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USING OVER-THE-COUNTER EAR FILTERS AS A TREATMENT TO IMPROVE DIZZINESS AND BALANCE IN PATIENTS DIAGNOSED WITH A TRAUMATIC BRAIN

By

Brandy Sue Whitney, Doctor of Physical Therapy

A doctoral project submitted in partial fulfillment
of the requirements for the

Doctorate of Physical Therapy

Physical Therapy Department
School of Allied Health Sciences
The Graduate College

University of Nevada, Las Vegas
May 2013

THE GRADUATE COLLEGE

We recommend the doctoral project prepared under our supervision by

Brandy Sue Whitney

Entitled

Using Over-the-Counter Ear Filters as a Treatment to Improve Dizziness and Balance in Patients Diagnosed with a Traumatic Brain

be accepted in partial fulfillment of the requirements for the degree of

Doctor of Physical Therapy
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ABSTRACT

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Background and purpose

People diagnosed with a Traumatic Brain Injury (TBI) usually have physical, cognitive, emotional, and sleep deficits. Sensory overload is a common symptom of TBI. One treatment prescribed for sensory overload is over the counter ear filters. Ear filters have shown to decrease sensory input. Could the ear filters have an effect on balance and dizziness without much cost to the patient or the clinic?

Subjects

Patients diagnosed with a mild or moderate brain injury, ages of 18-65 years old. They needed to be medically stable, potential to walk, and have complaints of dizziness and/or balance problems.

Methods

The Bohannon Timed Stance Battery, Berg Balance Scale and the Dynamic Gait Index are measured and Activities Specific Confidence Scale, Dizziness Handicap Inventory, the Vestibular Disorders Activities of Daily Living Scale and Fear of Falling Avoidance-Behavior Questionnaire are given. Over the counter ear filters are prescribed for use during vestibular rehabilitation either during the initial evaluation or one week later.

Results

Not enough subjects to perform an appropriate mixed factorial analysis; however, they do give an indicator of the probable effect sizes to power a future study.

Discussion/Conclusion

The results did not demonstrate a difference with the use of ear filters because of inconclusive data. Not enough time between immediate and delayed use of ear filters was seen for a favorable conclusion of usage.

KEYWORDS. Vestibular rehabilitation, Traumatic Brain Injury, dizziness.

Acknowledgements

Merrill Landers, PT, DPT, PhD, OCS. Department of Physical Therapy, UNLV.
Statistical analysis and advisor

Jamie Wolkenbreit, PT MSPT. Boulder Community Hospital Mapleton Center
Neurologic and Orthopedic Center.
IRB proposial

Table of Contents

Abstract…… iii

Acknowledgements……v

List of Tables …… vii

List of Graphs……..…….. viii

Introduction……1

Methods……..6

Overall Study Design……8

Results……10

Discussion……..12

Conclusion……..15

Tables and Graphs……. 16

Appendix 1……30

Appendix 2……31

Appendix 3……33

Appendix 4……35

Appendix 5……36

Appendix 6……37

Appendix 7……38

References……..30

Curriculum Vitae……... 41

LIST OF TABLES:

Table 1 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing BBS……..... 16

Table 2 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing BTSB…….18

Table 3 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing DGI……20

Table 4 Main Effect for Time or Group Suggesting Improvement Utilizing DGI……. 21

Table 5 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing FFABQ…….....23

Table 6 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing ABC……...25

Table 7 A Mixed Factorial ANOVA for Immediate and Delayed Variables DHI……..27

Table 8 Difference Between Groups for Immediate and Delayed Variables of DHI……..... 28

LIST OF GRAPHS:

Graph 1 Main Effect for Time or Group for Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing BBS…….. 17
Graph 2 A Mixed Factorial ANOVA Between Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing BTSB…….19
Graph 3 Main Effect for Time or Group for Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing DGI……22
Graph 4 Main Effect for Time or Group for Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing FFABQ…….....24
Graph 5 Main Effect for Time or Group for Variables (pre-treatment, post-treatment and six weeks post treatment) Utilizing ABC…….……..26
Graph 6 Main Effect for Time or Group for Immediate and Delayed for DHI…… 29

INTRODUCTION

Traumatic Brain Injuries (TBI) are becoming medically acknowledged by an increase of explosive events involving soldiers and professional football players speaking out on their concussions and brain injuries. TBIs also occur from motorized vehicle accidents, falls and from other sports such as biking, hockey, skiing and soccer. A concussion used to be thought of as a minor incident, with little or no repercussions, whereas a TBI was thought to have an increase of severity. A loss of consciousness was also equated to the severity of the concussion. Only 10% of concussions result in loss of consciousness. A concussion is often not the result of one large impact, but a series of small collisions to the head.[1] Due to impairments, and signs and symptoms associated with a concussion, the Centers for Disease Prevention now classifies a concussion as a TBI.[1] Concussion is defined as a complex pathophysiological process affecting the brain induced by traumatic biomechanical forces. A TBI is caused by a bump, blow or jolt to the head or a penetrating head injury that disrupts the normal function of the brain. It should be noted that not all blows or jolts to the head result in a TBI. The severity of a TBI may range from "mild," i.e., a brief change in mental status or consciousness to "severe," i.e., an extended period of unconsciousness or amnesia after the injury.[1-2]

With a "simple concussion," there are bigger implications if there is a second head injury within a short period of time, as the brain has not fully recovered. This is known as "Second Impact Syndrome".[1] In the fall of 2004, Jake Snakenburg, a freshmen, high

school football player in Colorado, died from Second Impact Syndrome. He sustained a head injury one week prior to his second head injury. His symptoms were not recognized and he was still permitted to play football. During his last game prior to his death, he sustained another head injury while playing football, collapsed, and never regained consciousness. That incidence portrayed the seriousness of brain injuries to change Colorado's legislation. On January 1, 2012, the law required all Colorado children ages 11-18 who sustain a concussion to undergo medical clearance prior to return to play.

Physical therapists play an important role in recovery of patients suffering a head injury. TBIs may have no apparent physical evidence, therefore assessing when athletes or other individuals can return to play or work can be an imperative decision. Managing the sequella of TBIs requires specialized neurological therapists who recognize, evaluate, and provide therapeutic interventions. Depending on the level of impairment, a speech and language pathologist and/or an occupational therapist may be treating the individual as well. There are four major categories of a concussion, which include physical, sleep, behavior, and cognition. Each of the categories include a graded set of clinical symptoms which may or may not include loss of consciousness. The signs and symptoms associated with each category of traumatic brain injury are of a TBI are:[1-2]

Physical	Headache, fatigue, dizziness, imbalance, nausea, light sensitivity, noise sensitivity
Sleep	Drowsiness, difficulty falling asleep, sleeping more or less than typical
Behavior	Irritable, emotionally labile, depressed, anxious, sad
Cognition	Delayed reaction time, memory deficits, “brain fog”, poor concentration

Dizziness and balance are common complaints after an injury.[3-9] In the physical category, dizziness and balance usually refer to the vestibular system. The vestibular system monitors position of the head in space and distinguishes body movement from surrounding visual movement. It is also connected to the auditory, visual, proprioceptive, and motor systems, which are critical for multisensory functioning. All movements whether they are static or dynamic are influenced by the vestibular system. When there are deficits to the vestibular system, fear of increasing the symptoms affects everyday activities, ability to work, social relationships, and quality of life. Another symptom experienced is sensory overload.[5] The brain has the ability to process competing stimulation and filter information as important or unimportant. For example, one may walk into a coffee shop and be able to process how many people are in the shop, the level of noise and notice details such as the smell, the temperature, the lighting before he orders a cup of coffee. Someone how has sensory overload has difficulty processing the

details previously mentioned. Their brain is healing and is therefore unable to handle all the information and being bombarded by certain environments, such as busy coffee shops. A study done by the Speech and Language and Hearing Sciences, the Neuroscience Program, and the Department of Psychology at the University of Colorado Boulder on the use of ear filters to decrease sensory overload for those diagnosed with a TBI.[10] There has been research by speech and language pathologists on the use of ear filters to decrease sensory overload for those diagnosed with a TBI. The auditory processing appears to be decreased by using ear filters in order to decrease the hypersensitivity experienced by these individuals. The results showed significant decrease in hearing difficulties in all environmental situations such as work, home, car and restaurants as well as family interactions.[10] With such favorable conclusions, there is a question of whether the vestibular component is also improved with the use of ear filters. Since the vestibular system is connected to the visual, auditory, proprioception and motor systems, could using a simple device of ear filters improve balance and decrease dizziness?

When reviewing the literature, vestibular deficits and TBI have limited treatment options. Much more literature is either addressing vestibular component or the TBI, but not together. The vestibular deficits are much more complicated among the TBI population. Their needs are much greater and sometimes require a rehab team of a speech and language pathologist, occupational therapist, physical therapist and possibly a trauma counselor. Since there has been positive research on ear filters and TBIs, why not see if

there is any measurable improvement in balance and dizziness. Could a simple device be used for both auditory and balance processing recovery? If the ear filters show to have significant difference on the vestibular symptoms, this could be implemented into a treatment plan with little cost to the patient or the clinic.

METHODS

Patients included in this study were diagnosed with either a mild or moderate brain injury between the ages of 18-65 years old. They needed to be medically stable and have the potential to walk. They had to have been referred to Mapleton Neurotrauma Outpatient Rehabilitation at Boulder Community Hospital by a physician for outpatient therapy. The patients had to have complaints of dizziness and/or balance problems. All patients were volunteers for the study. During the initial evaluation, a licensed physical therapist obtained a history and determined if the patient was appropriate to participate in this research. The therapist acquired consent and proceeded to administer the Bohannon Timed Stance Battery (BTSB), Berg Balance Scale (BBS) and the Dynamic Gait Index (DGI) (see appendix 1-3). The patient was given the following questionnaires to fill out: The Activities Specific Confidence Scale (ABC), Dizziness Handicap Inventory (DHI) and the Vestibular Disorders Activities of Daily Living Scale (VADL) and Fear of Falling Avoidance-Behavior Questionnaire (FFABQ) (see appendix 4-7). If they were unable to fill them out independently, a family member, caregiver or therapist could assist them with the questions and responses. These standardized assessment tools were used to determine the patients' current level of function and presence of vestibular deficits. A coin was flipped to determine if the first patient would receive ear filters during the evaluation and be considered the immediate group or receive them in one week and be part of the delayed group. From that point on, patients were alternated between starting the use of the ear filters upon evaluation or one week later. The ear

filters used were Etymotic ER 20 Hi-Fi Natural Sound Ear Plugs. The ear filters allow one to hear all frequencies clearly, but at a lower volume. All patients were assessed over a six week period following group allocation. They were all assessed (pre-treatment), three weeks later (post-treatment), and again three weeks later (6 weeks post-treatment). Treatment was consistent from patient to patient, regardless of when they started using the ear filters, by using various vestibular exercises using balance boards, uneven surfaces, and provocative positions. The participants were given the following questionnaires after six weeks: ABC, DHI, VADL, and FFABQ.

OVERALL STUDY DESIGN

Tests and measures

The physical dynamic balance tests utilized included Bohannon Timed Stance Battery (BTSB), the Balance Berg Scale (BBS), and the Dynamic Gait Index (DGI). The BTSB was assessing stationary single leg and double leg stance eyes open and eyes closed. The BBS assessed dynamic and static balance. The DGI assessed the ability to modify balance while walking in the presence of external demands during administration. Evidence supports the DGI for vestibular symptoms because of the head movements during gait.[11]

The questionnaires given were the Vestibular Disorders Activities of Daily Living Scale (VDAL), Activities Specific Confidence Scale (ABC), Fear of Falling Avoidance-Behavior Questionnaire (FABQ), and Dizziness Handicap Inventory (DHI). The VADL assesses higher levels of impairments for those diagnosed with vestibular disorders.[12] The ABC subjectively measures confidence in performing various ambulatory activities without falling.[13] The DHI assesses physical and emotional consequences of a vestibular disorder.[14] The FABQ was used to address fear-avoidance beliefs for those diagnosed with vestibular disorders.[15]

After the BSBT, DGI and BBS tests were administered, plan of care was established by using the patients' scores and the limiting factors found in the tests. Vestibular

rehabilitation was implemented for the six weeks of treatment with a reassessment at the three week interim. The VDAL, ABC, FABQ and DHI were given again at the end of the six week treatment for self reassessment.

RESULTS

All results of this pilot study should be interpreted with caution since there were not enough subjects to perform an appropriate mixed factorial analysis; however, they do give an indicator of the probable effect sizes to power a future study.

Berg Balance Scale (BBS)

A 2 (group: immediate and delayed) X 3 (time: pre-treatment, post-treatment, 6 weeks post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for BBS, $F(2,8)=.726$, $p=.444$, power=.134 (Table 1). Likewise, there was no main effect for time ($p=0.123$) or group ($p=0.296$) (Graph 1).

Bohannon Timed Stance Battery (BTSB)

A 2 (group: immediate and delayed) X 3 (time: pre-treatment, post-treatment, 6 weeks post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for the BTSB, $F(2,8)=.050$, $p=.952$, power=.055 (Table 2). Likewise, there was no main effect for time ($p=0.164$) or group ($p=0.231$) (Graph 2).

Dynamic Gait Index (DGI)

A 2 (group: immediate and delayed) X 3 (time: pre-treatment, post-treatment, 6 weeks post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for the DGI, $F(2,8)=1.691$, $p=.244$, power=.258 (Table 3). There was a significant main effect for time suggesting that all subjects regardless of group improved over time, $p=0.043$. They did not improve pre-treatment to post-treatment ($p=0.348$) but

did from the pre-treatment to 6 weeks (p=0.018) (Table 4). There was no main effect for group (p=0.304) (Graph 3).

Fear of Falling Avoidance Behavior Questionnaire (FFABQ)

A 2 (group: immediate and delayed) X 2 (time: pre-treatment, post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for the FFABQ, F(2,8)=.060, p=.822, power=.054 (Table 5). Likewise, there was no main effect for time (p=0.315) or group (p=0.148) (graph 4).

Activities Specific Balance Confidence Scale (ABC)

A 2 (group: immediate and delayed) X 2 (time: pre-treatment, post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for the ABC, F(2,8)=.544, p=.502, power=.089 (Table 6). Likewise, there was no main effect for time (p=0.194) or group (p=0.214) (Graph 5).

Dizziness Handicap Inventory (DHI)A 2 (group: immediate and delayed) X 2 (time: pre-treatment, post-treatment) mixed factorial ANOVA revealed no significant interaction between the variables for the DHI, F(2,8)=.176, p=.715, power=.058 (Table 7). Likewise, there was no main effect for time (p=0.541); there was, however, a difference between groups (p=0.025)(Table 8) (graph 6).

DISCUSSION

The results did not demonstrate that there is a difference with the use of ear filters. This is mainly due to inconclusive data. Only ten participants' data were examined and not all questionnaires were returned prior to discharge or the six week time period. Two participants did not finish the study because they discontinued therapy. What is interesting is that the questionnaire data does not indicate subjective improvement, but the subjects stated improvements to the therapist. They self-reported an increase in steadiness, able to participate in everyday activities with greater ease, less likely to fall and decrease in the feeling of dizziness. Therefore, was a decrease in sensory overload allowing them to fully engage and get the most out of their vestibular rehabilitation? The self-reported questionnaires could also be misleading due to TBI patients' ability to provide accurate information or fully participate in daily activities during the initial part of their recovery. They may lack awareness of participation. As they recover and are able to increase participation, self awareness increases and the sense of what they are able to do or not do is broadened. Their scores may drop in the questionnaires at the end of six weeks. A TBI requires more brain energy to accomplish tasks now compared to before the injury. As the patient starts to realize how much energy is spent on daily tasks they may not feel as confident on some of the tasks as before because of the increased energy required to complete them.

With positive subjective results on balance and the research backing a decrease in sensory overload, a physical therapist could prescribe over the counter ear filters for a patient diagnosed with a TBI. This would be similar to a physical therapist prescribing over the counter orthotics. Superfeet®, an over the counter orthotic, is often prescribed to adjust for faulty foot mechanics. Superfeet® are inexpensive orthotics that can be tried before or in place of custom orthotics. An assessment can then be made of whether or not the patient tolerates the orthotic, if their symptoms decrease and if a correction is made. If the orthotic works, then maybe a custom orthotic can be prescribed. This can be a cost effective trial, as custom orthotics can be expensive. This same principle can be applied to over the counter ear filters. The cost is under twenty dollars for a simple device that is known to decrease sensory overload for TBI patients and is reported subjectively to improve balance and decrease dizziness. Of course, if the over the counter ear filters work, custom ear filters could be explored.

Only one of the three tests really captured vestibular deficits in this population. The DGI tested true vestibular deficits with movements of the head and gait, which are more realistic to functional tasks. It was easier to develop a treatment plan by utilizing the DHI. The BTBS and BBS were not as sensitive to this population. Recommendations of using the DGI would be more efficient for this population if only one test was being used to evaluate progress or developing an individual treatment plan.

A future study would include longer duration between testing for the use of the ear filters and delayed use. One week difference did not allow enough time to conclude if there is a difference with or without the use of ear filters. Also with time being such a crucial element to a healing brain, a six week study may not be long enough to test whether progress is seen for the use of ear filters. TBI patients are frequently treated for several months and possibly years. With this increase of treatment duration, testing could be prolonged into months instead of weeks. Another possible addition to make this type of study more objective is to include audiology testing and a NeuroCom. Both are relatively important in vestibular testing and would give objective data to support findings.

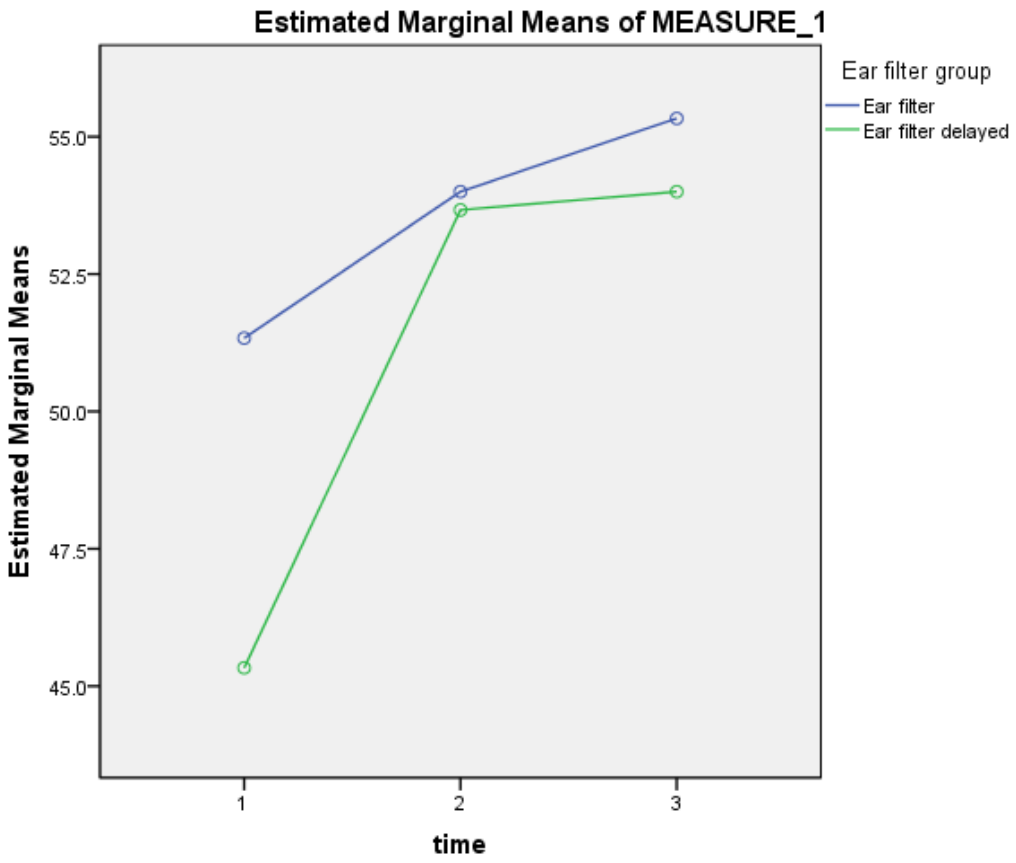
CONCLUSION

This study suggests a possible treatment option for those diagnosed with TBI and have vestibular symptoms. Use of ear filters has been shown to decrease sensory overload for TBI patients. The research by speech and language pathologists on the use of ear filters to decrease sensory overload for those diagnosed with a TBI are currently being prescribed by those disciplines. Although the data is inconclusive on whether a difference is measured for balance and dizziness, physical therapists could prescribe over the counter ear filters for sensory overload. If a physical therapist was not practicing in a trauma clinic, where a speech and language pathologist would normally prescribe ear filters, the physical therapist could prescribe ear filters as Best Practice. The functional value of using a simple device could be a powerful tool for patients recovering from a TBI who is having vestibular symptoms.

Table 1				
	Ear filter group	Mean	Std. Deviation	N
BBS pre	Ear filter	51.33	3.215	3
	Ear filter delayed	45.33	9.815	3
	Total	48.33	7.312	6
BBS post	Ear filter	54.00	1.732	3
	Ear filter delayed	53.67	1.528	3
	Total	53.83	1.472	6
BBS post6	Ear filter	55.33	1.155	3
	Ear filter delayed	54.00	1.732	3
	Total	54.67	1.506	6

A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing BBS. $F(2,8)=2.26$, $p=.444$, power=.134

Graph 1

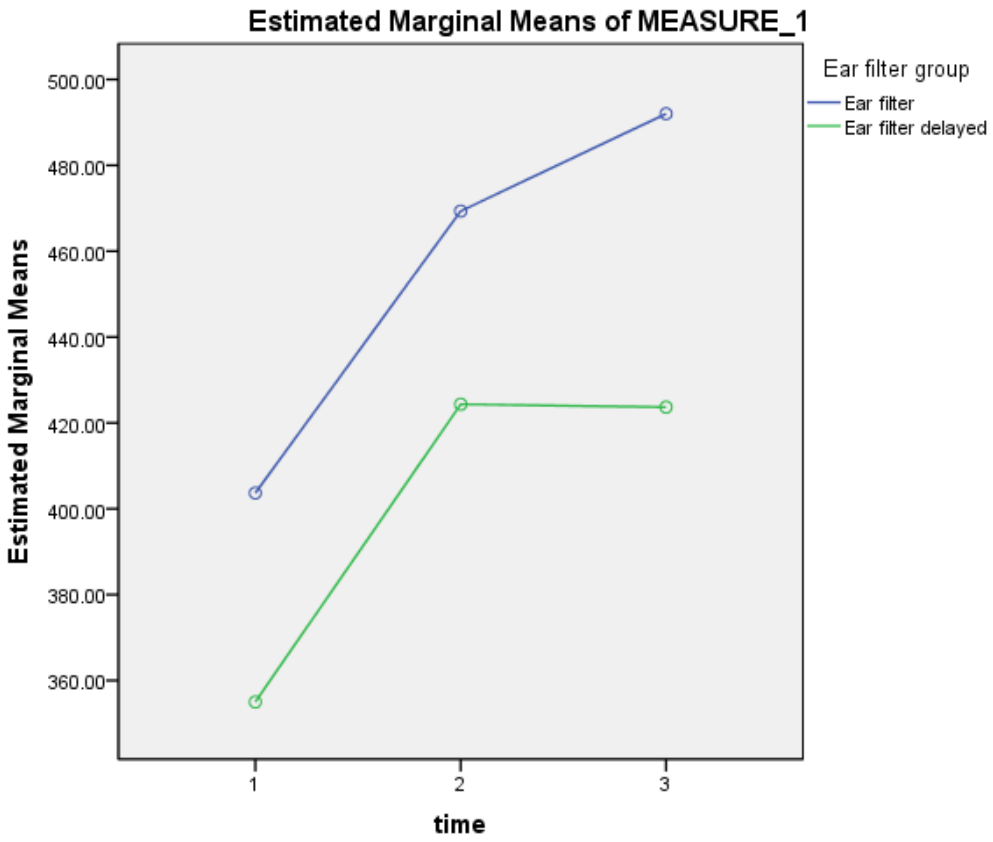


Main effect for time or group for variables (pre-treatment, post-treatment and six weeks post treatment) utilizing BBS. Time (p=0.123), Group (p=0.296)

Table 2				
	Ear filter group	Mean	Std. Deviation	N
Bohannon pre	Ear filter	403.6667	80.58743	3
	Ear filter delayed	355.0000	136.70040	3
	Total	379.3333	103.84155	6
Bohannon post	Ear filter	469.3333	27.30079	3
	Ear filter delayed	424.3333	48.21134	3
	Total	446.8333	42.84118	6
Bohannon post6	Ear filter	492.0000	41.61730	3
	Ear filter delayed	423.6667	46.49014	3
	Total	457.8333	54.38903	6

A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing BTSB. F(2,8)=.050, p=..952, power=.055

Graph 2



A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing BTSB. Time (p=0.164), Group (p=0.231)

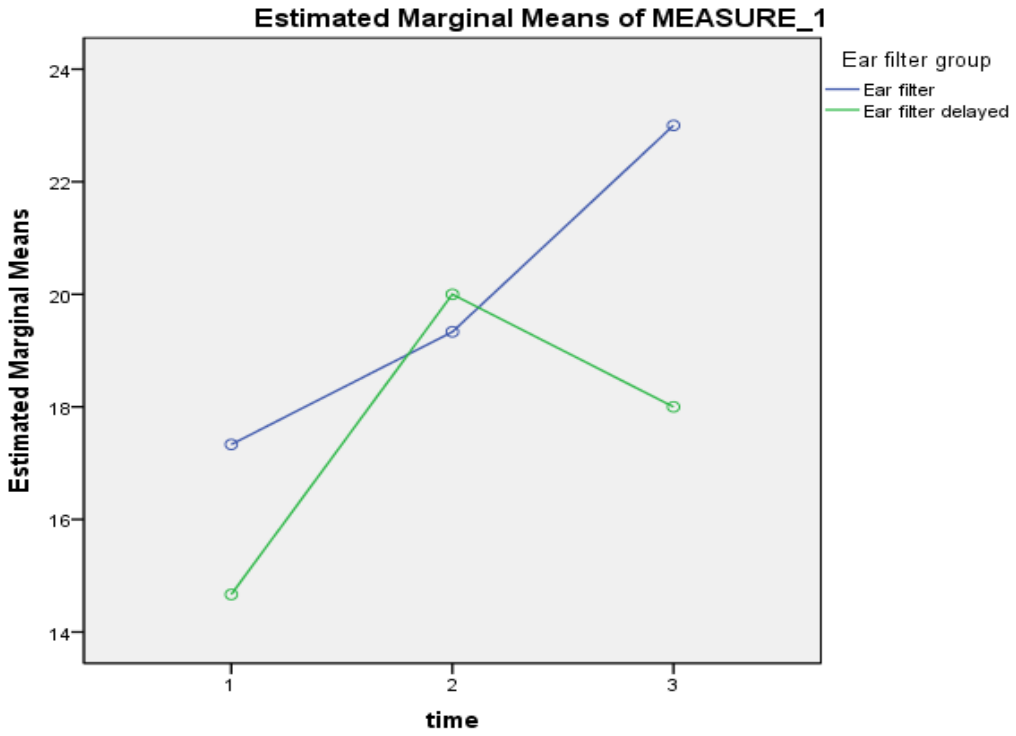
Table 3				
	Ear filter group	Mean	Std. Deviation	N
DGI pre	Ear filter	17.33	4.619	3
	Ear filter delayed	14.67	2.517	3
	Total	16.00	3.633	6
DGI post	Ear filter	19.33	4.041	3
	Ear filter delayed	20.00	3.606	3
	Total	19.67	3.445	6
DGI post6	Ear filter	23.00	1.732	3
	Ear filter delayed	18.00	2.000	3
	Total	20.50	3.209	6

A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing DGI. $F(2,8)=1.691$, $p=.244$, power=.258

Table 4				
time	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
1	16.000	1.518	11.784	20.216
2	19.667	1.563	15.326	24.008
3	20.500	.764	18.379	22.621

Main effect for time or group suggesting improvement utilizing DGI. (p=0.043)

Graph 3

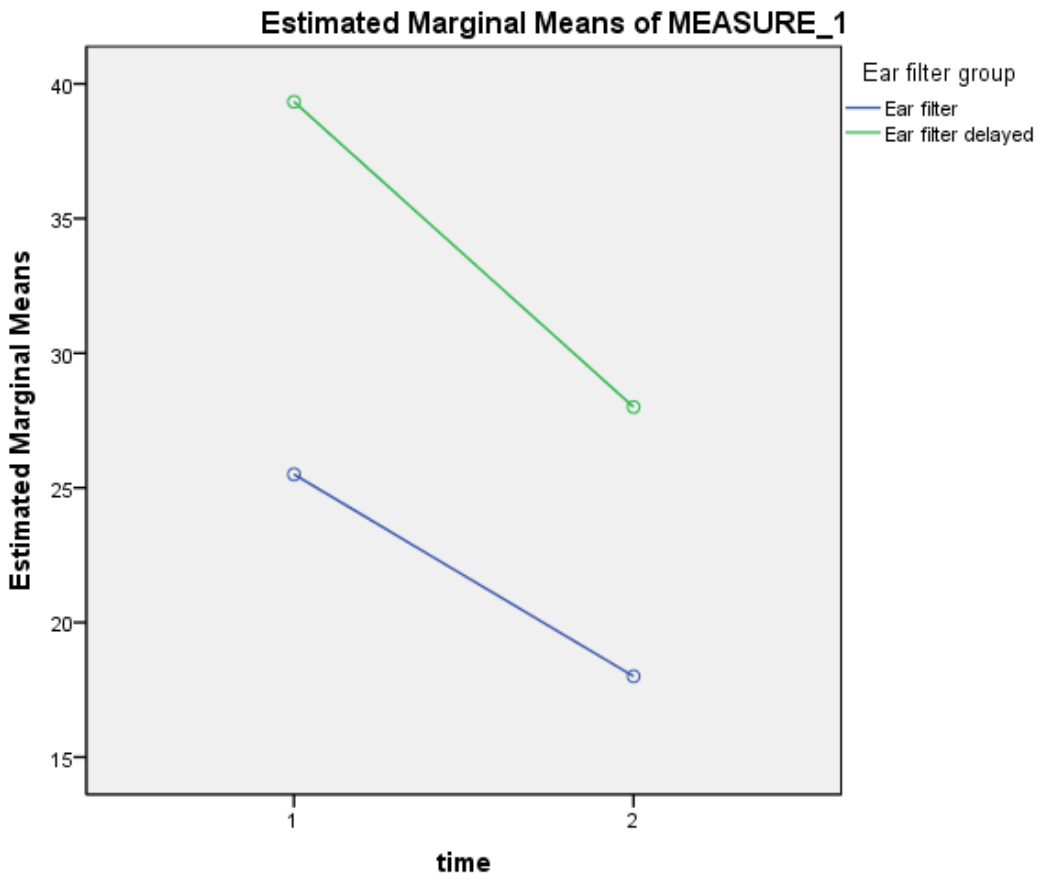


Main effect for time or group for variables (pre-treatment, post-treatment and six weeks post treatment) utilizing DGI. (p=0.304) Improvement from pre-treatment to six weeks p=0.018

Table 5				
	Ear filter group	Mean	Std. Deviation	N
FFABQpre	Ear filter	25.50	16.263	2
	Ear filter delayed	39.33	10.408	3
	Total	33.80	13.330	5
FFABQpost6	Ear filter	18.00	7.071	2
	Ear filter delayed	28.00	9.539	3
	Total	24.00	9.381	5

A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing FFABQ. $F(2,8)=.060$, $p=.822$, power=.054

Graph 4

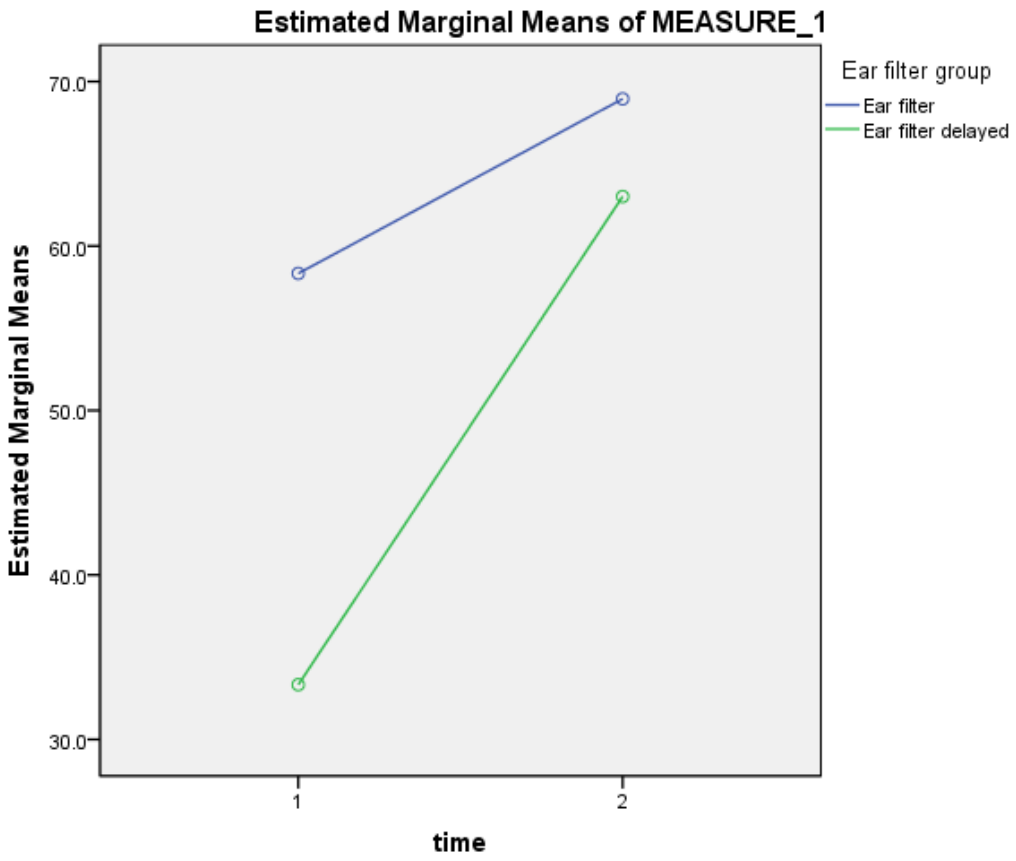


Main effect for time or group for variables (pre-treatment, post-treatment and six weeks post treatment) utilizing FFABQ. Time (p=0.315), Group (p=0.148)

Table 6				
	Ear filter group	Mean	Std. Deviation	N
ABC pre	Ear filter	58.333	22.0912	3
	Ear filter delayed	33.325	27.2977	3
	Total	45.829	26.0941	6
ABC post6	Ear filter	68.950	19.3890	3
	Ear filter delayed	63.008	7.3905	3
	Total	65.979	13.5208	6

A mixed factorial ANOVA between variables (pre-treatment, post-treatment and six weeks post treatment) utilizing ABC. $F(2,8)=.544$, $p=.502$, power=.089

Graph 5



Main effect for time or group for variables (pre-treatment, post-treatment and six weeks post treatment) utilizing ABC. Time (p=0.194), Group (p=0.214)

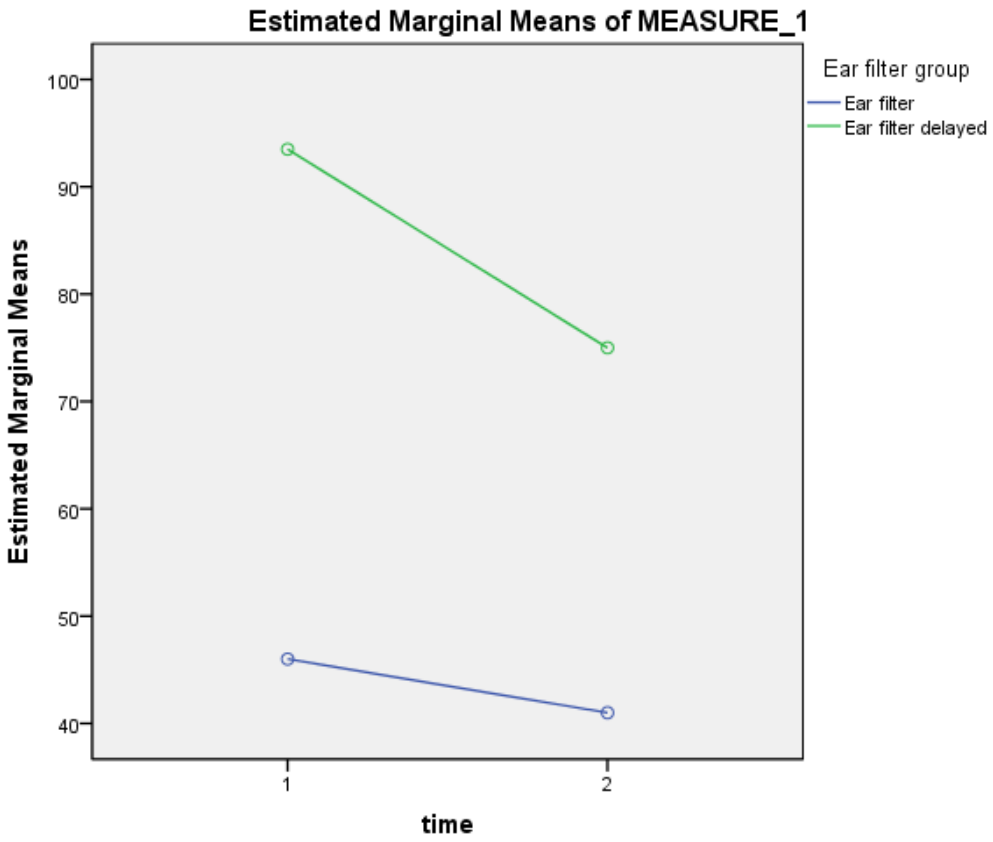
Table 7				
	Ear filter group	Mean	Std. Deviation	N
DHI pre	Ear filter	46.00	28.284	2
	Ear filter delayed	93.50	.707	2
	Total	69.75	31.920	4
DHIpost6	Ear filter	41.00	15.556	2
	Ear filter delayed	75.00	12.728	2
	Total	58.00	22.804	4

A mixed factorial ANOVA for immediate and delayed variables DHI. $F(2,8)=.176$, $p=.715$, power=.058

Table 8				
Ear filter group	Mean	Std. Error	95% Confidence Interval	
			Lower Bound	Upper Bound
Ear filter	43.500	4.627	23.593	63.407
Ear filter delayed	84.250	4.627	64.343	104.157

Difference between groups for immediate and delayed variables of DHI time (p=0.541)

Graph 6



Main effect for time or group for immediate and delayed for DHI (p=0.25)

Appendix 1

BOHANNON TIMED STANCE BATTERY[i]

NAME:
SS#:
DATE:

Instructions: Patient assumes the position indicated. Stance is timed for up to 30 seconds. Three trials are given for each stance position. Once a 30 second score has been reached in a trial of any one condition, assign any remaining trials in that condition a 30 second score and move on to the next condition.

1. Stand with feet shoulder width apart, eyes open	**Trial 1:** **Trial 2:** **Trial 3:**
2. Stand with feet shoulder width apart, eyes closed	**Trial 1:** **Trial 2:** **Trial 3:**
3. Stand with feet together, eyes open	**Trial 1:** **Trial 2:** **Trial 3:**
4. Stand with feet together, eyes closed	**Trial 1:** **Trial 2:** **Trial 3:**
5. Stand on one foot, eyes open	**Trial 1:** **Trial 2:** **Trial 3:**
6. Stand on one foot, eyes closed	**Trial 1:** **Trial 2:** **Trial 3:**
	TOTAL:

[i] Bohannon R, Timed stance battery. *Arch Phys Med Rehabil*, 1995:76:994-996.

Appendix 2

BERG BALANCE SCALE[i]

NAME:
DATE:

1. SIT TO STAND - "Please stand up. Try not to use your hands for support."
- ☐ 0 Needs moderate or maximal assist to stand
- ☐ 1 Needs minimal assist to stand or to stabilize
- ☐ 2 Able to stand using hands after several tries
- ☐ 3 Able to stand independently using hands
- ☐ 4 Able to stand with no hands and stabilize independently

2. STANDING UNSUPPORTED - "Stand for two minutes without holding."
- ☐ 0 Unable to stand 30 seconds unassisted
- ☐ 1 Needs several tries to stand 30 seconds unsupported
- ☐ 2 Able to stand 30 seconds unsupported
- ☐ 3 Able to stand 2 minutes with supervision
- ☐ 4 Able to stand safely for 2 minutes

3. SITTING UNSUPPORTED WITH FEET ON FLOOR - "Sit with arms folded for 2 minutes."
- ☐ 0 Unable to sit without support for 10 seconds
- ☐ 1 Able to sit for 10 seconds
- ☐ 2 Able to sit for 30 seconds
- ☐ 3 Able to sit for 2 minutes under supervision
- ☐ 4 Able to sit safely and securely for 2 minutes

4. STANDING TO SITTING - "Please sit down"
- ☐ 0 Needs assistance to sit
- ☐ 1 Sits independently but has uncontrolled descent
- ☐ 2 Uses back of legs against chair to control descent
- ☐ 3 Controls descent by using hands
- ☐ 4 Sits safely with minimal use of hands

5. TRANSFERS - "Please move from chair to bed and back again. One way toward a seat with armrests and one way toward a seat without armrests."
- ☐ 0 Needs two people to assist or supervise to be safe
- ☐ 1 Needs one person to assist
- ☐ 2 Able to transfer with verbal cueing and/or supervision
- ☐ 3 Able to transfer safely with definite need to use hands
- ☐ 4 Able to transfer safely with minor use of hands

6. STANDING UNSUPPORTED WITH EYES CLOSED - "Close your eyes and stand still for 10 seconds"
- ☐ 0 Needs help to keep from falling
- ☐ 1 Unable to keep eyes closed for 3 seconds but stays steady
- ☐ 2 Able to stand for 3 seconds
- ☐ 3 Able to stand for 10 seconds with supervision
- ☐ 4 Able to stand for 10 seconds safely

7. STANDING UNSUPPORTED WITH FEET TOGETHER - "Place your feet together and stand without holding."
- ☐ 0 Needs help to attain position and unable to hold for 15 seconds
- ☐ 1 Needs help to attain position but able to stand for 15 seconds
- ☐ 2 Able to place feet together independently but unable to hold 30 seconds
- ☐ 3 Able to place feet together independently and stand 1 min. with supervision
- ☐ 4 Able to place feet together independently and stand for 1 minute safely

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[i] Berg KO, Maki BE, Williams JI, et al. Clinical and laboratory measures of postural balance in an elderly population. *Arch Phys Med Rehabil* 1992;73:1073-1080.
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8. REACHING FORWARD WITH OUTSTRETCHED ARM - "Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can.

- ☐ 0 Needs help to keep from falling
- ☐ 1 Reaches forward but needs supervision
- ☐ 2 Can reach forward > 2 inches safely
- ☐ 3 Can reach forward > 5 inches safely
- ☐ 4 Can reach forward confidently > 10 inches

9. PICK UP OBJECT FROM THE FLOOR - "Pick up the shoe/slipper which is placed in front of your feet."

- ☐ 0 Unable to try/needs assistance to keep from falling
- ☐ 1 Unable to pick up and needs supervision while trying
- ☐ 2 Unable to pick up but reaches 1-2 inches from slipper and keeps balance independently
- ☐ 3 Able to pick up slipper but needs supervision
- ☐ 4 Able to pick up slipper safely and easily

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS - "Turn your upper body to look over your left shoulder and then over your right shoulder."

- ☐ 0 Needs assist to keep from falling
- ☐ 1 Needs supervision when turning
- ☐ 2 Turns sideways only but maintains balance
- ☐ 3 Looks behind one side only, other side shows less weight shift
- ☐ 4 Looks behind from both sides and weight shifts well

11. TURN 360 DEGREES - "Turn completely in a full circle. Pause. Then turn a full circle in the other direction."

- ☐ 0 Needs assistance while turning
- ☐ 1 Needs close supervision or verbal cueing
- ☐ 2 Able to turn 360 safely but slowly
- ☐ 3 Able to turn 360 safely one side only < 4 seconds
- ☐ 4 Able to turn 360 safely in < 4 seconds each side

12. DYNAMIC WEIGHT SHIFTING, STEP TOUCH MEASURED STOOL - "Place each foot alternately on the stool. Continue until each foot has touched the stool four times."

- ☐ 0 Needs assistance to keep from falling/unable to try
- ☐ 1 Able to complete > 2 steps needs minimal assist
- ☐ 2 Able to complete 4 steps without aid with supervision
- ☐ 3 Able to stand independently and complete 8 steps > 20 seconds
- ☐ 4 Able to stand independently and safely and complete 8 steps in 20 seconds

13. TANDEM STANCE - "Place one foot directly in front of the other. If you feel that you can't place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot."

- ☐ 0 Loses balance while stepping or standing
- ☐ 1 Needs help to step but can hold for 15 seconds
- ☐ 2 Able to take small step independently and hold for 30 seconds
- ☐ 3 Able to place foot ahead of other independently and hold for 30 seconds
- ☐ 4 Able to place foot tandem independently and hold for 30 seconds

14. SINGLE LEG STAND - "Stand on one leg as long as you can without holding."

- ☐ 0 Unable to try or needs assist to prevent fall
- ☐ 1 Tries to lift leg, unable to hold 3 seconds (remains standing independently)
- ☐ 2 Able to lift leg independently and hold = or > 3 seconds
- ☐ 3 Able to lift leg independently and hold for 5-10 seconds
- ☐ 4 Able to lift leg independently and hold for > 10 seconds

TOTAL SCORE: /56

(Fall risk < 46; High fall risk < 42)

Appendix 3

DYNAMIC GAIT INDEX[i]

NAME:
DATE:

1. GAIT LEVEL SURFACE

Instructions: Walk at your normal speed form here to the next mark (20'). Mark the lowest category that applies.

☐ **3 Normal:** Walks 20', no assistive devices, good speed, no evidence for imbalance, normal gait pattern.

☐ **2 Mild impairment:** Walks 20', uses assistive devices, slower speed, mild gait deviations

☐ **1 Moderate impairment:** Walks 20', slow speed, abnormal gait pattern, evidence for imbalance.

☐ **0 Severe impairment:** Cannot walk 20' without assistance, severe gait deviations, or imbalance.

2. CHANGE IN GAIT SPEED

Instructions: Begin walking at your normal pace (for 5'), when I tell you "go", walk as fast as you can (for 5'). When I tell you "slow", walk as slowly as you can (for 5').

☐ **3 Normal:** Able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speeds between normal, fast, and slow speeds.

☐ **2 Mild impairment:** Is able to change speed but demonstrates mild gait deviations, or no gait deviations but unable to achieve a significant change in velocity, or uses an assistive device.

☐ **1 Moderate impairment:** Makes only minor adjustments to walking speed, or accomplishes a change in speed with significant gait deviations, or changes speed but loses significant gait deviations, or changes speed but loses balance, but is able to recover and continue walking.

☐ **0 Severe impairment:** Cannot change speeds, or loses balance and has to reach for wall or be caught.

3. GAIT WITH HORIZONTAL HEAD TURNS

Instructions: Begin walking at your normal pace. When I tell you to "look right", keep walking straight, but turn your head to the right. Keep looking to the right until I tell you "look left", then keep walking straight and turn your head to the left. Keep you head to the left until I tell you "look straight", then keep walking straight, but return your head to the center.

☐ **3 Normal:** Performs head turns smoothly with no change in gait.

☐ **2 Mild impairment:** Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.

☐ **1 Moderate impairment:** Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.

☐ **0 Severe impairment:** Performs task with severe disruption of gait, i.e., staggers outside 15" path, loses balance, stops, reaches for wall.

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[i] Shumway-Cook A, Woollacott M. Motor control: Theory and practical applications. Williams & Wilkins, Baltimore, Md., 1995.

4. **GAIT WITH VERTICAL HEAD TURNS**

Instructions: Begin walking at your normal pace. When I tell your to "look up", keep walking straight, but tip your head and look up. Keep looking up until I tell you "look down". Then keep walking straight and turn your head down. Keep looking down until I tell you "look straight", then keep walking straight, but return your head to the center.

- ☐ **3 Normal:** Performs head turn with no change in gait.
- ☐ **2 Mild impairment:** Performs task with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.
- ☐ **1 Moderate impairment:** Performs task with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.
- ☐ **0 Severe impairment:** Performs task with severe disruption of gait, i.e., staggers outside 15" path, loses balance, stops, reaches for wall.

5. **GAIT AND PIVOT TURN**

Instructions: Begin walking at your normal pace. When I tell you "turn and stop", turn as quickly as you can to face the opposite direction and stop.

- ☐ **3 Normal:** Pivot turns safely within 3 seconds and stops quickly with no loss of balance.
- ☐ **2 Mild impairment**: Pivot turns safely in > 3 seconds and stops with no loss of balance.
- ☐ **1 Moderate impairment:** Turns slowly, requires verbal cueing, requires several small steps to catch balance following turn and stop.
- ☐ **0 Severe impairment:** Cannot turn safely, requires assistance to turn and stop.

6. **STEP OVER OBSTACLE**

Instructions: Begin walking at your normal speed. When you come to the shoe box, step over it, not around it, and keep walking.

- ☐ **3 Normal:** Is able to step over box without changing gait speed; no evidence for imbalance.
- ☐ **2 Mild impairment:** Is able to step over box, but must slow down and adjust steps to clear box safely.
- ☐ **1 Moderate impairment:** Is able to step over box but must stop, then step over. May require verbal cueing.
- ☐ **0 Severe impairment:** Cannot perform without assistance.

7. **STEP AROUND OBSTACLE**

Instructions: Begin walking at your normal speed. When you come to the first cone (about 6' away), walk around the right side of it. When you come to the second cone (6' past the first cone), walk around to the left.

- ☐ **3 Normal:** Is able to walk around cones safely without changing speed; no evidence of imbalance.
- ☐ **2 Mild impairment:** Is able to step around both cones, but must slow down and adjust steps to clear cones.
- ☐ **1 Moderate impairment:** Is able to clear cones but must significantly slow, speed to accomplish task, or requires verbal cueing.
- ☐ **0 Severe impairment:** Unable to clear cones, walks into one or both cones, or requires physical assistance.

8. **STEPS**

Instructions: Walk up these stairs as you would at home, i.e., using the rail if necessary. At the top, turn around and walk down.

- ☐ **3 Normal:** Alternating feet, no rail.
- ☐ **2 Mild impairment:** Alternating feet, must use rail.
- ☐ **1 Moderate impairment:** Two feet to a stair; must use rail.
- ☐ **0 Severe impairment:** Cannot do safely.

TOTAL SCORE: /24

<19 = increased fall risk

Appendix 4

The Activities-Specific Balance Confidence Scale (ABC)

NAME:
DATE:

For each of the following, please indicate your level of confidence in doing the activities without losing your balance or becoming unsteady by choosing one of the percentage points on the scale from 0% to 100%. **If you do not currently do the activities in question, try and imagine how confident you would be if you had to do these activities. If you normally use a walking aid to do the activities or hold onto someone, rate your confidence as if you were using these supports.** If you have questions about answering any of these things, please ask the administrator.

	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
No Confidence											**Completely Confident**

How confident are you that you will not lose your balance or become unsteady when you.....

1. Walk around the house? _____%
2. Walk up or down stairs?_____%
3. Bend over and pick up a slipper from the front of a closet floor?_____%
4. Reach for a small can off a shelf at eye level?_____%
5. Stand on your tiptoes and reach for something above your head?_____%
6. Sweep the floor?_____%
7. Walk outside of the house to a parked car in the driveway?_____%
8. Stand on a chair and reach for something?_____%
9. Get in or out of a car?_____%
10. Walk across the parking lot to the mall?_____%
11. Walk up or down a ramp?_____%
12. Walk in a crowded mall where people rapidly walk past you?_____%
13. Are bumped into by people as you walk through the mall?_____%
14. Step onto or off an escalator while you are holding onto a rail?_____%
15. Step onto or off an escalator while holding onto parcels such that you cannot hold onto the railing?_____%
16. Walk out side on a wet or slippery sidewalk?_____%

_____**Score**

Powell, L. E. & Myers, A. M. (1995). The activities-specific balance confidence scale. **The Journal of Gerontological Medical Science.**

Appendix 5

Dizziness Handicap Inventory

Name: _____ DOB: _____ Date: _____

Instructions: The purpose of this scale is to identify difficulties that you may be experiencing because of your dizziness or unsteadiness. Please answer "yes", "no" or "sometimes" to each question.
Answer each question as it applies to your dizziness or unsteadiness only.

ITEM	QUESTION		Y	N	S
1	Does looking up increase your problem?	P			
2	Because of your problem, do you feel frustrated?	E			
3	Because of your problem, do you restrict your travel for business or recreation?	F			
4	Does walking down the aisle of a supermarket increase your problem?	P			
5	Because of your problem, do you have difficulty getting into or out of bed?	F			
6	Does your problem significantly restrict your participation in social activities such as going out to dinner, the movies, dancing or to parties?	F			
7	Because of your problem, do you have difficulty reading?	F			
8	Does performing more ambitious activities such as sports or dancing or household chores such as sweeping or putting dishes away increase your problem?	P			
9	Because of your problem, are your afraid to leave your home without having someone accompany you?	E			
10	Because of your problem, are you embarrassed in front of others?	E			
11	Do quick movements of your head increase your problem?	P			
12	Because of your problem, do you avoid heights?	F			
13	Does turning over in bed increase your problem?	P			
14	Because of your problem, is it difficult for you to do strenuous housework or yard work?	F			
15	Because of your problem, are you afraid people may think you are intoxicated?	E			
16	Because of your problem, is it difficult for you to walk by yourself?	F			
17	Does walking down a sidewalk increase your problem?	P			
18	Because of your problem, is it difficult for you to concentrate?	E			
19	Because of your problem, is it difficult for you to walk around the house in the dark?	F			
20	Because of your problem, are you afraid to stay at home alone?	E			
21	Because of your problem, do you feel handicapped?	E			
22	Has your problem placed stress on your relationship with members of your family or friends?	E			
23	Because of your problem, are you depressed?	E			
24	Does your problem interfere with your job or household responsibilities?	F			
25	Does bending over increase your problem?	P			
			X 4	X 0	X 2
		=			
		TOTAL			

P _____ E _____ F _____

☐ 100-70= severe perception of having a handicap, ☐ 69-40= moderate perception of handicap, ☐ 39-0= low perception of handicap

Appendix 6

Vestibular Disorders Activities of Daily Living Scale

IDNO_____ Date_____

Instructions

This scale evaluates the effects of vertigo and balance disorders on independence in routine activities of daily living. Please rate your performance on each item. If your performance varies due to intermittent dizziness or balance problems please use the greatest level of disability. For each task indicate the level which most accurately describes how you perform the task. If you never do a particular task, please check the box in the column NA. The rating scales are exlained on bottom of page.

Independence Rating

Task	1 Independent	2 Uncomfortable, no change in ability	3 Decreased ability, no change in manner of performance	4 Slower, cautious, more careful	5 Prefer using an object for help	6 Must use an object for help	7 Must use special equipment	8 Need physical assistance	9 Dependent	10 Too difficult, no longer perform	NA
F-1 Sitting up from lying down											
F-2 Standing up from sitting on the bed or chair											
F-3 Dressing the upper body (e.g., shirt, brassiere, undershirt)											
F-4 Dressing the lower body (e.g., pants, skirt, underpants)											
F-5 Putting on socks/stockings											
F-6 Putting on shoes											
F-7 Moving in/out of the bathtub or shower											
F-8 Bathing yourself in the bathtub or shower											
F-9 Reaching overhead (e.g., to a cupboard or shelf)											
F-10 Reaching down (e.g., to the floor or a shelf)											
F-11 Meal preparation											
F-12 Intimate activity (e.g., foreplay, sexual activity)											
A-13 Walking on level surfaces											
A-14 Walking on uneven surfaces											
A-15 Going up steps											
A-16 Going down steps											
A-17 Walking in narrow spaces (e.g., corridor, grocery store aisle)											
A-18 Walking in open spaces											
A-19 Walking in crowds											
A-20 Using an elevator											
A-21 Using an escalator											
I-22 Driving a car											
I-23 Carrying things while walking (e.g., package, garbage bag)											
I-24 Light household chores (e.g., dusting, putting items away)											
I-25 Heavy household chores (e.g., vacuuming, moving furniture)											
I-26 Active recreation (e.g., sports, gardening)											
I-27 Occupational role (e.g., job, child care, homemaking, student)											
I-28 Traveling around the community (car, bus)											

Explanation of Independence Rating Scale

This scale will help us to determine how inner ear problems affect your ability to perform each task. Please indicate your current performance on each task, as compared to your performance before developing an inner ear problem, by checking the one of the columns in the center of the page. Pick the answer that most accurately describes how you perform the task.

1. Am **not disabled**, perceive no change in performance from before developing an inner ear impairment
2. Am **uncomfortable** performing the activity but **perceive no difference** in the quality of my performance
3. **Perceive a decrement** in the quality of my performance, **but have not changed** the manner of my performance
4. **Have changed** the manner of my performance, e.g., I do things more slowly or carefully than before, or I do things without bending
5. **Prefer using an ordinary object** in the environment for assistance (e.g., stair railing) but I am not dependent on the object or device to do the activity
6. **Must use** an ordinary object in the environment for assistance, but I have not acquired a device specifically designed for the particular activity
7. Must use **adaptive equipment** designed for the particular activity (e.g., grab bars, cane, reachers, bus with lift, reachers, wedge pillow)
8. Require another person for **physical assistance** or, for an activity involving two people, I need unusual physical assistance
9. Am **dependent** on another person to perform the activity
10. **No longer perform** the activity due to vertigo or a balance problem

NA **Not an activity** that I usually perform or **I prefer not to answer** this question

Cohen HS, Kimball KT (2000). *Development of the vestibular disorders activities of daily living scale.* Arch Otolaryngol Head Neck Surg. 126:881-887.

Appendix 7

Fear of Falling Avoidance-Behavior Questionnaire (FFABQ)

NAME:
DATE:

Please answer the following questions that are related to your balance. For each statement, please check one box to say how the **fear of falling** has or has not affected you. If you do not currently do the activities in question, try and imagine how your **fear of falling** would affect your participation in these activities. If you normally use a walking aid to do these activities or hold onto someone, rate how your **fear of falling** would affect you as if you were not using these supports. If you have questions about answering any of these statements, please ask the questionnaire administrator.

*Please check **one box** for each question*

Due to my fear of falling, I avoid…	*Completely disagree*	*Disagree*	*Unsure*	*Agree*	*Completely agree*
1. ***Walking***	☐	☐	☐	☐	☐
2. ***Lifting and carrying objects*** *(e.g., cup, child)*	☐	☐	☐	☐	☐
3. ***Going up and downstairs***	☐	☐	☐	☐	☐
4. ***Walking on different surfaces*** *(e.g., grass, uneven ground)*	☐	☐	☐	☐	☐
5. ***Walking in crowded places***	☐	☐	☐	☐	☐
6. ***Walking in dimly lit, unfamiliar places***	☐	☐	☐	☐	☐
7. ***Leaving home***	☐	☐	☐	☐	☐
8. ***Getting in and out of a chair***	☐	☐	☐	☐	☐
9. ***Showering and/or bathing***	☐	☐	☐	☐	☐
10. ***Exercise***	☐	☐	☐	☐	☐
11. ***Preparing meals*** *(e.g., planning, cooking, serving)*	☐	☐	☐	☐	☐
12. ***Doing housework*** *(e.g., cleaning, washing clothes)*	☐	☐	☐	☐	☐
13. ***Work and/or volunteer work***	☐	☐	☐	☐	☐
14. ***Recreational and leisure activities*** *(e.g., play, sports, arts and culture, crafts, hobbies, socializing, travelling)*	☐	☐	☐	☐	☐

Please make sure you have checked one box for each question. Thank you!

TOTAL:

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- Specializing in team oriented Brain Injury
- Vestibular Therapy
- Various Neurologic Diagnosis
- Breast Cancer and Various Cancer Rehabilitation
- Lymphedema Rehabilitation
- Amputee Rehabilitation
- Osteoporotic Rehabilitation

Professional Service
- Board of Directors of PIMA Physical Therapy Assistant Program (2005-2007)
- Coordinator of Cancer Survivorship Exercise Class (2011- present)
- Team Survivors Cancer Group (2005-2007)
- Clinical Instructor of Physical Therapy Students (2004-present)

Continuing Education
- Breast cancer rehabilitation-Klose Training
- Lymphedema certification-Klose Training
- Examination & intervention of dizziness. The vestibular system and orthopedics-Paul Vidal, DPT,MHS, OCS, FAAOMPT
- Bioness training for foot drop system-Bioness
- Brain Injury Conference-Vail Colorado
- Comprehensive cervical, thoracic, lumbar and sacral re-stabilization- AOM-US
- Osteoporosis- A comprehensive treatment strategy- Level 1-Sara Meeks PT, MS, GCS, KYT

- Multiple facets of gait training: intensive intervention for treatment of neurological conditions-Kay Wing PT, DPT, NCS, GCS
- Symposium on running injuries- Boulder Community Hospital
- Muscle Activation Techniques for trunk and spine- Greg Roskopf
- Diagnosis and treatment of movement impairment syndrome- level 1- Shirley Sahrmann PT, PhD, FAPTA
- Exercise as an adjunct to manual medicine- Mark Bookhout PT, MSPT