.

Randomization:

CRS facilities were divided into two groups according to these characteristics: the number of physical therapists in each facility, number of full-time vs. part-time physical

therapists, and physical therapists who split their time at more than one facility. The groups were then randomly assigned to the intervention or wait-listed group. All of the physical therapists were blinded to their group assignment and to the difference between the two groups in term of the initiation of intervention strategies.

Behavioral intervention strategies:

Behavioral intervention strategies used in this quality improvement project included dissemination of educational material, reminders, and educational training. Figure 1 shows the steps followed in providing the behavioral interventions. Educational material was emailed to physical therapists one week before the starting date of the project. This educational material included information about the MDS and CDRs. After the starting date, physical therapists were reminded via email if they omitted one or more items on the MDS (compliance reminder) or when they did not check off one or more treatment categories on the evaluation form that was recommended by the CDRs (adherence reminder). Compliance was defined as completing all required items of the MDS on the forms. Compliance reminders were provided to all physical therapists from the 1st day of the project. Adherence was defined as planning patients' care according to the CDRs. Physical therapists were given 2 weeks from sending the compliance reminders to complete the missing MDS or justify their decision for not completing the omitted MDS. They were also given 2 weeks from sending the adherence reminders to correct the treatment choice according to the CDRs or justify their decision regarding the plan of care. The last behavioral intervention was the educational training, which contained a webinar, short test, and competency training and testing. The webinar was 1.5 hours of theoretical information that was videotaped and distributed for the physical therapists to review. The short-test was completed online and included 10 multiple-choice questions about the tests and measures in the

evaluation forms, and the corresponding CDRs. The competency training and testing was delivered by one of the investigators (SLW) who provided a practical session followed by the competency test for each participating physical therapist.

An overall compliance rate of 90-95% in both groups was deemed appropriate by the investigators to start behavioral interventions (which included adherence reminders and the educational training) to assure that enough information in the forms was being collected to be able to evaluate the physical therapists' performance.[78,201] Thus, the compliance rate was monitored from the start of the project. By the end of week 16, a two-week washout period was dedicated to send reminders and collect responses from the 16-week recruitment period.

Data collection:

The evaluation forms were faxed to a secure fax server to which a data manager had dedicated access. Two data managers were trained and completed the required certification to be able to de-identify and extract the data from the evaluation forms.

Type of data collected:

Demographic information for physical therapists participating in the study was collected. Also, demographic information of patients was extracted from the evaluation forms. The average percentage of compliance for the physical therapists was calculated. The average percentage of adherence amongst each group was also calculated. Each evaluation form has 6 treatment categories that were classified as adherent, non-adherent, or over-utilized based on the CDRs. A treatment category was considered as adherent when the treatment category was checked off and the CDRs recommended it, or when it was not checked off and not recommended by the CDRs. Non-adherent treatment category was a treatment category that was not checked off in the evaluation form while recommended by the CDRs. When a treatment category was checked off

on the evaluation form while not supported by the CDRs it was classified as over-utilized. Therefore, an evaluation form was considered adherent if no treatment category was classified as non-adherent among the 6 treatment categories on the evaluation form. The adherence percentage was averaged for each physical therapist for pre and post intervention periods. The type and count of reminders sent to each group were collected. If the physical therapist was assigned to a new clinic after the group assignment, he/she was analyzed within the original group assignment. The compliance and adherence rates that were used in the analyses were the rates calculated after the physical therapists responded to the compliance or adherent reminders.

A follow-up survey regarding the project was sent to the participating physical therapists via email at the end of the project. The survey aimed to explore the value of the quality improvement project for the participating physical therapists.

4.3 STATISTICAL ANALYSES

Differences in baseline characteristics between physical therapists groups and in patients seen by the intervention and wait-listed groups were tested using parametric and non-parametric tests as appropriate. A mixed-factor ANOVA was used to compare the average adherence between/within groups based on adherence rates before and after the behavioral intervention. The p-value was set at 0.05.

4.4 RESULTS

A total of 23 physical therapists working at 15 clinics initially participated in the project. Four physical therapists were excluded because they were not assigned to a specific clinic. Nineteen physical therapists were included and randomized into two groups; 9 in the intervention group and 10 in the wait-listed group. A physical therapist was dropped from the wait-listed group since this therapist did not fax any evaluation forms in the post-intervention period. Therefore, 18 physical therapists were included in the analyses (See Figure 1). A total of 732 patients' evaluation forms were faxed and 580 patients' evaluation forms were included in the analyses. The excluded 152 evaluation forms were either completed by the four excluded physical therapists or the dropped physical therapist. Of the 580 included evaluation forms, 276 patients were seen by physical therapists in the intervention group and 304 patients were seen by physical therapists in the wait-listed group.

Group comparison:

Physical therapists:

No statistical differences were found between the groups in terms of demographic information (Table 2). All physical therapists who participated in the quality improvement project were female with average age of 38 and 36 years in the intervention and wait-listed groups, respectively.

Persons with balance and vestibular disorders:

No statistical differences were found between the patients seen by the physical therapists in the groups in terms of demographic information (Table 3). The average age of the patients was 32 years (range 7-90 years) in the intervention group and 41 years (range 7-93 years) in the wait-listed group. Patients were more likely to be female 64% and 65% in the intervention and wait-

listed groups, respectively. The median duration of symptoms was 7 weeks (range: 1-777 weeks) in the intervention group and 6 weeks (range: 1-529 weeks) in the wait-listed group.

A compliance rate of 90-95% or more was reached for both groups at week 7, therefore, the intervention group began to receive educational training during week 8. Also, adherence reminders started at the beginning of week 8 until the end of the project for the intervention group. The wait-listed group received educational training four weeks after the intervention group, which was during week 12. Adherence reminders also were started at the onset of week 12 for the wait-listed group until the end of the project. All of the physical therapists who participated in the quality improvement project reported that they had viewed the webinar. Their average score on the online short test were 96% for both intervention and wait-listed groups. There was no statistical difference between the groups in terms of their scores on the online short test (independent t-test: $p = 1$).

Table 4 shows the response rates to compliance and adherence reminders, respectively. The overall response rate to reminders was higher for compliance reminders than adherence reminders.

To examine the effect of the behavioral intervention on the adherence of the physical therapists to the CDRs for the intervention group, the adherence rates were averaged for the 4 weeks before and after the intervention group received the behavioral intervention. The average change in adherence increased by 5% across both groups. The within group difference was not significant ($p = 0.4$, effect size = 0.04). Between groups effect showed no significant difference ($p = 0.8$, effect size =0.005). There was no significant interaction effect of the behavioral intervention ($p = 0.3$, effect size = 0.08) with observed power of 0.2. (Table 5)

The effect of the behavioral intervention on adherence rates for both groups was examined using the average of adherence rates before and after the behavioral intervention was provided to each group (i.e. intervention group: 7 weeks before/ 9 weeks after, wait-listed group: 11 weeks before/5 weeks after). Average adherence rates increased significantly for both groups after the behavioral intervention (p = 0.008, effect size =0.4). The average change in adherence rates was 11% across the intervention wait-listed groups. The between group effect was not significant (p = 0.8, effect size = 0.003), indicating that the adherence rates were about the same. The interaction effect of intervention was not significant which suggests that the change in adherence rates was similar for both groups (p = 0.6, effect size = 0.01) with observed power of 0.07. (See Table 5)

Figure 2 shows an increase in the weekly compliance rates before and after the physical therapists responded to the compliance reminders for the whole sample (18 physical therapists) over the 16 weeks. When comparing the trends of compliance rates between the before and after the reminders, it appears that compliance reminders had an effect on the pre-reminders compliance rates mainly within the first 4 weeks; after that the compliance rates remained almost steady at higher levels.

In contrast, Figure 3 shows an increase in the weekly adherence rates for both intervention and wait-listed groups after the educational training and adherence reminders were initiated. However, it appears that the educational training had a greater effect on the adherence rates, as there is virtually no difference in adherence rates after the reminders were sent.

The amount of over-utilization for each treatment category was explored, except for the education category, since it was expected that all physical therapists would provide education in

each visit (Table 6). The balance activities category was the most over-utilized treatment and CRM was the least.

Overall, both groups showed less over-utilization of treatment in the post-intervention period than in the pre-intervention period. Figure 4 shows the percentage of sum of over-utilized treatment categories for the sample (18 physical therapists) while excluding education category. When pre-intervention was compared to post-intervention periods, it was found that evaluation forms that had no over-utilized treatment categories increased by 16%. Evaluation forms that over-utilized 1 treatment category decreased by 3%. A decrease of 9% was found in evaluation forms that over-utilized 2 treatment categories. Evaluation forms that had 3 or 4 over-utilized treatment categories decreased by 2% in the post-intervention period. There was less than 1% of the evaluation forms that over-utilized 5 treatment categories in the pre-intervention period and none in the post-intervention period. The quality improvement project appeared to decrease over-utilized treatment categories.

Figure 5 shows the adherence rates pre/ post- intervention for each physical therapist. Four of the physical therapists showed a 100% adherence in both the pre and post-intervention periods, and the adherence improved to 100% in six of the physical therapists. There was still room for improvement despite an increase in adherence in six of the physical therapists, even after the behavioral intervention was provided. The adherence decreased in two of the physical therapists. Of the four physical therapists who did not participate in the development of the CDRs, two of them showed 100% adherence post-intervention and two did not.

The post-hoc survey in this quality improvement project asked the physical therapists to provide feedback about the project and how to improve it. Twenty one out of the 23 physical therapists completed the survey with a response rate of 91%. The most common barrier to

complete the MDS was that there was not enough time to complete all the MDS (81%). However, most of the physical therapists reported that they rarely faced any barrier to adhere to the CDRs (81%). The majority (81%) of the physical therapists preferred a prompt electronic reminder (for instance, if entering the data in an electronic medical record) instead of email reminders while 19% preferred the email reminders. Also, a majority of the physical therapists (57%) thought the quality improvement project helped improve the quality of care.

The physical therapists were asked about the benefits of the quality improvement project and 10 physical therapists (48%) did not respond to this question, and thus, were considered as "no benefits". Six physical therapists (29%) thought it guided a complete and consistent evaluation. Four physical therapists (19%) said it directed their goal setting and treatment planning. One physical therapist said it provided extra training and established the CDRs. One physical therapist commented that it could be beneficial for students.

When asked about negative aspects to the quality improvement project, seven physical therapists (33%) did not respond, therefore, were considered as "no negative aspects". Also, one physical therapist commented that there were no negative aspects to this project. Seven physical therapists (33%) thought that faxing the balance and vestibular form and the concussion form was burdensome and consumed time. Five physical therapists (24%) commented that this quality improvement project was time consuming. Three physical therapists thought that this quality improvement project did not fit all patients and that they had to perform examinations against their clinical judgment. Two physical therapists thought it was an extra task to do. One physical therapist commented on receiving reminders after the first visit while they have two visits to complete the forms. One physical therapist said that she had to fax the forms each visit since it was hard to keep track of which to send every two weeks. One physical therapist thought that

quality improvement projects are not suitable for experienced clinicians. One physical therapist commented that this quality improvement project did not add anything to her clinical management.

The physical therapists were asked for their ideas to improve this quality improvement project. Twelve physical therapists (57%) did not respond. Also, one physical therapist commented that it was good the way it was. Five physical therapists (24%) thought an electronic data collection method would make it easier than paper-based and faxing. Two physical therapists thought that the forms should be reconstructed to include the MDS only rather than having MDS included within a more comprehensive form, which would make it easier to complete the MDS. One physical therapist suggested that the CDRs for the 4-item DGI should be reconsidered, as it is very conservative.

4.5 DISCUSSION

Improvement in adherence to clinical guidelines following guidelines implementation is reported to be usually 5-10%.[210] Our results showed 11% improvement in adherence rates to the CDRs. Bekkering and colleagues[211] defined the important difference in adherence to clinical guidelines as 20%, yet they concluded that it was optimistic. Bekkering and colleagues[211] compared the adherence of physical therapists to low back pain clinical guidelines and found a difference of 12% in adherence rates in favor of the intervention group. In their study, the control group received the guidelines by mail whereas the intervention group received the guidelines by mail and also received a multifaceted intervention that included education, discussion, role playing, feedback, and reminders.[211] In fact many studies reported that the use of quality improvement

could improve patient care, increase provider satisfaction and decrease process variation and healthcare costs.[11-13]

During the 4-week period when the intervention group received the educational training and adherence reminders, the 11% increase in adherence in the intervention group was not significantly different from the 2% decrease in the wait-listed group. The lack of a significant finding can be related to the low power of the study. A post-hoc power analysis revealed that 34 physical therapists were needed to be recruited in this study. However, this was a fixed group and recruiting more physical therapists was not possible.

Adherence rates were approximately 80% before intervention was provided and above 90% after providing the intervention. Previous studies showed that quality improvement projects that involve the clinicians in the process are likely to be successful.[79] For example, Van der Wees and colleagues[212] found that adherence to guidelines in providing interventions for individuals with acute ankle injury was very high at 92% and physical therapists in their study were familiar with the guidelines. Besides having the physical therapists participating in the guidelines development, the physical therapists were involved in two meetings to discuss the acute ankle injury guidelines.[212] Since most of the physical therapists in our study were involved in developing the CDRs, this could have played a role in the high adherence rates. Moreover, the participating physical therapists have been involved in monthly meetings for over 5 years that review the latest findings in balance and vestibular rehabilitation. Whereas the physical therapists had high adherence rates, the pre-reminder compliance rates were relatively low, even though the MDS was agreed upon by the physical therapists. The high adherence rates might be explained by the physical therapists developing the CDRs based on their daily practice which was in line with evidence; the low pre-reminders compliance rates may by due to not completing

all the MDS in their daily practice for every person with balance and vestibular disorders. In fact, some of the physical therapists in our project mentioned in the survey that the MDS does not fit every patient they examined. The effect of the quality improvement project could have started before the initiation of the project, when the physical therapists participated in the development of the MDS and CDRs and were aware that their performance was to be assessed.

The response rates to reminders of both types were not very high in this quality improvement project. The reason for this was in part related to the system we used to remind the physical therapists, which was email. In order to respond to the reminders, the physical therapists would need to retrieve a patient's information and re-fax or email their responses, which consumed time and effort. An efficient method would be an electronic data entry system that promptly reminds the physical therapists about their lack of compliance to the MDS and/or non-adherence to the CDRs, and the physical therapists would have to respond prior to submitting the electronic evaluation form in the future. Furthermore, electronic reminders were reported to increase the chance of receiving care according to clinical guidelines over paper-based reminders.[84] In a study by Sequist and colleagues[84], 35% of the participating physicians in the survey reported that the electronic reminders encouraged them to act according to the recommendations. McDonald et al[213] reported that the compliance rate (to order a test or record a finding) increased significantly from 12 and 20% to 23 and 49%, respectively. Also, the adherence rate (to alter a treatment plan) increased significantly from 29 to 43%.[213] They used electronic reminders to cue the physicians when they were in the intervention period.[213] However, it appears that giving the clinicians the choice to act upon reminders or ignore them would not be as effective as having the clinicians either act upon the reminders or briefly justify their non-recommended decision. The reason given by the clinicians for not being adherent to the

clinical guidelines at the time of the visit would be valuable information to amend the guidelines to fit atypical cases. Litzelman et al[214] found that physicians who were required to respond to the electronic reminders showed significantly higher compliance rate (46%) than those who received electronic reminders without being required to respond (38%). Moreover, a systematic review reported that the overall median change in adherence to guidelines as a result of electronic reminders was 6%, however, when responding to reminders was required the median increased to 13%.[215]

In this study, compliance rates were higher after the physical therapists responded to the compliance reminders, mainly within the first 4 weeks. These findings suggested that reminders were very effective in increasing the rates of compliance and that the physical therapists retained that improvement throughout the rest of this quality improvement project. It was reported that completeness and consistency of medical records is essential to evaluate clinicians' performance.[78,201] In contrast, a moderate increase in the weekly adherence rates occurred mainly after adherence reminders and educational training were provided to each group. However, adherence reminders did not have an effect on adherence rates since the adherence rates did not seem to change much before and after the physical therapists responded to the adherence reminders. These findings suggest that the moderate increase in adherence rates was related to the webinar and competency testing/training rather than adherence reminders since there were a small number of adherence reminders. It was reported that educational training is more effective than educational materials dissemination in terms of changing clinical behavior.[23,187] Also, educational training and reminders have the same effectiveness in changing clinical behavior.[187] Moreover, an intervention that combines educational training and reminders is expected to be more effective in changing clinical behavior than individual intervention.[23,187]

This quality improvement project was effective in decreasing the percentage of over-utilized treatments after the behavioral intervention was provided. Overuse was defined as providing treatment that lacked evidence of effectiveness.[73] It was reported that the use of guidelines could have an important effect in reducing over-utilization, mainly when the guidelines are simple and easy to use.[216] Although the CRM should not be provided when positional testing is negative, it was over-utilized in our study but it was over-utilized the least. Hence, we think that CDRs that are specific and imply a negative direction (if positional testing is negative then CRM should not be provided) are easier to follow and help in adherence to clinical guidelines. These findings support the idea that developing guidelines that have rules for negative examination results as well as positive results leads to less over-utilization of treatment. A review stated that well-established guidelines have a promising potential to decrease over-utilization.[217]

The physical therapists reported that the most chosen barrier to complete the MDS was lack of time, which might suggest that a shorter or a diagnosis specific MDS was needed. Also, the physical therapists said that they sometimes did not agree with the importance of the MDS to their specific patient, and that the patient refused to perform and/or complete the MDS. Sequist and colleagues [84] surveyed physicians who participated in their study and the response rate was 62%. They found lack of time during office visits to be the most selected barrier to guideline adherence (50%), followed by patient refusal (42%) and then disagreement with guideline recommendations (34%),[84] which is similar to our findings.

Most of the physical therapists said they rarely had problems with adhering to the CDRs, which reflects the moderate change in their adherence rates. Among the barriers to adhere to the CDRs was that the physical therapists reported that they sometimes forgot to check the treatment

category they planned to provide to their patients. In Sequist and colleagues[84] study, 26% of the physicians reported forgetting to follow the guideline recommendations.

Faxing the evaluation forms was considered by the physical therapists to be a negative aspect to the quality improvement. The physical therapists suggested that an electronic data collection method would enhance the quality improvement project. Electronic reminders were preferred over email reminders by most of the physical therapists. An electronic reminding system would make it easier for the physical therapists and would be cost and time effective. It was reported that 71% of the physicians who participated in a survey favored an electronic clinical decision support system over a paper-based system.[84]

Physical therapists considered the quality improvement project as beneficial in guiding a complete and consistent evaluation, and directing their goals-setting and treatment planning. More than half of the physical therapists thought the quality improvement project helped to improve the quality of patient care. Sequist et al[84] reported that 76% of the physicians in their study thought that the electronic reminder system assisted in patient care improvement. Also, it has been reported that adherence to clinical guidelines is associated with improvements in quality of care.[175]

4.6 LIMITATIONS

One of the limitations in this quality improvement project was that the sample of physical therapists in this project was not sufficient to have enough power, which therefore increases the chance of not been able to find a significant effect of the behavioral intervention while in fact there was an effect.[218] Also, treatment categories were generic and could cover a wide variety of

treatment modalities and exercises, which might have led to choosing treatment categories that were not recommended by the CDRs (over-utilization). Moreover, the CDRs that we developed were positive rules only. We did not provide rules for cases where examinations were negative. This over-utilization might have inflated the adherence rate.

Electronic data entry would be more efficient than paper and faxing. An electronic medical record would have insured that we received all patients' evaluation forms that were completed by the participating physical therapists.

A design that has a pre quality improvement period (baseline) would provide more information on the clinical behavior of physical therapists before any intervention was provided including the dissemination of educational materials and compliance reminders.

4.7 CONCLUSION

To the best of our knowledge, this is the first quality improvement project in balance and vestibular rehabilitation. This quality improvement project was effective in demonstrating the same level of improvement in adherence to the CDRs between groups. Both groups' adherence levels improved over the 16-week study. Over-utilization of treatment decreased as a result of this quality improvement project. Also, completeness of the evaluation forms (MDS) improved over the 16 weeks of study, which means improvement in documentation.

The high adherence rates in both groups from the beginning of this project may be because the rules are broad, and they were developed and agreed upon by most of the participating physical therapists. Among our behavioral intervention strategies, the email reminders and on-site educational sessions were considered the most beneficial. Although we

cannot anticipate the response from the physical therapists to the passive methods (educational materials dissemination and educational webinar) we can say that an active in-person educational session and email reminders were effective in changing physical therapists clinical behavior.

Figure 1 Quality improvement project timeframe. [1] Four physical therapists were excluded because they were not assigned to a specific clinic. [2] A physical therapist was dropped from the wait-listed group since this therapist did not fax any evaluation forms in the post-intervention period.

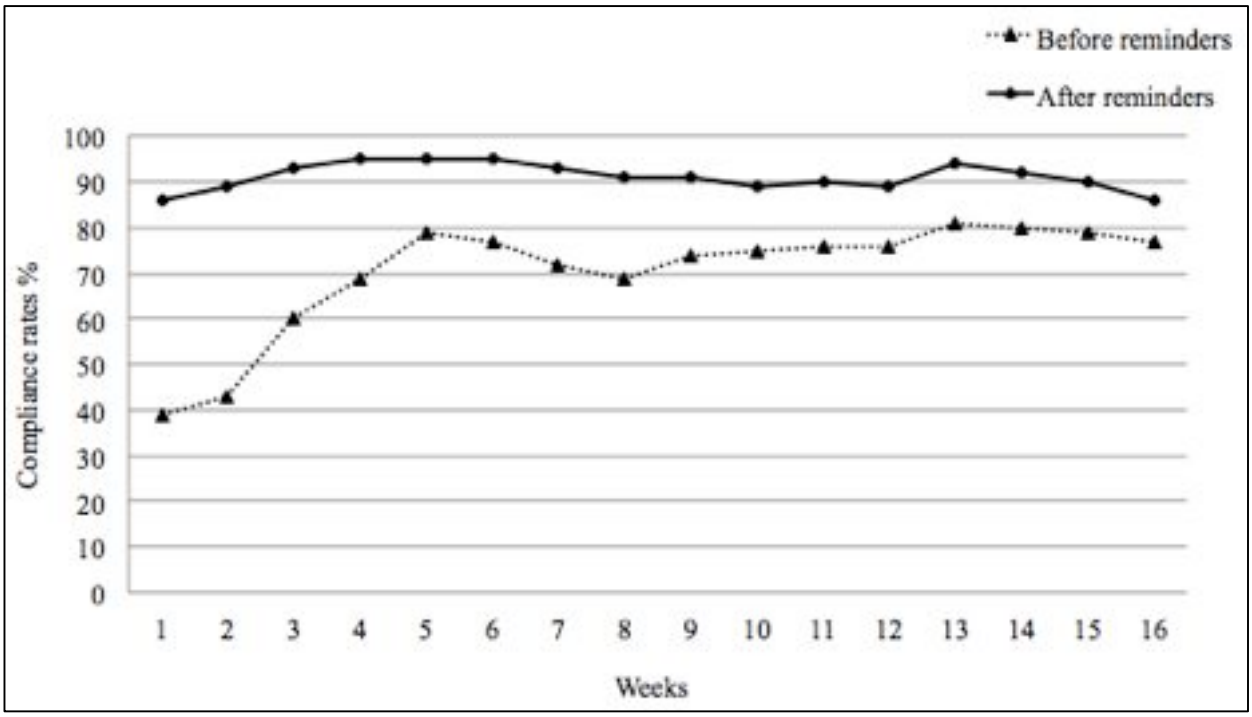

Figure 2 Weekly compliance rates before and after the compliance reminders for the whole sample (n=18 physical therapists). Since not every physical therapist had sent data every week, three-weeks running averages were calculated to reflect an estimate of compliance rate for the physical therapists during each week. The dashed line (before reminders) represents the original compliance rate before the compliance reminders were sent to the physical therapists. The solid line (after reminders) represents the compliance rates after the physical therapists responded to the compliance reminders.

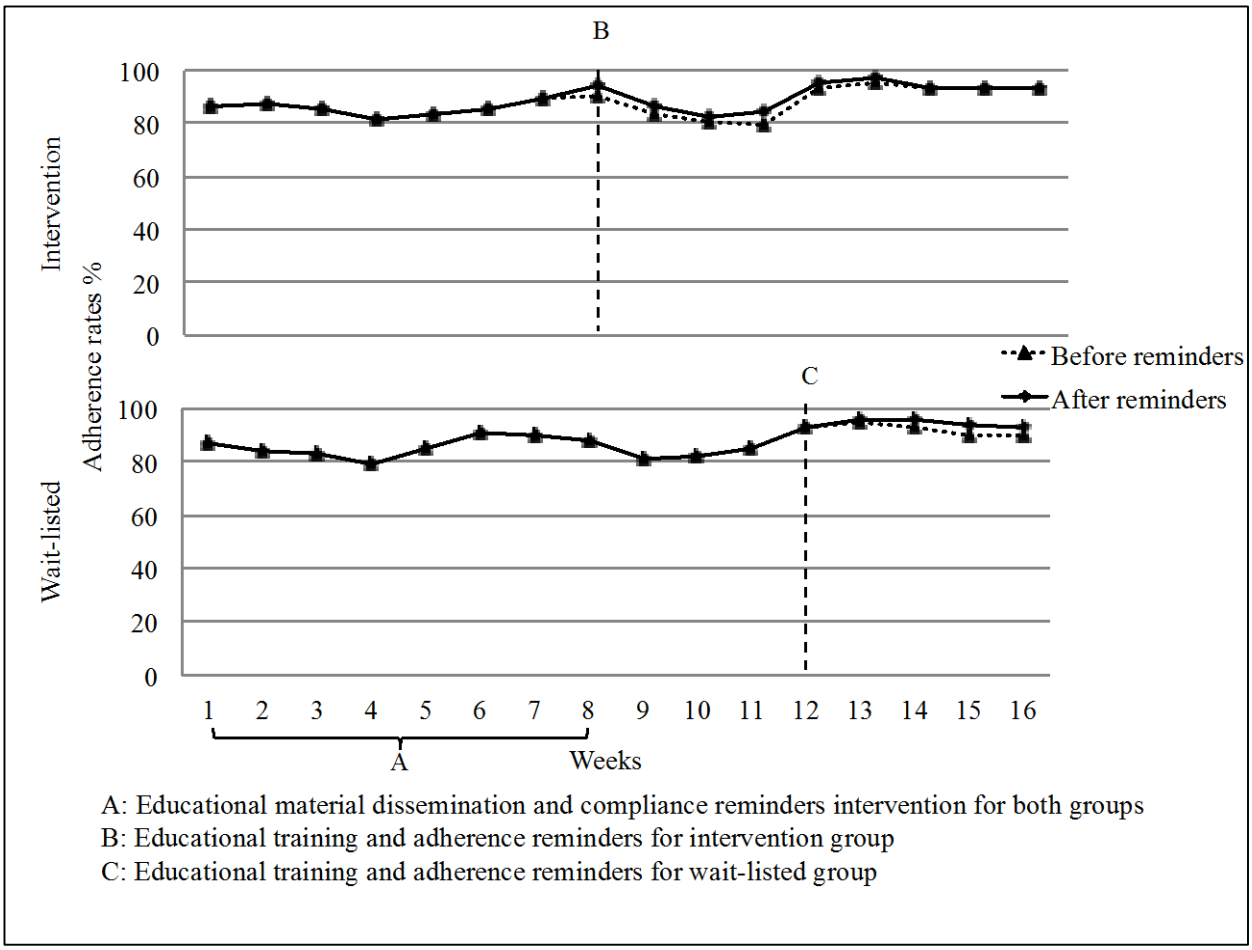

Figure 3 Weekly adherence rates before and after adherence reminders for the intervention (n= 9 physical therapists) and wait-listed group (n= 9 physical therapists). Since not every physical therapist had sent data every week, three-weeks running averages were calculated to reflect an estimate of compliance rate for the physical therapists during each week. The dashed line (before reminders) represents the original adherence rate before the adherence reminders were sent to the physical therapists. The solid line (after reminders) represents the adherence rates after the physical therapists responded to the adherence reminders.

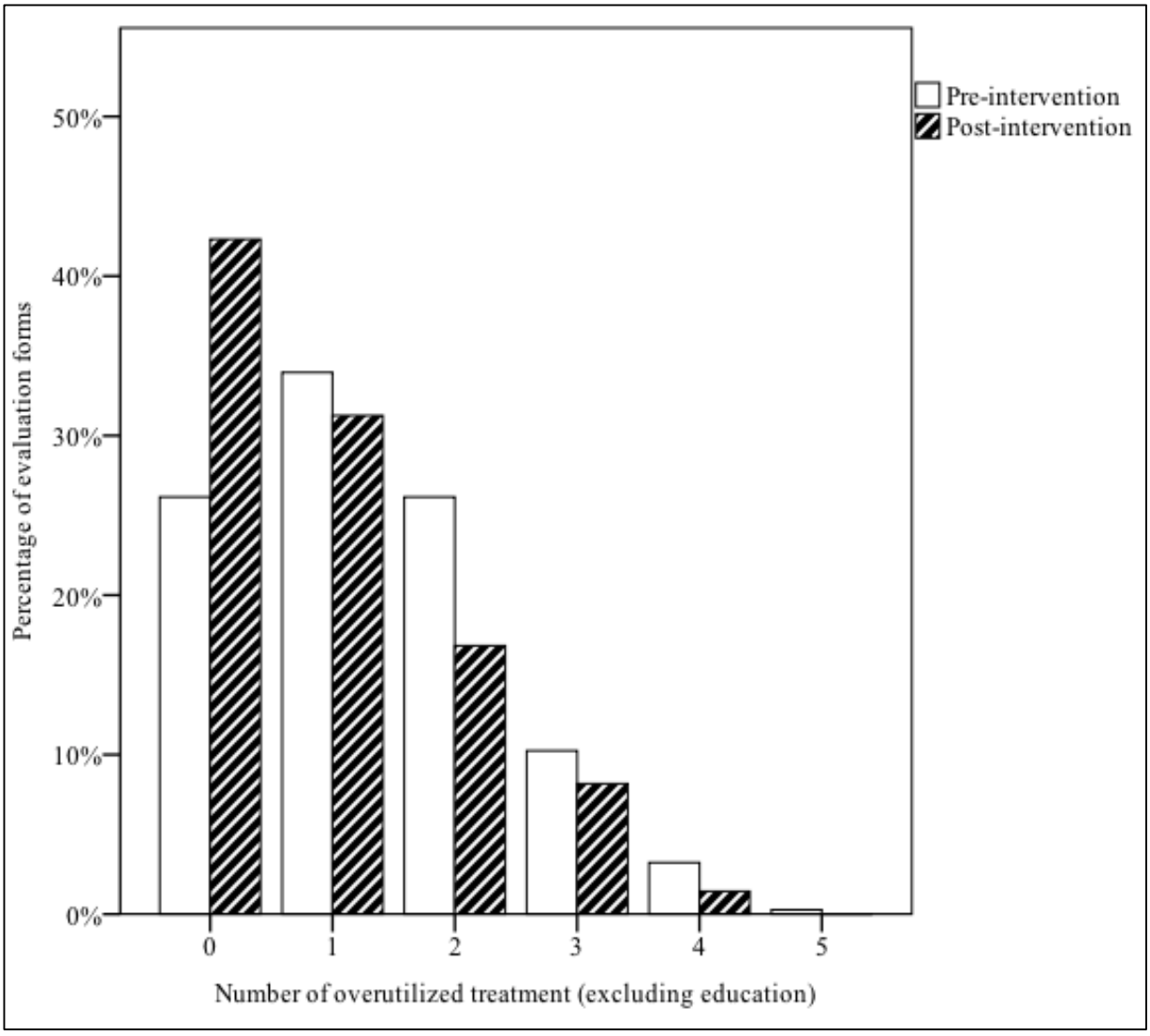

Figure 4 Percentage of evaluation forms categorized by the number of over-utilized treatment categories for the sample (n= 18 physical therapists). The white bar represents the pre-behavioral intervention period. The shaded bar represents the post- behavioral intervention period. An evaluation form could maximally have 5 over-utilized treatment categories out of 6 treatment categories; the education category was excluded since it was ideal to provide patients with education regarding their balance and vestibular dysfunction. 0: percentage of evaluation forms that did not have any over-utilize treatment category. 1 -5: percentage of evaluation forms that have 1 through 5 over-utilized treatment categories.

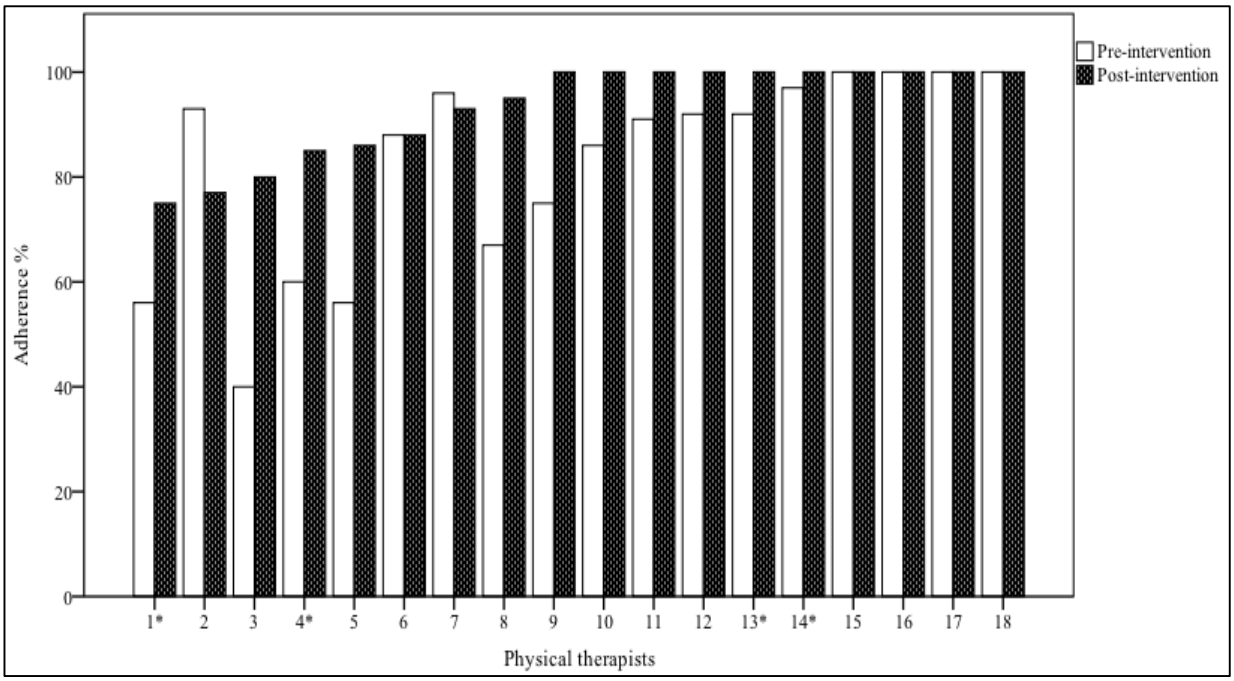

Figure 5 Individual adherence rates pre/post intervention for physical therapists (n= 18). The white bar represents the adherence rate during the pre-behavioral intervention period and the black bar represents the post-behavioral intervention period. The asterisk (*) indicates that the physical therapist was not involved in the development of the minimum data set (MDS) and clinical decision rules (CDRs).

Table 1 Clinical decision rules (CDRs).

Test/examination	Clinical decision rules
History of falls	If the patient reports one or more falls in the previous six months, then provide the falls education packet
Head thrust test (HTT)	If head thrust test is positive, then do gaze stabilization exercises
Dynamic visual acuity (DVA)	If the patient loses greater than 2 lines on the clinical DVA test, then do gaze stabilization exercises
Convergence	If the patient has difficulty with vergence (defined as a near point of convergence greater than 6 cm from the tip of the nose), then do convergence exercises
Vestibulo-ocular reflex (VOR) cancellation	If symptoms increase with VOR cancellation, then do optokinetic training
Positional testing	- If the patient demonstrates a positive Dix-Hallpike on the left (upbeating torsional nystagmus that fatigues), then do the left canalith repositioning maneuver (CRM) - If the patient shows a positive Dix-Hallpike on the right (upbeating torsional nystagmus that fatigues), then do a right CRM - If the patient shows a positive roll test to the right or left, then do the log roll maneuver (as part of CRM category)
Balance [the Modified Clinical Test of Sensory Interaction and Balance (mCTSIB)]	If the patient fails to complete any of the mCTSIB items as described, then work on static standing and/or dynamic standing activities Criteria for indication: - Stood less than 30 seconds per trial - Movement of the hands from the start position - Eye opening when their eyes are to be closed - Movement of the feet on the floor
Gait speed	If gait speed is less than 0.8 m/s, then provide ambulation program

Table 1 (continued)

Activities-specific Balance Confidence (ABC)	If patient's ABC is less than 70%, then provide education to increase his/her balance confidence
Dynamic gait index (DGI-4 item)	If DGI-4 is less than 12, work on an ambulation program

Table 2 Physical therapists' characteristics (n= 18).

	Intervention (n=9)	Wait-listed (n=9)	*p*
Age (years): mean (SD)	38 (8)	36 (11)	0.6 $^{\delta}$
Highest degree earned: BS: n (%) MS: n (%) DPT: n (%)	 0 (0%) 1 (11%) 8 (89%)	 2 (22%) 0 (0%) 7 (78%)	0.5 $^{\alpha}$
Specialty certification (NCS): yes (%)	2 (22%)	3 (33%)	1 $^{\alpha}$
Advanced Vestibular Training (Emory Course): yes (%)	4 (44%)	6 (67%)	0.6 $^{\alpha}$
Total years of practice: mean (SD)	13 (7)	13 (12)	1 $^{\delta}$
Years of practice in balance and vestibular rehabilitation: mean (SD)	7 (4)	5 (4)	0.3 $^{\delta}$
Full-time employment (%)	6 (67%)	7 (78%)	1 $^{\alpha}$
SD: standard deviation BS: Bachelor degree MS: Masters degree			

Table 2 (continued)

DPT: Doctor of Physical Therapy

NCS: Neurologic Clinical Specialist

$^{\alpha}$ Fisher's exact test

$^{\delta}$ Independent t-test

Table 3 Patients' characteristics (n=580).

	Intervention (n=276)	Wait-listed (n=304)	*p*
Age of the patients (years): median (range)	32 (7-90)	41 (7-93)	0.2 $^{\beta}$
Gender: Female (%)	178 (64%)	197 (65%)	1 $^{\alpha}$
Duration of symptoms (weeks)*: median (range)	7 (1-777)	6 (1-529)	0.3 $^{\beta}$

$^{\alpha}$ Chi-Square test

$^{\beta}$ Mann-Whitney test

* Duration of symptoms was missing in 2 and 4 patients in the intervention and wait-listed groups, respectively

Table 4 Response rates to compliance and adherence reminders during the 16-week period of the quality improvement project.

Group	Sent reminders	Received responses	Response rate
Compliance reminders:			
Intervention	111	77	69%
Wait-listed	70	56	80%
Total	181	133	73%
Adherence reminders:			
Intervention	15	8	53%
Wait-listed	6	4	67%
Total	21	12	57%

Table 5 Mixed-factor ANOVA of adherence rates for weeks 4-12 and all 16 weeks.

Group	N	Means (SD)%		Within		Between		Interaction	
		Pre	Post	*p*	ES	*p*	ES	*p*	ES
Weeks 4-11:									
I	8*	75 (31)	86 (16)	0.4	0.04	0.8	0.005	0.3	0.08
W	9	84 (24)	82 (23)						
All 16 weeks:									
I	9	83 (18)	92 (10)	0.008	0.4	0.8	0.003	0.6	0.01
W	9	83 (21)	95 (8)						

Groups: (I) Intervention and (W) wait-listed. N: number of physical therapists. SD: standard deviation. Pre: Adherence mean pre-intervention. Post: Adherence mean post-intervention. P: p-value. ES: effect size (partial eta squared), where 0.01 = small effect, 0.06 = moderate effect, and 0.14 = large effect.[219]

* One physical therapist in the intervention group did not send any data in the post-intervention period (weeks 8-11).

Table 6 Treatment categories categorized according to the CDRs situations (n=580 evaluation forms).

Treatment categories	CDRs indicated	Number received (%)	Number did not receive (%)	CDRs not indicated	Over-utilized (%)
Eye-head activities	387	374 (97%)	13 (3%)	193	103 (53%)
Balance Activities	173	172 (99%)	1 (<1%)	407	289 (71%)
Ambulation program	228	210 (92%)	18 (8%)	352	175 (50%)
Canalith repositioning	120	112 (93%)	8 (7%)	460	35 (8%)
Optokinetic training	312	277 (89%)	35 (11%)	268	84 (31%)
CDRs: clinical decision rules					

5.0 THE EFFICACY OF A QUALITY IMPROVEMENT PROJECT ON OUTCOMES OF PERSONS WITH BALANCE AND VESTIBULAR DISORDERS

5.1 INTRODUCTION

The prevalence of vestibular disorders was reported to be 35% in Americans at the age of 40 years and older.[33] The risk of falling is highly linked to balance and vestibular disorders, which may result in fall-related injuries and consequent costs.[33] In addition, activities of daily living and quality of life are adversely affected in individuals with balance and vestibular disorders.[34-36,38,39] Balance and vestibular rehabilitation improves the performance of activities of daily living and decreases the level of functional disability in individuals with vestibular disorders.[39,64-67]

Variation in clinical practice leads to healthcare inadequacies which can be minimized by the use of practice guidelines and quality improvement.[72,74] Quality improvement is a structured process of utilizing quality indicators to detect the reasons for differences in practice and outcomes of care with the goal of enhanced clinical performance.[78] Quality improvement may improve clinical outcomes[8-10], increase patient and provider satisfaction[11,12], and minimize variation, and costs of healthcare.[13] In a recent quality improvement project, 76% of clinicians reported improvement in the quality of care by the use of an electronic reminder system.[84] However, others have demonstrated that quality improvement effects on healthcare outcomes were unclear and reported to have low to moderate success in achieving aims.[14,83]

Clinical guidelines are a set of rules that affect clinical decision-making and can enhance quality of care and clinical outcomes.[173,175] McGuirk et al[220] reported a greater improvement in outcomes of patients with low back pain who were treated in clinics that utilized evidence-based guidelines compared with patients who received their care at clinics in which these guidelines were not introduced. However, quality improvement projects and implementation of guidelines concentrate mostly on evaluating the processes with less focus given to the effect of adherence to guidelines on clinical outcomes.[221] Clinical outcomes can be used as benchmarks to assist in determining if the quality of healthcare is improving.[78]

In this study, we explored the effect of a quality improvement project on clinical outcomes for persons with balance and vestibular disorders. The process of quality improvement implementation typically includes development of a minimum data set (MDS) and clinical decision rules (CDRs). In a previous report, changes in compliance to the MDS and adherence to the CDRs were previously evaluated in the vestibular rehabilitation setting.[222] The purpose of this study was to examine if adherence to CDRs has a beneficial effect on patient outcomes. We hypothesized that persons with balance and vestibular disorders who were treated according to the CDRs would benefit from vestibular rehabilitation more than those who were not treated according to the CDRs.

5.2 METHODS

A four-month quality improvement project was implemented within the University of Pittsburgh Medical Center (UPMC) Centers for Rehab Services outpatient neurological physical therapy clinics. This project was approved by the UPMC Quality Improvement subcommittee. The aim

of the project was to evaluate the effect of behavioral intervention strategies provided to physical therapists to explore adherence to the CDRs and patient outcomes over the 16-week quality improvement project.

Physical therapists completed the MDS which included physical therapist selected codes of the International Classification of Diseases (ICD-9), current medical history, date of onset, history of falls, symptoms of dizziness during different activities, the Dizziness Handicap Inventory[101] (DHI), the head thrust test[105] (HTT), dynamic visual acuity[113] (DVA), vestibulo-ocular reflex (VOR) cancellation,[125] convergence,[119] positional testing,[132,133] the Modified Clinical Test of Sensory Interaction and Balance (mCTSIB),[149,151] gait speed,[159] the Activities-specific Balance Confidence (ABC) scale,[156] the 4-item Dynamic Gait Index[168,169] (DGI 4-item), and the plan of care. The plan of care consisted of six treatment categories[202] selected by the physical therapists as appropriate based on the examination findings and the CDRs. The plan of care included eye-head coordination exercises, balance activities, ambulation training, the canalith repositioning maneuver, optokinetic training, and patient education.

The MDS was included in the evaluation form used by physical therapists when they performed an initial evaluation for an individual with dizziness or imbalance. Also, physical therapists were to decide on the plan of care based on pre-determined CDRs, as described in Almohiza et al.[222] The CDRs provided a care decision for 10 out of the 16 items on the evaluation form that included the MDS. The CDRs were developed based on evidence-based practice and consensus among the experienced physical therapists who participated in the quality improvement project.

Physical therapists transmitted the evaluation forms to a secure fax to which an honest broker had access. The honest broker verified if the physical therapists completed the MDS and

selected choices within the plan of care that they would utilize according to the CDRs. The clinical evaluation forms completed by the physical therapists who participated in the quality improvement project were classified as adherent or non-adherent to the CDRs.

Behavioral intervention strategies:

Three behavioral intervention strategies were utilized: 1) educational material dissemination, 2) email reminders, and 3) educational training. Physical therapists were educated on how to complete the MDS, how to perform examinations on the form, and how to choose the appropriate intervention based on the CDRs.

There were two types of email reminders: compliance and adherence reminders. Compliance reminders were sent to any physical therapist who omitted one or more items in the MDS. Compliance referred to completing all mandatory items (i.e. the MDS) on the evaluation forms. Therefore, physical therapists were considered non-compliant when they faxed a form with an incomplete MDS. Compliance reminders were provided to all physical therapists from the onset of the project.

The overall design of the quality improvement project is illustrated in Figure 6. In the quality improvement project, the physical therapists were randomized into intervention and wait-listed groups that determined the time of receiving the behavioral intervention. The behavioral intervention included educational training and adherence reminders. Adherence reminders were sent when physical therapists had a treatment plan checked that did not conform to the CDRs. Adherence referred to consistency in implementation of the CDRs. Physical therapists were considered non-adherent if they did not follow the CDRs as indicated by the MDS. Adherence reminders were provided to the intervention and waitlisted groups from weeks 8 and 12, respectively.

Study sample:

Physical therapists who were participated in the quality improvement project were asked to include consecutive patients over the 4-month period for whom they completed the physical therapy evaluation form and clinical outcome measures.

Outcome measures:

Three self-report outcome measures were agreed upon by the participating physical therapists and used in this study as benchmarks of patient improvement. Clients completed the Activities-specific Balance Confidence (ABC) scale,[156] the Dizziness Handicap Inventory[101] (DHI), and the 15-point Likert Global Rating of Change[170] (GRC) at least every two weeks. The physical therapists faxed these clinical outcomes to the honest broker. Also, the minimal clinically important difference (MCID), if established, or the minimal detectable change (MDC) was used to compare the change of scores in each outcome measure. The MDC is the smallest amount of change beyond the measurement error for an instrument.[218] The MCID is defined as the smallest amount of change in scores of an instrument that can be considered beneficial.[170]

The ABC is a 16-item self-report tool that quantifies the difficulty of activities and fear of falling in elderly individuals.[156] Items include activities with different levels of difficulty, ranging from walking around the house to walking on icy sidewalks.[156] It is scored from 0% to 100%, and higher scores indicate a more confident individual.[156] The sensitivity and specificity of the ABC for falls prediction in community-dwelling older adults were 84% and 87%, respectively.[157] The ABC has high internal consistency ($\alpha = 0.96$) and good test-retest reliability $r = 0.92$, $p<0.001$.[156] The ABC has a strong correlation with the DHI ($r = 0.64$, $p<0.001$), which indicates convergent validity.[158] The cutoff score for the ABC is 67% for fall risk.[157] Our group of experts' clinical decision rule for the ABC was to provide education for patients with an ABC

score less than 70% to increase their balance confidence. Seventy percent was chosen instead of 67% to be more conservative. The MCID for the ABC has not yet been established; however, the MDC for the ABC in persons with Parkinson's disease is 13 points.[223]

The Dizziness Handicap Inventory (DHI) is a 25-item questionnaire that was developed by Jacobson and Newman.[101] The DHI was designed to record the handicapping effect of dizziness in persons with vestibular disorders.[101] It is scored from 0 to 100, and lower scores indicate less handicap.[101] The DHI has good internal consistency for the total score ($\alpha = 0.89$), satisfactory internal consistency for subscales ($\alpha = 0.72 - 0.85$), and high test-retest reliability ($\alpha = 0.97$).[101] Discriminant validity has also established a good relationship between DHI scores and the number of dizziness episodes.[92] The DHI was also found to be responsive to change as a measure in vestibular rehabilitation.[104] Our group of experts did not establish a clinical decision rule for DHI total or its sub-items. The MCID for the DHI in persons with vestibular dysfunction is 18 points.[101]

The 15-point Likert Global Rating of Change (GRC) measures the change in health status from the patient's perspective.[170-172] The GRC outcome measure helps in determining if patients perceive that they are improving.[170-172] The GRC is a 15-point score ranging from +7 (a very great deal better) to -7 (a very great deal worse), with 0 indicating no change.[170] Further, it was divided into three ranks of change: +1 to +3 or -1 to -3 which indicate small change, +4 and +5 or -4 and -5 which indicate moderate change, and finally, +6 and +7 or -6 and -7 which indicate large change.[170] Therefore, changes on the GRC scale between +1 to +3 or -1 to -3 represent the MCID.[170]

The ABC and DHI were part of the MDS and therefore, the baseline scores were retrieved from the initial evaluation forms. However, the GRC was administered only on follow-

up and discharge. For the ABC, DHI, and GRC, when the discharge data was missing for an outcome measure, the intention to treat principle was utilized by considering the most recent follow-up data as the discharge data.

Data collection:

Data was de-identified by two honest brokers. Physical therapists were classified as adherent or non-adherent based on their average adherence rate during the 4-month trial. To be considered adherent, physical therapists had to have an average adherence that was equal to or above than the group's average of 90%. Also, patients' evaluation forms were classified as adherent vs. non-adherent. An evaluation form was considered non-adherent if one or more of the 6 treatment categories on the form were not checked off while the CDRs recommended that a treatment category be utilized.

Demographic information for persons with balance and vestibular disorders was retrieved from the evaluation forms. Also, physical therapists' demographic information was collected. A survey was sent to participating physical therapists via email at the end of the quality improvement project to explore how the physical therapists perceived the quality improvement project. The questions and responses related to the clinical outcome measures were collected. The survey was anonymous and contained questions related to the clinical outcomes.

5.3 STATISTICAL ANALYSES

The demographic characteristics of physical therapists and persons with balance and vestibular disorders were compared between adherent and non-adherent groups using parametric and non-parametric tests as appropriate. A mixed-factor repeated measures ANOVA was used to examine

the effects of time (baseline and discharge scores), adherence (adherent and non-adherent) and the interaction on the ABC and DHI scores. For the GRC, the discharge data for the adherent and non-adherent evaluation forms were compared using the Mann-Whitney U test. A significance level of 0.05 was used.

5.4 RESULTS

During the 4-month trial, a total of 732 evaluation forms were completed by the 23 physical therapists who participated in the quality improvement project. However, only 454 of these evaluation forms were included in the analyses since no follow-up information was available for 278 patients. Table 7 demonstrates the number of evaluation forms that were included in the analysis of each clinical outcome. All 23 physical therapists completed all of the training provided.

Twelve physical therapists were classified as adherent and 11 physical therapists as non-adherent. All physical therapists were female with an average age of 38 years in the adherent group and 36 years in the non-adherent group. No statistical differences were found between the physical therapists based on their adherence rates. (Table 8)

The number of evaluation forms classified as adherent was 397 and the number classified as non-adherent 57. The age of the patients was significantly different between the adherent and non-adherent evaluation forms (mean age 34 and 51 years, respectively) (p <0.001). There was no statistical difference between adherent and non-adherent evaluation forms in terms of gender of the patients (p =0.6), with higher percentages of females in both classifications of adherent and non-adherent evaluation forms (66 and 61%, respectively). Also, no statistical difference

was found in terms of duration of symptoms (p =0.6), with average duration of symptoms of 6 weeks in the adherent evaluation forms and 9 weeks in the non-adherent evaluation forms. (Table 9)

A mixed-factor repeated measures ANOVA was performed to compare baseline scores and discharge for the ABC. Baseline scores were significantly different between adherent and non-adherent evaluation forms (the average ABC baseline score was 73 points in adherent evaluation forms and 61 points in non-adherent evaluation forms, p = 0.001) and were added to the model as a covariate. Also, the model was adjusted for patients' age since it was significantly different between adherent and non-adherent evaluation forms. The effect of baseline scores as a covariate was significant (p <0.001) and it explained 83% of the variance in the ABC scores. Also, the effect of patients' age as a covariate was significant (p <0.001) and it explained 5% of the variance in the ABC scores. There was a significant effect of time on the ABC scores (p <0.001) with a large effect size (partial eta squared= 0.4). The change in the ABC scores was 12 points across both groups. There was no difference in the change in the ABC scores between the adherent and non-adherent evaluation forms (p = 0.4). In addition, the interaction between time and adherence was not significant (p=0.4) (Table 10)

A mixed-factor repeated measures ANOVA was performed to compare baseline scores and discharge for the DHI. Baseline scores were not different between adherent and non-adherent evaluation forms (p = 0.06). The model was adjusted for patients' age since it was significantly different between adherent and non-adherent evaluation forms. The effect of patients' age as a covariate was significant (p <0.001) and it explained 3% of the variance in the DHI scores. The effect of time on the DHI scores was significant (p < 0.001) with a moderate effect size (partial eta squared= 0.1). The change in the DHI scores was 17 points across both

groups. The difference between adherent and non-adherent evaluation forms in the change of the DHI scores was not significant ($p = 0.3$). Also, the interaction effect between time and adherence was not significant ($p = 0.8$). (See Table 10)

There was no significant difference in the GRC between adherent and non-adherent evaluation forms ($p = 0.4$). The median scores were 5 for the adherent evaluation forms and 4.5 for non-adherent evaluation forms (See Table 10). Also, there was a significant difference between the median of the GRC scores across groups of 5 and the MCID of 3 ($p < 0.001$), which indicates that the overall change in the health status perceived by the patients was significantly higher than the MCID for the GRC.

A post-hoc survey was provided to the physical therapists at the end of the 16-week period. Physical therapists were asked about the barriers to completing the three outcome measures (ABC, DHI, and GRC). Eleven physical therapists (52%) reported that they rarely faced any barriers with completing the outcome measures, five physical therapists (24%) said that patients often refused to complete the forms, five physical therapists (24%) claimed that time during the treatment sessions was not enough to complete them, four physical therapists (19%) said that they often forgot to complete the outcome measures, and two physical therapists (10%) reported that they often did not agree with the importance of these outcome measures to their specific patient.

5.5 DISCUSSION

The investigators determined the effect of a quality improvement project on clinical outcomes of persons with balance and vestibular disorders. Both adherent and non-adherent evaluation forms

demonstrated changes in the scores of the ABC, DHI, and GRC that had improved or were approaching the MCID and MDC. However, being adherent to the CDRs did not enhance the improvement in the ABC, DHI, and GRC scores compared to being non-adherent. Bekkering et al[224] found that the guidelines implementation strategies they have used did not improve outcomes of patients with low back pain. In their study, the control group received the guidelines by email while the intervention group received education sessions, group discussion, role playing, feedback, and reminders.[224] Also, they found improvement in the outcomes of patients treated by physical therapists in both groups, similar to our study.[224]

We compared the change in the ABC and DHI in this project to the change in the same measure from a study by Meretta et al[225] which was performed in one of the 15 clinics participating in this quality improvement. The change in the ABC was similar (12 points) in both Meretta et al[225] study and in this study. The change in the DHI was higher (17 points) in this study than Meretta et al[225] study (11 points). This indicates that the results from this quality improvement in terms of improvement in the ABC and DHI were comparable to previous research.

Cherkin and colleagues[226] reported that providing education to clinicians did not enhance patient outcomes. Conversely, Fritz et al[175] reviewed patients information retrospectively and classified patient records as adherent or non-adherent. They reported that patients who were treated in adherence to the guidelines showed greater improvement in disability and pain, and were more likely to achieve a successful physical therapy outcome than those receiving non-adherent care. Adherence to clinical guidelines was found to enhance the clinical outcomes,[175] however, our results demonstrated no enhancement in the outcomes as a result of the CDRs implementation, which was supported by Bekkering et al[224] study.

The method to calculate adherence to guidelines has been reported to be arbitrary and there appears to be no convention on a specific definition of adherence.[175] The definition of adherence that was used in this study may have been too liberal. Our adherence definition did not exclude over-utilized treatments, which may have led to a higher number of adherent evaluation forms than non-adherent evaluation forms.

Also, the effect of engaging the clinicians in the development of the guidelines and to develop guidelines that are related to their clinical practice was reported to lead to better adherence.[79] Physical therapists in our study were actively involved in the development of the CDRs over a 1.5 year period and apparently had developed decision rules that reflected their everyday practice, which may have led to higher number of adherent evaluation forms compared to non-adherent evaluation forms.

Not all clinical outcomes in this study were related to specific CDRs. The CDR recommends a fall risk education program when a person's score on the ABC was less than 70%. However, it is ideal to provide persons with balance and vestibular disorders with education regarding falls and other balance and vestibular problems whether or not it was recommended by the CDRs. Patient education in this study was frequently provided regardless of the ABC scores. Also, the DHI and GRC were not linked to any rule in the CDRs. It has been reported that measuring outcomes that are not responsive to the guidelines may contribute to the lack of effectiveness findings of guidelines on patients outcomes.[227] The ABC, DHI and GRC were global clinical outcomes that the physical therapists chose to collect in this study as part of having the physical therapists involved in selecting the important indicators for persons with balance and vestibular disorders. Therefore, these global clinical outcomes might not have been responsive to the CDRs as they were not rules-specific clinical outcomes.

Most of the physical therapists reported no barriers to completing the outcome measures in the survey; however, 77 out of the 732 evaluation forms were missing the clinical outcomes data. The physical therapists were reminded to send the missing follow-up data and yet the data manager did not receive any information regarding these missing follow-ups. An electronic medical record would have allowed access to all follow up data if a different therapist had seen the patient or when the therapy was not completed. Electronic medical records have been reported to contain detailed and complete information compared to paper medical records.[228,229]

One physical therapist (<1%) thought that introducing the GRC as an outcome measure was one of the benefits of the quality improvement project. In fact, many physical therapists reported during the competency testing/training that they started using the GRC form for patients with various diagnoses because they thought it is a useful measure. The physical therapists were asked for their ideas to improve the quality improvement project. One physical therapist (<1%) commented that the GRC should be part of the treatment diary to remind the therapists to complete it. One physical therapist (<1%) suggested that the GRC should be reworded so patients would complete it on their own instead of having the physical therapists read it to them. Overall, the responses on the survey from participating physical therapists seemed to reflect that they have perceived the GRC form positively.

Future studies should focus on using outcome measures that are rules-specific, that is, should be responsive to the CDRs. Thus, more information would be available regarding the effect of adherence to guidelines on patients' clinical outcomes. The use of electronic medical records should provide better follow-up compliance.

5.6 LIMITATIONS

The physical therapists were required to indicate the plan of care during the initial evaluation form, however, they were not required to inform the investigators of any changes in the plan of care on subsequent visits, which could have changed the classification from adherent to non-adherent or vice versa.

Data were collected in this project by faxing evaluation forms, follow-up, and discharge data, which was time consuming and burdensome for the physical therapists. Electronic data entry might have decreased the amount of missing data and captured any changes in the plan of care.

5.7 CONCLUSION

To the best of our knowledge, this was the first study that compared the effect of a quality improvement project on clinical outcomes of persons with balance and vestibular disorders. Both adherent and non-adherent evaluation forms showed improvement based on the ABC, DHI, and GRC as outcome measures. This improvement was not different between the adherent and non-adherent evaluation forms.

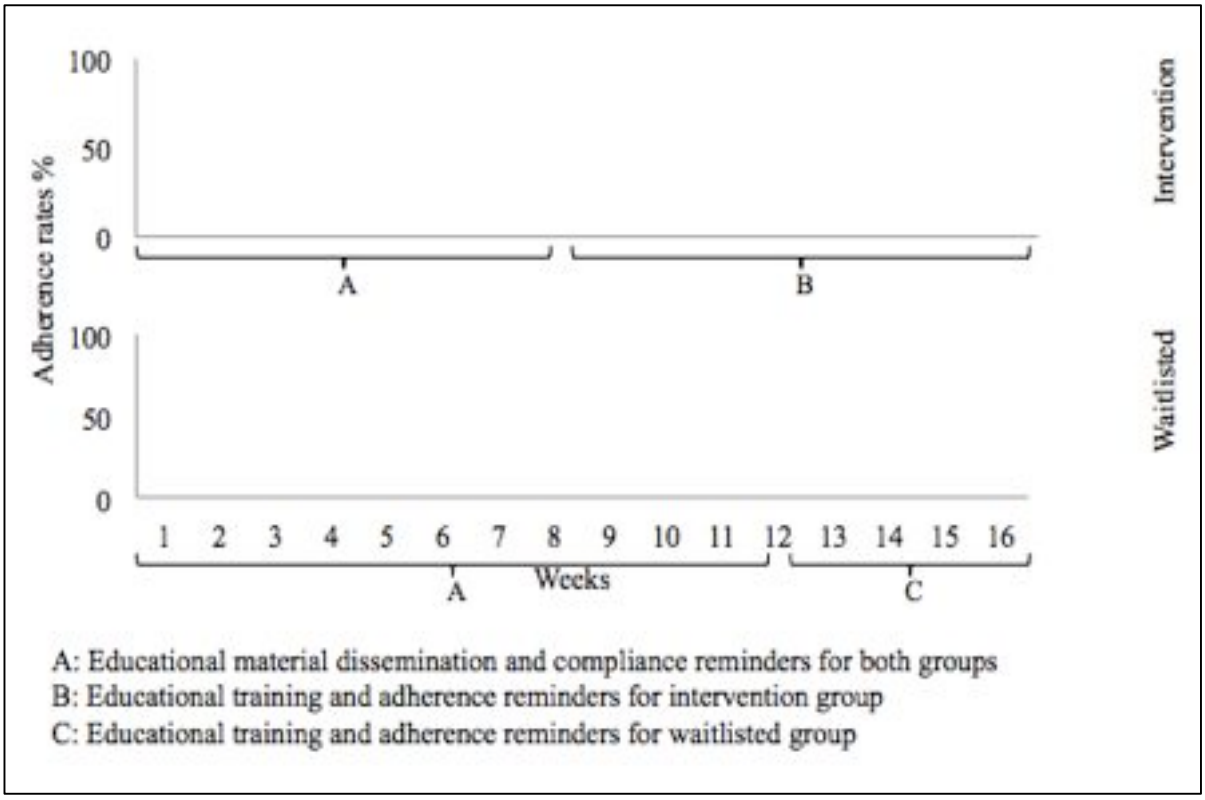

Figure 6 The quality improvement project design.

Table 7 Number of evaluation forms for which discharge or last follow-up data were received for the adherent and non-adherent submitted evaluation forms.

	ABC	DHI	GRC
Total number of evaluation forms	732	732	732
No show	77	77	77
Missing	201	209	234
Discharge or last follow-up data	454	446	421
Adherent forms	397	389	367
Non-adherent forms	57	57	54

Total number of evaluation forms was 732.

ABC: Activities-specific Balance Confidence scale.

DHI: Dizziness Handicap Inventory.

GRC: Global Rating of Change.

No show: the physical therapists reported that patient did not return for follow-up care.

Missing: the physical therapists did not send follow-up data and did not report that the patients did not return for follow-up care.

Discharge or last follow-up data: the physical therapists sent the follow-up data.

Table 8 Physical therapists' characteristics (n= 23).

	Adherent (n=12)	Non-adherent (n=11)	*p*
Age in years: mean (SD)	38 (11)	36 (9)	0.6 $^{\delta}$
Highest degree earned: BS: n (%) MS: n (%) DPT: n (%)	 1 (8%) 2 (17%) 9 (75%)	 1 (9%) 0 (0%) 10 (91%)	0.7 $^{\alpha}$
Specialty certification (NCS): yes (%)	2 (17%)	5 (45%)	0.2 $^{\alpha}$
Advanced Vestibular Training (Emory Course): yes (%)	4 (33%)	6 (54%)	0.4 $^{\alpha}$
Total years of practice: mean (SD)	13 (11)	12 (11)	0.8 $^{\delta}$
Years of practice in balance and vestibular rehabilitation: mean (SD)	5 (5)	8 (7)	0.3 $^{\delta}$
Employed full-time	8 (67%)	8 (73%)	1 $^{\alpha}$
SD: standard deviation BS: Bachelor degree MS: Masters degree			

Table 8 (continued)

DPT: Doctor of Physical Therapy

NCS: Neurologic Clinical Specialist

$^{\alpha}$ Fisher's exact test

$^{\delta}$ Independent t-test

Table 9 Patients' demographics (n=454).

	Adherent (n=397)	Non-adherent (n=57)	*p*
Age of the patients in years: mean (SD), median (range)	34 (22) 25 (7-93)	51 (26) 57 (11-90)	<0.001 $^{\beta}$
Gender: Female (%)	262 (66%)	35 (61%)	0.6 $^{\alpha}$
Duration of symptoms in weeks: median (range)	6 (1-764)*	9 (1-529)	0.4 $^{\beta}$

SD: standard deviation

$^{\alpha}$ Chi-Square test

$^{\beta}$ Mann-Whitney test

Effect size of the age difference was (r=0.22)

*The data were missing for 3 patients in the adherent group.

Table 10 Mixed-factor ANOVA for the Activities-specific Balance Confidence scale (ABC) and Dizziness Handicap Inventory (DHI), and comparisons between adherent and non-adherent discharge scores for the Global Rating of Change (GRC).

Group	N	Means (SD)		Within		Between		Interaction	
		Baseline	Discharge	*p*	ES	*p*	ES	*p*	ES
ABC[α, 1]:									
A	397	73 (24)	82 (22)	<0.001	0.4	0.4	0.001	0.4	0.001
NA	57	61 (26)	75 (23)						
DHI[α, 2]:									
A	389	42 (22)	26 (24)	<0.001	0.1	0.3	0.002	0.8	<0.001
NA	57	48 (22)	31 (24)						
GRC[β]:									
A	367	-	5 (-5 - 7)	-	-	0.4	0.04	-	-
NA	54	-	4.5 (0 - 7)						

Groups: (A) Adherent and (NA) Non-adherent. N: number of evaluation forms.

α Mixed-factor ANOVA. SD: standard deviation. P: p-value. ES: effect size (partial eta squared), where 0.01 = small effect, 0.06 = moderate effect, and 0.14 = large effect.[219]

For the ABC: the effect of the baseline scores as a covariate was significant (p<0.001) with an effect size of 0.83, and the effect of patients' age as a covariate was significant (p<0.001) with an effect size of 0.05.

Table 10 (continued)

For the DHI: the effect of patients' age as a covariate was significant ($p<0.001$) with an effect size of 0.03.

[1] Baseline scores were different between groups and were added as a covariate; also age was added as a covariate (it did not change the time effect nor the group effect, and it made the interaction effect 0.4 instead of 0.8).

[2] Baseline scores were not different between groups and were not added as a covariate. Patients' age was added as a covariate (it did not change the time effect nor the group effect, and it made the interaction effect 0.8 instead of 0.7).

β Mann-Whitney U test (Median and range were reported instead of mean and SD).

P: p-value. ES: effect size (r), where 0.1 = small effect, 0.3 = moderate effect, and 0.5 = large effect.[219]

6.0 GENERAL DISCUSSION

The degree to which physical therapists were compliant to the important indicators (MDS) in persons with balance and vestibular disorders, and adherent to the evidence-based practice of balance and vestibular rehabilitation were unknown. This quality improvement project showed improvement in documentation (compliance to the MDS), increase in adherence to the CDRs, and decrease of over-utilized treatment. The behavioral interventions used in this project were educational material dissemination, compliance reminders, adherence reminders, and educational training. The educational training included a webinar, short test, and competency testing/ training.

Improvement in completeness of documentation was found as a result of the compliance reminders. Adherence rates increased to the same level in both intervention and wait-listed groups after they had received the behavioral interventions (adherence reminders and educational training). The improvement of adherence rates resulted from the educational training rather than the adherence reminders since the weekly adherence rates in both groups did not seem to change after the physical therapists responded to the reminders.

This quality improvement project did not show difference in the patients' clinical outcomes between adherent and non-adherent evaluation forms. However, both adherent and non-adherent evaluation forms showed significant improvement in the discharge scores of the clinical outcomes relative to baseline scores.

The physical therapists participating in this project reported that it was a burdensome and time consuming mainly because of the paper-based data collection and faxing. An electronic data collection system was preferred by the participating physical therapist, such a data collection system that electronically reminds the physical therapists regarding compliance to the MDS and adherence to the CDRs.

Educational training and competency testing sessions:

Three face-to-face sessions were scheduled at week 8 for the intervention group and week 12 for the wait-listed group. Instruction regarding the over-utilization of treatment was provided as part of the educational training.

Among physical therapists in both groups the following interesting variations in care were noted during the competency testing. There were wide differences in how persons performed the dynamic visual acuity testing. All had access to metronomes and the correct chart, but the speed and the position in which it was tested varied by setting. Some did the test in sitting, some in standing and the speed varied between 1 and 2 Hz. Those with less experience also frequently did not move the head at a high enough velocity for the head impulse test. About 20% of physical therapists moved the head outwards rather than inwards. There is less risk to the patient and the facility if the head is moved rapidly into the center (head in neutral) rather than rotating the head outwards in the yaw plane. It was suggested that all physical therapists during training minimize risk by bring the head in to the center (0◦).

Most therapists were able to competently perform the Dix-Hallpike but several (approximately 20%) had to be reminded to keep the head extended while performing the modified Epley when moving the head from position one (initial head hanging) to position two (head rotated 90◦ to the opposite side). When the head flexes during the transition from position

1 to 2 above, it is possible to convert a posterior canal to a horizontal canal benign paroxysmal positional vertigo.[230] Canal conversion would make the patient worse and possibly prolong their treatment time, thus make the physical therapists less efficient in their care.[230] In addition, about 20% of the physical therapists made safety errors when demonstrating the Epley maneuver by not holding onto the patient after they resumed the sitting position. Donning and doffing the goggles was also included as part of the competency testing, as it is easy to shear off an older persons skin when removing the goggles. Having the patient remove the goggles was reviewed with all therapists during the competency testing as part of our goal of improving care and reducing risk in persons with vestibular disorders.

The competency testing took a minimum of 20 to 30 minutes per person. Questions were answered about the quality improvement project and other questions that they had about vestibular rehabilitation were also answered during the 1:1 or 1:2 educational sessions. Each physical therapist performed the testing on either an aide in the clinic or another neurologic physical therapist.

6.1 LIMITATIONS

One of the limitations in this quality improvement project was that treatment categories were generic and could cover a wide variety of treatment modalities and exercises, which might have led to the over-utilization of treatment. Moreover, the CDRs that we developed were positive rules only. No clinical decision rules were provided for cases were clinical examinations were negative.

Faxing the evaluation forms and clinical outcomes was time consuming and increased the burden on the physical therapists. Moreover, some faxes were blank or not a complete form due to sending via fax, which consumed more time and effort from the physical therapists to retrieve the patient information and re-fax them. Also, faxing the clinical outcomes might have led to the missing follow-up and discharge data. We planned to use electronic medical records, however, for resources consideration that was not possible. If such electronic method has been used, we believe that the completeness of data might have been better, the completeness of follow-ups would also have been better (since in many cases the patient was seen by another physical therapist at follow up and thus follow up outcome measure were missing even though we attempted to remind the physical therapists to send the most recent ones).

Also, we had small sample of physical therapists in our project, which might decrease the power of the study.[218] Among the limitations in this project was that the physical therapists were required to indicate the plan of care by choosing one or more of the pre-determined treatment categories, however, they were not required to inform us of any changes in the plan of care changed on the subsequent visit, which could change the classification from adherent to non-adherent or vice versa.

6.2 FUTURE RESEARCH

Future research should focus the development of a more specific CDRs that have rules for positive and negative results of clinical examinations. Implementation of prompt reminders that are integrated within the electronic medical records in a way that a physical therapist would have to complete all required items on the form before submitting it would be optimal. The physical

therapists could then choose the appropriate treatment categories according to the CDRs as they would be unable to submit their electronic evaluation forms unless justifying their decisions. Moreover, using outcome measures that are rules specific would provide a conclusive judgment regarding the benefits of implementing CDRs, that is, the clinical outcomes should be responsive to the CDRs. Thus, more information would be available regarding the effect of adherence to guidelines on patients' clinical outcomes. Also, a definition of adherence that account for over-utilization of treatment would help in identifying those who are adherent and decrease the overlap between adherent and non-adherent evaluation forms.

A design that has a pre quality improvement period (baseline) would give more information on the behavior of physical therapists before any intervention was provided including the dissemination of educational materials and compliance reminders. Quality improvement projects should be continuous and ongoing; it is not the type of research that ends at the end of data collection. The importance of the continuity part of quality improvement is best illustrated by this example: a multifaceted intervention to improve physicians' management of depression in Sweden revealed decreases in suicide rates, however, after a 3 year follow up, suicide rates returned to the previous levels as physicians' management of depression had changed. Thus, the authors recommended follow-up and continuous education.[90,91]

6.3 CONCLUSION

To the best of our knowledge, this was the first quality improvement project in the balance and vestibular rehabilitation. This quality improvement project was effective in demonstrating the

same level of improvement in adherence to the CDRs between groups. Both groups' adherence levels improved over the 16-week study. Over-utilization of treatment decreased as a result of this quality improvement project. Also, completeness of the evaluation forms (MDS) improved over the 16 weeks of study (mainly the first 4 weeks), which means improvement in documentation.

We could not anticipate that the high adherence rates from the beginning of the project were as a result of the educational materials dissemination since the compliance rates were low at the start of the project. The educational material that was disseminated covered both the MDS and CDRs. Therefore, the high adherence rates in both groups from the beginning of this project might be because the rules were broad. The CDRs were developed and agreed upon by most of the participating physical therapists and seemed to reflect what the participating physical therapists do in their clinics in every day practice, which might explain the high adherence rates.

Among our behavioral intervention strategies the email reminders and on-site educational sessions were considered the most beneficial. Although we cannot conclusively determine the effect of the passive methods (educational materials dissemination and educational webinar) we would say that an active in-person educational sessions and email reminders appeared to be effective in changing the clinical behavior of the physical therapists in this study.

Although both adherent and non-adherent evaluation forms showed substantial improvement on the outcomes, the difference between the adherent and non-adherent forms was trivial in all three outcomes. Physical therapists in this project were engaged in the development of CDRs and it reflected their daily practice which may contribute to the high adherence with the CDRs, and therefore high scores on the clinical outcomes.

APPENDIX A

BALANCE AND VESTIBULAR EVALUATION FORM

UPMC Centers for Rehab Services
Balance & Vestibular Initial Evaluation

Name: _____ Age: ____ DOB: ___/___/___ Date: ___/___/___

Diagnosis: Referred by: _____

PT ICD-9 Primary Dx: ***Secondary:***

Chief Complaint/Current Medical History:

☐ ***Balance*** ☐ ***Dizziness/Vertigo*** ☐ ***Space and motion*** ☐ ***Nausea*** ☐ ***Headache*** ☐ ***Blurry vision***

Date of Onset: ___/___/___ ☐ Gradual ☐ Sudden ☐ Traumatic ☐ Unsure

Medications: ☐ Reviewed on Intake Form

Past Medical History: ☐ Reviewed on Intake Form

Anxiety Disorder ☐ Y ☐ N ☐ Unk
Strabismus/Ocular Misalignment ☐ Y ☐ N ☐ Unk
Personal History Migraine ☐ Y ☐ N ☐ Unk
Previous eye surgery ☐ Y ☐ N ☐ Unk
Impaired cognition ☐ Y ☐ N ☐ Unk
Family History Migraine ☐ Y ☐ N ☐ Unk
Impaired vision ☐ Y ☐ N ☐ Unk
DM ☐ Y ☐ N ☐ Unk

Hearing: ☐ WNL @ conversation level ☐ Aural Fullness ☐ Impaired ☐ L ☐ R _____ ☐ Tinnitus ☐ L ☐ R _____ ☐ Hearing Aide(s) ☐ L ☐ R ☐ Other _____

Vision: ☐ WFL ☐ Macular Degeneration ☐ Corrected w/Glasses or Contacts ☐ Other _____ ☐ Difficulty Focusing Date of Last Eye Exam: ___/___/___

Social History:

Prior Level of Function:

Cervical ROM:

Falls: ☐ ***No falls*** ***# Last Month:*** ***# Last 6 Months:***

LOB: ☐ Injury ☐ Injury

Dizziness Description: **Dizziness Rating(0-10):** ____ **Worst in Past Week**____**(0-10)** **Space and Motion Discomfort Rating (0-10):** ____ **Best in Past Week**____**(0-10)**

Worse with:

V N Getting Out of Bed (DHI # 5)
V N Rolling (DHI #13)
☐ Lying down
☐ Sit to Stand
☐ Bending Over
V N Quick Head Movements (DHI #11)
☐ Repetitive Movements
☐ Showering ☐ EO ☐ EC
☐ Darkness/Eyes Closed
☐ Walking: Even Surfaces
☐ Walking: Uneven Surfaces
☐ Escalators
☐ Elevators
☐ Visual Motion
☐ Shopping
☐ Reading
☐ Computer Work
☐ Watching TV
☐ Driving
☐ Passenger in Car
☐ Fatigue
☐ Walking: Direction Changes
☐ Stairs
☐ Looking up/Reaching up

Duration of Symptoms:
☐ Seconds/Minutes
☐ Constant but Fluctuating
☐ Constant but not Fluctuating
☐ Hours

DHI 2-Item (#5 + #13): ____

DHI Total: ____ ☐ ***NT:***

ROM Limitations: ☐ None
Upper Extremities: _____
Lower Extremities: _____
Strength: _____

Ocular Motor:	Normal	Abnormal	↑Sym	Comments:
Head Thrust	☐	☐	☐	☐ ***L*** ☐ ***R*** ☐ ***NT:***
Dynamic Visual Acuity	☐	☐	☐	***logMAR change:*** ____ ***lines*** ☐ ***NT:***
VOR Cancellation	☐	☐	☐	☐ ***NT:***
Convergence	☐	☐	☐	☐ ***NT:***
Vibration Induced Nystagmus	☐	☐	☐	☐ NT ☐ L ☐ R
Cover/Uncover	☐	☐	☐	☐ NT
Cross Cover	☐	☐	☐	☐ NT
Smooth Pursuit/ Tracking	☐	☐	☐	☐ NT
Saccades	☐	☐	☐	☐ NT BP____
VOR x 1	☐	☐	☐	☐ NT HR____

Sensation: ☐ NT	☐ Functionally Intact	☐ Impaired:	
Proprioception:	☐ NT	Other:	

Fixation Blocked: ☐ NT	Normal	Abnormal	Gaze Evoked Nystagmus			Room Light			Fixation Blocked
Head Shaking Nystagmus	☐	☐	NT ☐						

Positional Testing

	Nausea	(+)	Tor↑	Tor↓	↑ No Tor	↓ No Tor	R Beat	L Beat	Dur >60s	Symptoms:	NT
Dix-Hallpike R	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Dix-Hallpike L	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Roll Test R	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Roll Test L	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐

Other:

Balance:	Firm	Foam	Symptoms:
Eyes Open (sec):	Time: ☐ ↑ Sway ☐ NT	Time: ☐ ↑ Sway ☐ NT	☐ None ☐ Dizziness ☐ Balance ☐ Headache ☐ Nausea
Eyes Closed (sec):	Time: ☐ ↑ Sway ☐ NT	Time: ☐ ↑ Sway ☐ NT	☐ None ☐ Dizziness ☐ Balance ☐ Headache ☐ Nausea

NT:

Gait Speed: m/sec	☐ NT:	Device: ☐ None	Deviations:	Assistance/Limitations:	
ABC Score:	☐ NT:	DGI 4 Item(#1-4):	/12	☐ NT:	FGA: /30 ☐ NT
FTSTS: ☐ NT	Sec	TUG: ☐ NT	Sec	DGI:	/24 ☐ NT

NT:

Treatment Plan:

☐ Eye-Head Activities	☐ Gaze stab ☐ Convergence ☐ Eye Sacc/ Pursuit ☐ Gaze saccade ☐ Imaginary Target
☐ Balance Activities	☐ Static Standing (SOT) ☐ FT/EO ☐ FT/EC ☐ Foam/EO ☐ Foam/EC ☐ Wt. shift ☐ Single leg ☐ Dynamic Standing ☐ March in place ☐ Step level (fwd/side) ☐ Step(up/down) ☐ Turn in place ☐ March in place
☐ Ambulation Program	☐ Forward ☐ Backward ☐ Head turns ☐ Stairs ☐ Dual task ☐ Different surfaces
☐ Canalith Repositioning	☐ Post. canal ☐ L ☐ R ☐ Horiz. canal ☐ L ☐ R ☐ Ant. Canal ☐ L ☐ R ☐ Brandt-Daroff
☐ Optokinetic Training	
☐ Education	☐ Patient education ☐ Home instructions ☐ Falls Education Handout

PT Diagnosis:

Timed Codes: (15 min) Visit #:				Untimed Codes:			
CRS Code		Min	Units	CRS Code		Min	Check here √
TE	97110			PTEVAL	97001		
NMR	97112			PTREEVAL	97002		
AMB	97116			CRM	95992		
FTA	97530			Other:			
SMT	97535						
T&M/FCE	97750			☐ No show			
Other:				☐ Cancel			
Total Timed:				Total Untimed:			
Total Treatment Session Minutes (timed + untimed):							

Progress Narrative:
☐ See treatment diary for modalities/procedures and/or TE

S:

O:

A:

P:

Physical Therapist Signature

Physical Therapist Printed Name

/ /

Patient Name: DOB:

APPENDIX B

CONCUSSION EVALUATION FORM

UPMC Centers for Rehab Services

Concussion Balance/Vestibular Initial Evaluation

Name: DOB: Date:

PT ICD-9 ***Primary Dx:*** ***Secondary Dx:*** Referred by:

Chief Complaint/Current Medical History: Date of Injury: / /

Initial Sx's:

Current Sx's: ☐ Photosensitivity ☐ Phonosensitivity

LOC?	☐ No	☐ Yes (Duration in Min):
Retrograde Amnesia?	☐ No	☐ Yes (Duration in Min):
Post-Traumatic Amnesia?	☐ No	☐ Yes (Duration in Min):

Headache:	☐ ***No***	☐ ***Yes (rating 0-10):***	Now:	Worst:	Best:
Dizziness:	☐ ***No***	☐ ***Yes (rating 0-10):***	Now:	Worst:	Best:
Space/Motion:	☐ ***No***	☐ ***Yes***	Sleep disturbance:	☐ No	☐ Yes
Imbalance:	☐ ***No***	☐ ***Yes***	Mood Changes:	☐ No	☐ Yes
Neck Pain:	☐ No	☐ Yes	Fatigue:	☐ No	☐ Yes
Vision:	☐ ***No***	☐ ***Yes:*** ☐ ***Blurred Vision*** ☐ ***Diplopia*** ☐ ***Other:***			
Hearing/Aural	☐ No	☐ Yes: ☐ Impaired ☐L ☐R ☐ Fullness ☐L ☐R ☐ Tinnitus ☐L ☐R Other:			
Cognitive:	☐ No	☐ Yes (ImPACT /cognitive info):			

Past Medical History: ☐ Reviewed on Intake Form

Migraines (personal history):	☐ No	☐ Yes	Prior Concussions:	☐ No	☐ Yes
Motion discomfort:	☐ No	☐ Yes	Migraines (family history):	☐ No	☐ Yes
Strabismus/Ocular Misalignment:	☐ No	☐ Yes	Anxiety history:	☐ No	☐ Yes
			Vision Impairment:	☐ No	☐ Yes

Other:

Medications:

Social History:

Prior Level of Function:

Other Diagnostic Testing:

Falls: ***# Last Month*** ***# Last 6 Months:***

Description: ☐ No Injury ☐ Bruises/Contusions ☐ Dislocations/Fx's ☐ Head Injury ☐ Other:

Dizziness Description: ☐ Spinning ☐ Lightheaded ☐ Off Balance

☐ None ☐ Sensation of Motion ☐ Nausea ☐ Other:

Worse with:

DHI Total: ☐ ***NT***

☐ ***Yes***	☐ ***No***	***Getting out of bed (DHI #5)***	☐ Elevators
☐ ***Yes***	☐ ***No***	***Rolling (DHI #13)***	☐ Escalators
☐		Lying Down	☐ Visual Motion
☐		Sit to Stand	☐ Shopping
☐		Bending Over	☐ Reading
☐ ***Yes***	☐ ***No***	***Quick Head Mvmt (DHI #11)***	☐ Computer Work
☐		Looking/Reaching Up	☐ Watching TV
☐		Repetitive Mvmts	☐ Driving
☐		Showering ☐ EO ☐ EC	☐ Passenger in Car
☐		Darkness/EC	☐ Fatigue
☐		Walking: Even Surfaces	☐ Walking: Direction Changes
☐		Walking: Uneven Surfaces	☐ Stairs

Duration of Symptoms:

☐ Seconds/Minutes

☐ Constant but Fluctuating

☐ Constant but not Fluctuating

☐ Hours

Cardiopulmonary: ***Seated*** BP HR ***Standing*** BP HR ☐ NT

ROM Limitations:

Upper Extremity: ☐ None ☐ Yes:

Lower Extremity: ☐ None ☐ Yes:

Posture: ☐ **Normal** ☐ **Kyphotic** ☐ **Scoliotic**

Cervical Instability Testing:	**Norm**	**Abn**	**NT**
Sharps Purser	☐	☐	☐
Lateral Shear	☐	☐	☐
Kick Test	☐	☐	☐

Cervical Spine RSB___° Ext___° LSB___°

RRot___° Flex ___° LRot___°

Strength Deficits:	☐ None	☐ Yes:	Sensory Deficits:	☐ None	☐ Yes:

Balance:	Firm	Foam	Symptoms:
Eyes Open (sec):	*Time:* ☐ ↑ *Sway* ☐ *NT*	*Time:* ☐ ↑ *Sway* ☐ *NT*	☐ *None* ☐ *Dizziness* ☐ *Balance* ☐ *Headache* ☐ *Nausea*
Eyes Closed (sec):	*Time:* ☐ ↑ *Sway* ☐ *NT*	*Time:* ☐ ↑ *Sway* ☐ *NT*	☐ *None* ☐ *Dizziness* ☐ *Balance* ☐ *Headache* ☐ *Nausea*

Tandem/Eyes Open: _____ sec	Tandem/Eyes Closed: _____ sec	Other:

Gait Speed: *m/sec* ☐ *NT:*	Device: ☐ None ☐ Other:	Deviations:	Assistance/Limitations:

ABC Score: _____ % ☐ *NT:*	*DGI 4-Item:* _____ /12 ☐ *NT:*

Ocular Motor:	*NT*	*Norm*	*Abn*	*↑'d Sx's*	*Comments:*
Head Thrust	☐	☐	☐	☐	☐ *L* ☐ *R*
Dynamic Visual Acuity	☐	☐	☐	☐	*logMAR change:* _____ *lines*
VOR Cancellation (Optokinetic Stim)	☐	☐	☐	☐	
Convergence	☐	☐	☐	☐	*Near Point:* _____ *cm* *Recovery:* _____ *cm*
Accommodation	☐	☐	☐	☐	L: ____cm R: ____cm
Pursuits/Tracking	☐	☐	☐	☐	
Saccades	☐	☐	☐	☐	
VOR x 1	☐	☐	☐	☐	
Cover/Uncover	☐	☐	☐	☐	
Alternate Cover	☐	☐	☐	☐	
Maddox Rod Horizontal Alignment	☐	☐	☐	☐	
Maddox Rod Vertical Alignment	☐	☐	☐	☐	
Other:	☐	☐	☐	☐	

Gaze Evoked Nystagmus:	☐ Fixation Blocked ☐ Room Light Convergence Spasm: ☐ No ☐ Yes	

Positional Testing Nystagmus:

	Norm	*(+)*	*Tor↑*	*Tor↓*	*↑ No Tor*	*↓ No Tor*	*R Beat*	*L Beat*	*Dur >60s*	*Symptoms/Comments:*	*NT*
Dix-Hallpike R	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Dix-Hallpike L	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Roll Test R	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐
Roll Test L	☐	☐	☐	☐	☐	☐	☐	☐	Y☐ N☐		☐

Treatment Plan:

☐ *Eye-Head Activities*	☐ Gaze Stability ☐ Convergence ☐ Saccades/Pursuits ☐ Gaze Saccade ☐ Imaginary Target
☐ *Balance Activities*	☐ Static Standing (SOT) ☐ FT/EO ☐ FT/EC ☐ Foam/EO ☐ Foam/EC ☐ Wt. Shift ☐ Single Leg ☐ Dynamic Standing ☐ March in Place ☐ Step Level (fwd/side) ☐ Step (up/down) ☐ Turn in Place
☐ *Ambulation Program*	☐ Forward ☐ Backward ☐ Head Turns ☐ Stairs ☐ Dual Task ☐ Different Surfaces
☐ *Canalith Repositioning*	☐ Post Canal ☐ L ☐ R ☐ Horiz Canal ☐ L ☐ R ☐ Anterior Canal ☐ L ☐ R ☐ Brandt Daroff
☐ *Optokinetic Training*	
☐ *Education*	☐ Patient Education ☐ Home Instructions ☐ Falls Education Handout

Timed Codes: (15 min)				Untimed Codes:			
Visit #:							
CRS Code		Min	Units	CRS Code		Min	Check here √
TE	97110			PTEVAL	97001		
NMR	97112			PTREEVAL	97002		
AMB	97116			CRM	99992		
FTA	97530			Other:			
SMT	97535						
T&M/FCE	97750			☐ No show			
Other:				☐ Cancel			
Total Timed:				Total Untimed:			
Total Treatment Session Minutes (timed + untimed):							

Progress Narrative:

☐ See treatment diary for modalities/procedures and/or TE

S:

O:

A:

P:

_____ _____ / /

Physical Therapist Signature | Physical Therapist Printed Name | Date

Patient Name: DOB:

APPENDIX C

CONTRAINDICATIONS TO BALANCE AND VESTIBULAR TESTING

Dizziness Handicap Inventory (DHI):

- Cognitively impaired
- No complaint of dizziness
- The person is blind without someone available to help with completing the form
- Unable to read
- Patient arrived late
- Patient refused
- Family completed

Head Thrust test (HTT):

- Artery issues
- Cervical fracture
- Cord compression
- Occluded vertebral artery(ies)
- Positive sharps-purser test
- Recent cervical fusion
- Report of clunking in the neck s/p MVA- no MRI available
- Severe motion sickness
- Severe anxiety
- Severely restricted neck motion
- Significant nausea
- Significant neck pain
- Suspected cervical instability
- Unable to relax neck musculature
- Wearing cervical collar
- Patient refused

Dynamic Visual Acuity (DVA):

- Can't see the chart
- Cervical fracture
- Corrective lenses not available
- Forget glasses
- Mute
- Recent cervical fusion
- Restricted neck motion
- Sensitive to head having touched
- Severe anxiety
- Severe motion sickness
- Severe nausea
- Significant dizziness
- Significant neck pain
- Suspected instability
- Unable to relax neck musculature
- Visual impairment (interferes with static acuity)
- Wearing cervical collar
- Patient refused

Vestibulo-ocular reflex (VOR) cancellation:

- Unable to test- patient too motion sensitive

Convergence:

- There were no indications to perform vergence testing

Positional testing:

- *Cardiovascular pathology:*
    - Cardiac bypass < last 3 months
    - Cardiac dysrhythmia
    - Cardiovascular disease
    - Carotid sinus syncope
    - Carotid stenosis
    - Vascular dissection syndrome
    - Vertebral artery stenosis
    - Vertebrobasilar vascular disease (insufficiency)
- *Vertebral spine pathology:*
    - Acute neck trauma
    - Aplasia odontoid process

    - Back pathology
    - Cervical myelopathy
    - Cervical soft tissue disorders
    - Cervical spine disease
    - Cervical spine fracture
    - Cervical spine instability (atlantoaxial subluxation)
    - Cervical spine spondylosis
    - Fractured odontoid peg
    - Nerve root compression
    - Previous cervical spine surgery
    - Prolapsed intervertebral disc with radiculopathy
    - Spinal injury
- > 6 months pregnant (Roll test)
- Arnold-Chiari malformation
- BP parameters
- Detached retina
- Medical fitness
- Occipitoatlantal instability (Down's syndrome)
- Orthopnea/ sleep apnea
- Recent eye surgery
- Recent stroke
- Rheumatoid arthritis
- Patient refused

Balance:

- Not safe to test
- Patient does not stand
- Patient missing a limb

Gait speed:

- Cannot walk 4 meters
- Dangerous to walk with you (no help available)
- Does not ambulate (wheelchair bound)

The Activities-specific Balance Confidence (ABC) scale:

- Not able to read (blind) and no help available
- Patient arrived late- did not complete
- Patient reports no problems with their balance
- Patient refused

The Dynamic Gait Index 4-item (DGI 4-item):

- Cannot follow directions
- Dangerous to walk alone (no help available)
- Does not ambulate (wheelchair bound)

APPENDIX D

CLINICAL DECISION RULES

Test/examination	Clinical decision rules
History of falls	If the patient reports one or more falls in the previous six months, then provide the falls education packet
Head thrust test (HTT)	If head thrust test is positive, then do gaze stabilization exercises
Dynamic visual acuity (DVA)	If the patient loses greater than 2 lines on the clinical DVA test, then do gaze stabilization exercises
Convergence	If the patient has difficulty with vergence (defined as a near point of convergence greater than 6 cm from the tip of the nose), then do convergence exercises
Vestibulo-ocular reflex (VOR) cancellation	If symptoms increase with VOR cancellation, then do optokinetic training
Positional testing	- If the patient demonstrates a positive Dix-Hallpike on the left (upbeating torsional nystagmus that fatigues), then do the left canalith repositioning maneuver (CRM) - If the patient shows a positive Dix-Hallpike on the right (upbeating torsional nystagmus that fatigues), then do a right CRM - If the patient shows a positive roll test to the right or left, then do the log roll maneuver (as part of CRM category)
Balance [the Modified Clinical	If the patient fails to complete any of the mCTSIB items as described, then work on static standing and/or dynamic standing activities

Test of Sensory Interaction and Balance (mCTSIB)]	Criteria for indication: - Stood less than 30 seconds per trial - Movement of the hands from the start position - Eye opening when their eyes are to be closed - Movement of the feet on the floor
Gait speed	If gait speed is less than 0.8 m/s, then provide ambulation program
Activities-specific Balance Confidence (ABC)	If patient's ABC is less than 70%, then provide education to increase his/her balance confidence
Dynamic gait index (DGI-4 item)	If DGI-4 is less than 12, work on an ambulation program

APPENDIX E

SHORT TEST

Question	%	Number responded
1. If the patient reports that he/she gets dizzy when getting out of bed, moving his/her head quickly, and rolling in bed, your management should be:		
A) Perform positional testing	96	23
B) Provide a canalith repositioning maneuver (CRM)	4	1
C) None of the above	0	0
2. A score of 70 on the DHI indicates:		
A) Mild handicap	0	0
B) Moderate handicap	4	1
C) Severe Handicap	96	23
3. During the head thrust test, when the eyes make a corrective saccade:		
A) The test is negative	0	0
B) The test is positive	100	24

4. In a positive DVA test (the patient loses >2 lines), the clinical decision rule is to:		
A) Perform a Dix-Hallpike	0	0
B) Provide ambulation training	0	0
C) Provide gaze stabilization exercises	100	24
5. Optokinetic training is the clinical decision rule when:		
A) Their convergence test results are abnormal	4	1
B) The Activities-specific Balance Confidence (ABC) scale is <70	0	0
C) When VOR cancellation increases the patient's symptoms	96	23
6. The clinical decision rule for convergence test defines the cut-off value as:		
A) 3 cm	0	0
B) 4 cm	8	2
C) 6 cm	92	22
7. BPPV is characterized by:		
A) Brief episodes of vertigo that last less than 1 minute and occur with changes of head orientation	100	24
B) Brief episodes of vertigo that last greater than 2 minutes and occur with changes of head orientation	0	0
8. According to the clinical decision rule, if the patient fails to complete any of the mCTSIB items, _____ should be initiated.		

A) Balance activities	100	24
B) The canalith repositioning maneuver	0	0
C) Eye-head activities	0	0
9. The optimal cut-off score for our evidence-based rule for gait speed is:		
A) < 1 m/s	33	8
B) < 0.6 m/s	4	1
C) < 0.8 m/s	63	15
10. According to our clinical decision rules, if the patient's Activities-specific Balance Confidence scale is less than 70%, then we should:		
A) Provide optokinetic training	0	0
B) Provide patient education	100	24
C) Provide Eye-head activities	0	0

APPENDIX F

BALANCE AND VESTIBULAR PYSICAL THERAPY DIAGNOSIS AND ICD-9 CODES

ICD-9	**Diagnosis**
781.2	Abnormality of gait
386.2	Vertigo of central origin
850.9	Concussion, unspecified
780.4	Dizziness and giddiness
386.11	Benign paroxysmal positional vertigo (BPPV)
850	Concussion
386.53	Hypoactive labyrinth, unilateral
386.9	Unspecified vertiginous syndromes and labyrinthine disorders
386	Vertiginous syndromes and other disorders of vestibular system
386.4	Labyrinthine fistula
346	Migraine
781.3	Lack of coordination
334.2	Primary cerebellar degeneration
384.2	Perforation of tympanic membrane

386.12	Vestibular neuronitis
386.5	Labyrinthine dysfunction
386.54	Hypoactive labyrinth, bilateral
386.1	Other and unspecified peripheral vertigo
850.1	Concussion with brief loss of consciousness
850.12	Concussion, with loss of consciousness from 31 to 59 minutes
850.4	Concussion with prolonged loss of consciousness, without return to pre-existing conscious level
346.90	Migraine, unspecified, without mention of intractable migraine without mention of status migrainosus
850.2	Concussion with moderate loss of consciousness
310.2	Post-concussion syndrome
850.11	Concussion, with loss of consciousness of 30 minutes or less

APPENDIX G

POST-HOC SURVEY

Question	**%**	**Number responded**
Multiple choices questions:		
1. What were the barriers to complete the required items on the vestibular and concussion initial evaluation forms: (please check all that apply)		**21**
Patients often refused to perform or complete the required items	14	3
Lack of time during initial evaluation	81	17
Lack of knowledge on how to perform some of the clinical tests	0	0
Did not know which items were required	0	0
I often forgot to complete the required items	0	0
I often did not agree with the importance of these required items to my specific patient	24	5
I rarely faced any barriers to complete the required items	19	4
2. What were the barriers to adhere to the CDRs: (please check all that apply)		**21**

Patients often refused the indicated treatment	0	0
Lack of knowledge of the CDRs	0	0
I often forgot to check the treatment categories that I plan to provide to my patients	24	5
I often did not agree with the CDRs	0	0
I rarely faced any barriers to adhere to the CDRs	81	17
3. What were the barriers to complete the three outcome measures (ABC, DHI, and GRC) on follow-ups and at discharge: (please check all that apply)		**21**
Patients often refused to complete these outcome measures	24	5
Lack of time during treatment sessions	24	5
Lack of knowledge on how to complete these outcome measures	0	0
Did not know which outcome measures were required	0	0
I often forgot to complete these outcome measures	19	4
I often did not agree with the importance of these outcome measures to my specific patient	9	2
I rarely faced any barriers to complete these outcome measures	52	11
4. Would you prefer that the email reminders for compliance and adherence be replaced with prompt electronic reminders that are integrated with an electronic medical record (or forms)? (Please choose one)		**21**
Yes	81	17
No	19	4

5. What do you think of the Balance and vestibular Quality Improvement project? (Please choose one)		**21**
I think it helped to improve the quality of my patient care	57	12
I think it did not change the quality of my patient care	43	9
Open ended Questions		
6. Were there any benefits to you from your participation in the QI project?		**11**
1st response: Learning consistent measurement for outcomes		
2nd response: Yes, it helped to direct my patient care and goal setting		
3rd response: Review of tests and assessment of each clinic (and therapists) technique		
4th response: Kept me more organized More focused		
5th response: I think I did a more complete and comprehensive evaluation		
6th response: Routine objective data!		
7th response: Help guide my treatment by having a problem list in front of me		
8th response: Extra training. Establishment of CDRs. Use of GRC		
9th response: It did make me more thorough in my evaluation. Made me think about which tests were the most important to		

complete at the first visit		
10th response: Made me think a little more about why I chose certain treatments; good for students		
11th response: Increased consistent evaluation		
7. Where there any negative aspects to the QI project?		**14**
1st response: The faxing was necessary but did take time		
2nd response: Administrative time to fax information was time consuming, and did not always have office staff to assist		
3rd response: Very time consuming		
4th response: Getting a reminder that something was not completed in the initial evaluation when it was my understanding we had two sessions to complete it		
5th response: No		
6th response: Having to perform measures that I did not feel fit the patient at times		
7th response: Having to fax form rather than input data to a database such as the LBI project		
8th response: One more thing for us AND secretaries to do. Sometimes I didn't feel that the "required" items allowed for our clinical judgment. I was always concerned that if I decided it didn't make sense to do a particular test, that I would be taken to task in some way for that		
9th response: Time consuming- one more thing to do! I had to		

personally complete all aspects of it as aide assistance was rarely available to assist. I just sent data with each visit (rather than every 2 weeks) as it was difficult to keep track of which needed to be sent in every 2 weeks		
10th response: The time it took to complete and fax the required information		
11th response: I think that QI, in general, is good for young or novice clinicians. However, it is a time-burden for experienced clinicians who already manage patients according to the guidelines. There are more cases of exceptions that you would imagine. There are not good ways to manage patients who are atypical with traditional QI		
12th response: Time requirement, although became easier as the project progressed; fax machine down occasionally		
13th response: Faxing was a bit cumbersome- but I don't know how else you could have accomplished this		
14th response: Took too much time to fax all the information. The only reason I did not feel like it helped me and my practice as much because I feel that these were items I was already assessing and following up with		
8. How could we have made this QI project better?		**9**
1st response: Electronic medical records would make data collection MUCH easier		

2nd response: Hopefully in the future, less paper, electronic documentation, program that scores the outcome measures automatically, possibly the ABC, DHI, GRC etc. on an ipad or computer		
3rd response: Integrate the GRC into the daily treatment diary as a reminder to complete it		
4th response: Method of collecting the data		
5th response: Having special forms with the required data would make the project more clear, for instance the GRC was not a part of the evaluation or progress notes		
6th response: I think that there should have been a standard form to fax in for the data. Easy to fill in rather than making our own		
7th response: The GRC is a good idea; but in practice was difficult to complete - because it should be in a format that it can be given to the patient and completed. Because of the wording, it had to be asked directly to the patients - and then the accuracy was suspect. The clinical decision rule regarding 4-Item DGI - not sure on this one. If 10 triggers gait activities, ok; but if 11/12 triggers, this is too stringent. There are too many kids who just walk slowly. The overall process will be easier once electronic; doing it via paper is way too time-consuming		
8th response: I don't think you could have....you did a great job!		
9th response: I think this is not an ideal project to while we still		

document on paper. I think once we document electronically and this information can just be collected from data input with documentation that that would make it much easier. If it had to be done again while we still did paper documentation, having a system set up similar to the LBI project would help where data is entered online and followed in that regard		

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