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# Dizzy and Balanced: Vestibular Rehabilitation on Post-Concussion Symptoms

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# DIZZY AND UNBALANCED: VESTIBULAR REHABILITATION ON POST-CONCUSSION SYMPTOMS

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Class of 2018



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# Table of Contents

## Dizzy and Unbalanced: Vestibular Rehabilitation on Post-Concussion Symptoms

*Abstract*

<i>1. Background and Purpose.....</i>	<i>4</i>
<i>2. Case Description.....</i>	<i>9</i>
<i>3. Evidence-Based Analyses.....</i>	<i>11</i>
<i>4. Discussion.....</i>	<i>26</i>
<i>5. Reference List.....</i>	<i>31</i>
<i>6. Reference Table.....</i>	<i>33</i>
<i>Appendix A: Evidence Appraisal Worksheet.....</i>	<i>37</i>
<i>Appendix B: PEDRO Scoring.....</i>	<i>72</i>
<i>Appendix C: Oxford Level of Evidence.....</i>	<i>76</i>

## **ABSTRACT**

**Background/Purpose:** The purpose of this in-depth literature analysis is to see if in patients with post-concussion symptoms, vestibular rehabilitation therapy (VRT) can improve balance and dizziness. A concussion is also known as a mild traumatic brain injury (mTBI) and will be used interchangeably.

**Case Description:** This analysis is centered around a young, athletic male whom reported to an outpatient orthopedic clinic with persistent balance problems and dizziness following a head trauma during a football game with friends.

**Outcomes:** Though there is little high-level evidence, current studies show that VRT can improve patient outcomes in regards to balance issues and dizziness. There is no set recommendation for either the evaluation or the treatment of a mTBI.

**Discussion:** While VRT needs to be tailored for each individual, the lack of recommendations makes it difficult to do a thorough evaluation of an individual with a mTBI. Most therapists do not have vestibular specializations and/or in-depth training on concussion evaluation and treatment. Without anything set in place, inexperienced therapists may miss an impairment of the patient that could lead to prolongation of symptoms, or miss a pertinent referral to another provider.

## SECTION 1: BACKGROUND AND PURPOSE

During clinic, an athletic male in his mid-twenties presented with persistent dizziness and balance issues at an outpatient orthopedic clinic. He had hit his head on the ground when he got tackled playing football with his friends. Directly afterward the patient reported he had a headache, but nothing he considered out of the ordinary. Within a couple days he was having mild, but persistent dizziness and some issues with balance. After seeing his provider, he was told he might have a mild concussion. His provider recommended that he should rest for a while and his symptoms should improve. When his symptoms did not improve after a couple weeks, he was referred to physical therapy.

According to the Brain Injury Association of America (BIAA) (2015), the Centers for Disease Control's (CDC) Report to Congress on Mild Traumatic Brain Injury (mTBI) in the United States, also known as a concussion, is an injury to the head resulting from blunt trauma, or acceleration or deceleration forces with one or more of the following:

"1) Any period of observed or self-reported transient confusion, disorientation, or impaired consciousness; 2) any period of observed or self-reported dysfunction of memory (amnesia) around the time of injury; 3) observed signs of other neurological or neuropsychological dysfunction" (including seizures, irritability, lethargy, vomiting, headache, dizziness, fatigue, poor concentration; "4) any period of observed or self-reported loss of consciousness lasting 30 minutes or less."

Authors Gardner and Yaffe (2015) report that there's an estimated 42 million people worldwide suffering from a mTBI. The University of Pittsburgh's Brain Trauma Research Center states that about 300,000 sports-related concussion occur in the U.S. per year (American Association of

Neurological Surgeons (AANS), 2017). With these numbers increasing, mTBI is recognized by the American Physical Therapy Association (APTA) (2017) to be a serious public health problem.

Aligene and Lin (2013) found that evidence suggests that balance issues and other post-concussive symptoms usually resolve by 10 days without physical therapy intervention. However, in people that have persistent post-concussive symptoms certain physical therapy techniques can help address these symptoms. The current accepted management of concussion is rest. For sports-related concussion the management is rest, then graded physical exertion without exacerbation of symptoms, non-contact reintroduction to the sport, and finally return to sport with his/her provider's permission. There's no set time for each of these steps to allow for each person to recover at his/her own pace (AANS, 2017).

Presently there is no set standard or protocol that calls for physical therapy for patients after a concussion with or without persistent post-concussive symptoms. As stated above, rest is recommended for all concussions, with the addition of graded physical exertion for sports-related concussions. According to Move Forward (2017), a physical therapist's role is to prescribe rest and the most appropriate recovery program, restore strength and endurance, stop dizziness and improve balance, reduce headaches, and help return the patient to normal activity or sport. In addition, the APTA (2017) states, "physical therapists provide a unique contribution to the concussion care management team, particularly in the areas of balance and vestibular evaluation and rehabilitation."

The physical therapist is able to identify a mTBI through a series of tests and measures including a physical examination, functional testing, and self-reported symptoms. Hoffer, Schubert, and Balaban (2015) stated:

“Patients with acute mTBI can be identified with greater than 90% selectivity and sensitivity with a test battery that includes saccade testing (saccades, antisaccades, and saccadic reaction times), smooth pursuit performance, vestibular performance (harmonic rotation, visual enhancement/suppression of the horizontal, and head impulse testing), optokinetic testing, as well as self-reports of posttraumatic migraine-like symptoms.”

This same study also found that balance issues post a mTBI are unique due to their high level of occurrence. Along with dizziness, these balance issues are most often treated with vestibular rehabilitation therapy (VRT).

VRT originated in the 1940s when Cooksey and Cawthorne used it to treat patients with dizziness and balance dysfunction. Since then it has expanded to meet individual patient’s needs using several treatments (Murray, Meldrum, & Lennon, 2017). These treatments include, but are not limited to: gaze stabilization/eye-head coordination exercises, standing balance, walking/ambulation with a balance challenge, canalith repositioning maneuvers, habituation exercises, substitution exercises, and aerobic exercise (Alsalaheen, et al., 2010; Murray, et al., 2017). Alsalaheen et al. (2013), found that the three most common treatment types prescribed were eye-head coordination exercises, standing static balance, and ambulatory exercises.

Alsalaheen, et al. (2010), found that following a VRT program, both adults and children had statistically significant improvements in all self-reported measures, gait speed and function, the Timed Up and Go (TUG), posture, balance, and dizziness. This retrospective study suggests that VRT can improve both dizziness and balance. Schneider, et al. (2014), determined that a

combination of VRT with cervicospinal therapy decreased the return to sport-or-work time by 3.91 times versus the control group. Though not solely VRT, this study also shows an improvement in outcomes for patients that received physical therapy for post-concussive symptoms.

Gurley, Hujsak, and Kelly (2013), reviewed the different tests and treatments you can use to address these post-concussive symptoms. The review indicated that VRT was helpful to help return the patient to his/her prior level of function, but it was important to do a thorough evaluation to determine what the exact cause is of the symptomology. Cause dictates the treatment, and treatment is only effective when tailored to the individual. Once the proper treatment is selected, it's important to only progress the patient when she/he is asymptomatic at the current level. By picking the correct treatment and progressing it appropriately, Gurley, et al. (2013), found that VRT can decrease dizziness and improve static and dynamic balance.

Currently there is very little high-level evidence for the use of VRT in mTBI, but the little that exists shows that VRT can lead to improved outcomes (Murray et al., 2017). The purpose of this capstone is to provide an in-depth review of the current available literature as related to the improvement of balance issues and dizziness post-concussion. The following case description provides the background and circumstances that lead to the selection of this review. It's also an example of how more high-level clinical research can improve patient care and promote the profession of physical therapy in mTBI management.

## SECTION 2: CASE DESCRIPTION

This review arose from an encounter with a 27-year-old male that had been diagnosed with a concussion two and a half weeks prior and had residual post-concussive symptoms of dizziness and balance. His provider had told him to rest and when that didn't resolve his symptoms after a couple of weeks, he was referred to physical therapy. As stated previously, a mTBI is caused by a blow to the head and can result in several symptoms. Directly after his concussion, he reported that he had a headache and then a couple days later developed dizziness and balance issues.

Vestibular function plays several roles in relation to head stabilization, maintaining the center of balance, sensing and perceiving motion, and maintaining a vertical orientation (Valovich-McLeod & Hale, 2014). This patient was having issues maintaining his center of balance, perceiving motion properly, and maintaining a vertical orientation.

Upon observation of the patient, no asymmetry was noted between the eyes, no discoloration at the site of impact, and gait was consistent, though slightly unsteady. Through the clinical test Dix-Hallpike, it was found that the patient did not have the results consistent with benign paroxysmal positional vertigo (BPPV). Next, cranial nerve testing was done to rule out cranial nerve damage or a more severe brain injury. He was negative for damage to the optic, oculomotor, trochlear, abducens, and vestibulocochlear nerves as related to his symptoms. Smooth pursuits, convergence, and visual acuity were intact though the patient reported they were more difficult than before his mTBI. Saccades (quick eye movements) increased his dizziness. The balance testing done included the Romberg. The test was done on a flat surface, feet in semi-tandem, with eyes open and closed. He had increased sway, but was

able to maintain his balance with eyes open, but as soon as he shut his eyes he lost balance and overcompensated with a huge step and threw his arms out laterally to grab the wall and the evaluating therapist. This was the extent of the testing done in the initial evaluation.

The setting was at a primarily orthopedic outpatient therapy clinic. The therapist evaluating him had had a short course on vestibular physical therapy in school, but did not have any specific certifications or experience with patients that had vestibular issues or mTBIs. Prior to the appointment the therapist looked up mTBI on the APTA website and found that there were only vague recommendations for both evaluation and interventions. This is what ultimately lead to the clinical question: *In patients with post-concussion symptoms, does vestibular rehabilitation training improve balance and dizziness?*

## SECTION 3: EVIDENCE-BASED ANALYSIS

### Search Methodology:

Three research databases were included in this article review including: Pubmed, PEDro, and World Cat. A plethora of related keywords/search terms were used to answer the PICO question: In patients with post-concussion symptoms, does vestibular rehabilitation training improve balance and dizziness? Terms included in the literature search were “vestibular,” “exercises,” “rehab,” “rehabilitation,” “training,” “after,” “post,” “concussion,” and “balance.” Refer to Table 1 for details regarding search terms, results, and article inclusion/exclusion.

<b>Table 1: Systematic Literature Selection Process</b>			
Search Terms	Number of Articles	Fit Criteria	Included/Excluded
<b>PUBMED</b>	<b>44</b>	<b>3</b>	<b>2</b>
Vestibular rehabilitation concussion	44	3	Included: 2 (Alsalaheen 2010), (Gurley 2013) Excluded: 1 (repeat study)
<b>WORLD CAT</b>	<b>67</b>	<b>7</b>	<b>5</b>
Vestibular exercises after a concussion	10	3	Included: 2 (Alsalaheen 2013), (Murray 2017) Excluded: 1 (population didn't match)
Vestibular rehab for balance after concussion	12	1	Included: 1 (Valovich-McLeod 2015) Excluded: 0
Vestibular rehab post-concussion	23	2	Included: 1 (Hoffer 2015) Excluded: 1 (didn't match PICO)
Vestibular training and concussion	22	1	Included: 1 (Aligene 2013) Excluded: 0
<b>PEDRO</b>	<b>2</b>	<b>1</b>	<b>1</b>
Vestibular concussion	2	1	Included: 1 (Schneider 2014) Excluded: 0
<b>Total Articles Selected for Analysis</b>			<b>8</b>

**Articles selected for further analyses: 8 (for relevance to PICO)**

Aligene, K. & Lin, E. (2013). Vestibular and Balance Treatment of the Concussed Athlete. *NeuroRehabilitation*, 32(3), 543-553. doi: 10.3233/NRE-130876.

Alsalaheen, B.A, Mucha, A., Morris, L.O., Whitney, S.L., Furman, J.M., Camiolo-Reddy, C.E., Collins, M.W., Lovell, M.R., & Sparto, P.J. (2010). Vestibular Rehabilitation for Dizziness and Balance Disorders After Concussion. *Journal of Neurological Physical Therapy*, 34(2), 87-93. doi: 10.1097/NPT.0b013e3181dde568

Alsalaheen, B.A., Whitney, S.L., Mucha, A., Morris, L.O., Furman, J.M., & Sparto, P.J. (2013). Exercise Prescription Patterns in Patients Treated with Vestibular Rehabilitation After Concussion. *Physiotherapy Research International*, 18(2), 100-108. doi: 10.1002/pri.1532

Gurley, J.M., Hujsak, B.D., & Kelly, J.L. (2013). Vestibular Rehabilitation Following Mild Traumatic Brain Injury. *NeuroRehabilitation*, 32(3), 519-528. doi: 10.3233/NRE-130874

Hoffer, M.E., Schubert, M.C., & Balaban, C.D. (2015). Early Diagnosis and Treatment of Traumatic Vestibulopathy and Post-Concussive Dizziness. *Neurologic clinics*, 33(3), 661-668. doi: 10.1016/j.ncl.2015.04.004

Murray, D.A., Meldrum, D., & Lennon, O. (2017). Can Vestibular Rehab Exercises Help Patients with Concussion? A Systematic Review of Efficacy, Prescription, and Progression Patterns. *British Journal of Sports Medicine*, 51(5), 442-451. doi: 10.1136/bjsports-2016-096081

Schneider, K.J., Meeuwisse, W.H., Nettel-Aguirre, A., Barlow, K., Boyd, L., Kang, J., & Emergey, C.A. (2014). Cervicovestibular Rehabilitation in Sport-Related Concussion: A Randomised Controlled Trial. *British Journal of Sports Medicine*, 48(17), 1294-1298. doi: 10.1136/bjsports-2013-093267

Valovich-McLeod, T.C. & Hale, T.D. (2015). Vestibular and Balance Issues Following Sport-Related Concussion. *Brain Injury*, 29(2), 175-184. doi: 10.3109/02699052.2014.965206.

(For article analyses tables, refer to Appendix A)

**Summaries of In-depth Article Analyses:**

(Refer to Appendix C for Oxford Level of Evidence Scoring)

**REFERENCE #1**

Aligene, K. & Lin, E. (2013). Vestibular and Balance Treatment of the Concussed Athlete. *NeuroRehabilitation*, 32(3), 543-553. doi: 10.3233/NRE-130876.

**Level of Evidence**

Based upon the Oxford Level of Evidence, this research paper is rated at 2b. Meaning that this article, under Economic and Decision Analysis section, is included in the follow criteria: Analysis based on clinically sensible costs or alternatives; limited review(s) of the evidence, or single studies; and including multi-way sensitivity analyses.

**Purpose**

This article states that due to the lack of discrete time boundaries to make judgment calls following a concussion, the purpose of the article is to offer a guide to help with the decisions necessary for treatment of the post-concussive athlete. The term athlete being a very vague term including anyone obtaining a concussion while doing an athletic activity. Most concussions resolve on their own within 10 days, however, proper management is necessary and can help prevent progression of neurological dysfunction and other injury sequelae.

**Methods**

This article used several studies and other research papers to give background information on the vestibular system, how it works, how it impacts function, what a concussion is, how a concussion impacts the vestibular system, what current methods there are for treatment and management.

**Results**

A multidisciplinary approach is needed to make a decision about disqualification and return to play for the athlete. There are currently no clear guidelines, but it is important to address and manage the concussion as not doing so can lead to another, or more serious implications. The article suggests that concussions should be assessed in a stepwise manner, from the initial injury to the absence of symptoms. Currently, in sports, guidelines require that athletes that have had a concussion are asymptomatic at rest and with activity before they can return to sport. In regards to balance and other post-concussive symptoms, about 80% of athletes have spontaneous recovery. If symptoms have delayed recovery, the athlete should be reassessed for possible structural issues. Management protocols are focused on each individual and his/her unique factors (such as comorbidities, pre-existing mental issues and conditions). Medication hasn't been thoroughly researched in aiding healing, but certain medications such as aspirin and medication that alter the mental state should be avoided for the first few weeks under the supervision of a physician.

### **Critique/Bottom Line**

This article was a good resource for understanding and explaining in simple terms the vestibular system and how a person is affected by a concussion. It also gave a summary of treatment techniques and their effectiveness on treating different causes and aspect of post-concussive symptoms. This article, in combination with RCTs, would be a good resource for patient care and evidence for insurance companies.

### **REFERENCE #2**

Alsalaheen, B.A, Mucha, A., Morris, L.O., Whitney, S.L., Furman, J.M., Camiolo-Reddy, C.E., Collins, M.W., Lovell, M.R., & Sparto, P.J. (2010). Vestibular Rehabilitation for Dizziness

and Balance Disorders After Concussion. *Journal of Neurological Physical Therapy*, 34(2), 87-93. doi: 10.1097/NPT.0b013e3181dde568

### **Level of Evidence**

In accordance with the Oxford Level of Evidence, I gave this article a 2b under the prognosis category. It was looking to see if the prognosis of the patient with post-concussive symptoms would improve with physical therapy rehabilitation.

### **Purpose**

The purpose of this retrospective study was to examine how severe the symptoms of dizziness, gait, and balance dysfunction were in people that were referred for vestibular rehabilitation after a concussion. The study also investigated if rehabilitation improved these areas, and if there was a difference between adults and children in the recovery outcomes.

### **Methods**

This was a retrospective study, so the authors did a chart review of 114 patients at the center for rehab services. The patients that came more than once (n=84) when it was indicated, were analyzed on several outcome measures including self-reported measures and gait and balance performance.

### **Results**

All of the measures improved by a statistically significant amount, with children improving more so in the dizziness handicap inventory, the functional gait assessment, and the 5 time sit-to-stand.

### **Critique/Bottom Line**

This study is essentially a set up for further research in the area of vestibular rehabilitation post-concussion. It showed that for patients with lasting symptoms, vestibular rehabilitation can help diminish or eliminate residual issues.

### **REFERENCE #3**

Alsalaheen, B.A., Whitney, S.L., Mucha, A., Morris, L.O., Furman, J.M., & Sparto, P.J. (2013). Exercise Prescription Patterns in Patients Treated with Vestibular Rehabilitation After Concussion. *Physiotherapy Research International*, 18(2), 100-108. doi: 10.1002/pri.1532

### **Level of Evidence**

In accordance with the Oxford Level of Evidence, I gave this article a 2b under the decision analysis category. It explored the framework and type of exercises prescribed for vestibular rehabilitation and how to progress these exercises.

### **Purpose**

The purpose was to describe exercise prescription patterns for vestibular physical therapists for patients post-concussion. Also how to progress these exercises to challenge the patient.

### **Methods**

A team of 8 physical therapists analyzed the charts and HEPs of 114 patients to look for exercise prescription patterns. They looked at five different areas including eye-head coordination, sitting balance, standing static balance, standing dynamic balance, and ambulation. They also looked at which exercises were prescribed in these five areas and how they were progressed.

### **Results**

The top three areas that the therapists addressed were eye-head coordination, standing static balance, and ambulation. The most common exercises in the eye-head coordination area were the Vestibular Ocular Reflex x1 (VORx1), VOR cancellation, convergence, and VORx2. In the standing static balance area, the most frequent were standing upright on level and foam surfaces, single leg stance (SLS), weight shifting (WS) in various directions, and sit-to-stand. The last category included forward ambulation followed by backward ambulation and walking with turns.

Depending on the area the exercise was in, they were progressed accordingly. Ways to progress the exercises include changing the surface, altering the base of support (BOS), changing the position of the patient, add in cognitive tasks, and which balance systems were included (vision, proprioception, vestibular).

### **Critique/Bottom Line**

I will use this article in my practice when I have a patient to make sure I am addressing the patient's impairments and functional limitations. It will be a good guide for which areas to address, what exercises to use, and the different ways you can modify the exercises.

### **REFERENCE #4**

Gurley, J.M., Hujsak, B.D., & Kelly, J.L. (2013). Vestibular Rehabilitation Following Mild Traumatic Brain Injury. *NeuroRehabilitation*, 32(3), 519-528. doi: 10.3233/NRE-130874

### **Level of Evidence**

In accordance with the Oxford Level of Evidence, I gave this article a 2b under the decision analysis category. It reviewed the current accepted methods of treatment, what

factors went into deciding treatment, what structures/impairments were involved, and the prognosis of the impairments based upon treatment.

### **Purpose**

The purpose of this review was to evaluate the accepted current methods used to determine and treat vestibular dysfunction following a concussion. It also looked at the incidence of structures affected, the prognostic indicators for each, and the common barriers to recovery.

### **Methods**

This article gave a thorough background on how balance and dizziness were implicated in a concussion and what structures may be involved. The authors then discussed these impairments and what treatments were appropriate for each. Then prognoses based on impairments were discussed along with the common barriers that are associated with concussion. Also included were comorbidities associated with concussion that can create barriers and make the methods of treatment more difficult to employ.

### **Results**

The authors found that current accepted practices were beneficial in treating dizziness/vertigo and static/dynamic balance issues. However, it is vital to find what structures are involved and how they are creating the impairment. This is key in deciding which treatment to use and improving the patient's prognosis. As post-concussive symptoms are multidimensional, it is important to coordinate with other providers. This is especially true for patients that have comorbidities including headaches and underlying visual and oculomotor dysfunction. Lastly, it's important that we start the patient in a quiet environment and start

with simple exercises. Progression is dependent on the patient and his/her ability to complete the task without exacerbation of symptoms.

### **Critique/Bottom Line**

Though fairly technical in its writing, the article was very informative and addressed many important areas necessary to understand the implications of a concussion. It gave clinically applicable information on what tests to use and what outcome measures are beneficial in discovering the patient's impairments.

### **REFERENCE #5**

Hoffer, M.E., Schubert, M.C., & Balaban, C.D. (2015). Early Diagnosis and Treatment of Traumatic Vestibulopathy and Post-Concussive Dizziness. *Neurologic Clinics*, 33(3), 661-668. doi: 10.1016/j.ncl.2015.04.004

### **Level of Evidence**

In accordance with the Oxford Level of Evidence, I gave this article a 2b under the decision analysis category. It reviewed mild traumatic brain injury (mTBI) prevalence, discussed clinical evidence of balance disorders post-mTBI, and explained current diagnostic tools and treatments.

### **Purpose**

The purpose was to set a definition for what a mTBI entailed, the commonly associated balance issues, and a review on diagnostic and treatment techniques. The prevalence of mTBI has increased and is a common public health issue. However, it's difficult to diagnose due to several definitions and individual differences in presentation. Lack of diagnosis and/or treatment can lead to chronic issues that severely affect both the individual's quality of life and her/his balance function. The authors state that balance disorders present a unique

opportunity in diagnosing mTBI as they are almost universally present, easily documented with qualitative and quantitative tests, and treatment of this impairment can result in marked improvement in symptoms and function.

### **Methods**

The authors used the CDC's definition of a TBI and then defined what was needed to classify the TBI as mild. They then used emergency department (ED) and school reports from other articles to discuss the population affected and common demographic trends. Next, balance disorders were discussed from both blast injuries and blunt head injury. Different ways of diagnosing these mTBI and balances disorders were then discussed. When the impairments were properly selected, different modes of treatment were discussed including rehabilitation and pharmaceuticals.

### **Results**

A mTBI can lead to chronic issues if not diagnosed and treated properly. Vestibular rehabilitation from a physical therapist is the current standard treatment for dizziness and balance issues. Clinical trials regarding the effectiveness of pharmaceutical management is lacking and there needs to be more clinical trials in regard to vestibular rehabilitation.

### **Critique/Bottom Line**

This article was unique as it took the time to separately address the menial nuances that define a concussion and what trends were present. It was also helpful as it pulled in incidence from the CDC and separated concussion types. I thought it was beneficial for my understanding of the different types of concussion and what symptoms can result. It was also beneficial as it

separated out diagnosis and treatment with a very clear demarcation. I also thought the statistical references brought in from other articles were beneficial.

#### **REFERENCE #6**

Murray, D.A., Meldrum, D., & Lennon, O. (2017). Can Vestibular Rehab Exercises Help Patients with Concussion? A Systematic Review of Efficacy, Prescription, and Progression Patterns. *British Journal of Sports Medicine*, 51(5), 442-451. doi: 10.1136/bjsports-2016-096081

#### **Level of Evidence**

In accordance with the Oxford Level of Evidence, this article was assigned 3a- under the Therapy/Prevention/Etiology/Harm descriptor. The minus is due to the lack of homogeneity in the systematic review (SR).

#### **Purpose**

The goal of the systematic review was to evaluate published evidence supporting the use of VRT post-concussion to treat patients, to determine if there are certain patterns in outcome measures used, and the prescription and progressions of exercises used.

#### **Methods**

The authors did a systematic search and review of all literature available using the PRISMA guidelines. They also looked through reference lists from retrieved articles to expand their literature and found grey literature to include as well. Inclusion criteria comprised of there being an article or abstract of original research, patient population has a mTBI w/vestibular symptoms, interventions detailed VRT, and measurement of outcomes pre- and post-VRT. The authors then did a narrative review and a best evidence synthesis (2 articles).

#### **Results**

Ten articles met the inclusion criteria. However, most were low evidence. In the majority of the articles, improvements were seen across all outcome measures. Not all studies used the same outcome measures though, with the most common being balance impairment (9/10 articles). Basically, the evidence supporting VRT was low, though it showed a trend toward a positive outcome. In addition, there was a huge variety between exercise prescription and how the patients were progressed. There was also no concurrence about when to start exercises nor any differentiations based on gender or age.

### **Critique/Bottom Line**

This article was an eye opener on how little high level evidence there is on VRT even though it is the current standard of care for patients post-mTBI. However, the little evidence that exists suggest that when symptoms persist in a patient post-mTBI, VRT is an emerging and effective intervention.

### **REFERENCE #7**

Schneider, K.J., Meeuwisse, W.H., Nettel-Aguirre, A., Barlow, K., Boyd, L., Kang, J., & Emergey, C.A. (2014). Cervicovestibular Rehabilitation in Sport-Related Concussion: A Randomised Controlled Trial. *British Journal of Sports Medicine*, 48(17), 1294-1298. doi: 10.1136/bjsports-2013-093267

### **Level of Evidence**

In accordance to the Oxford Level of Evidence this RCT received a 1b under the therapy, prevention, etiology, and harm category. On the Pedro Scale, this article received 8/10 due to the inability to fully blind the subjects, and the treating therapist knew if they were doing vestibular and cervical rehab.

### **Purpose**

To determine if the joint therapies of the cervical spine and vestibular system helped to improve post-concussive symptoms as compared to a control group. There hasn't been a ton of good literature on treatment of post-concussive symptoms, especially combined therapies.

### **Methods**

Individuals at University of Calgary Sport Medicine Centre w/a diagnosis of sport-related concussion and symptoms greater than 10 days were screened by a physician. If the physician thought they met the criteria, they were sent to a physiotherapist for assessment (including the secondary outcomes). Of all the patients, 31 met the criteria and agreed to participate in the study (though 2 of the control group dropped later). A computer-generated randomization allocated the participants to either the control group or intervention group. Each group was seen once a week for 8 weeks or until they were medically cleared to return to sport by the physician. The vestibular and cervical rehabilitation program were created for each individual, so each HEP was different. The control group participants had a HEP as well.

### **Results**

Clinically and statistically significant improvements in medical clearance, Disability Handicap Inventory (DHI), and the SCAT2 total score.

### **Critique/Bottom Line**

This RCT was set up pretty well, and though the subject population was small and specific, it still showed improvements. Overall, I think it's beneficial to know that this combo therapy helped people beat the symptoms and return to their lives quicker than just rest and graded exertion.

**REFERENCE #8**

Valovich-McLeod, T.C. & Hale, T.D. (2015). Vestibular and Balance Issues Following Sport-Related Concussion. *Brain Injury*, 29(2), 175-184. doi: 10.3109/02699052.2014.965206.

**Level of Evidence**

In accordance with the Oxford Level of Evidence this article is a 2b under the category of Decision Analysis. No PEDro score is indicated as it is not a RCT.

**Purpose**

To review all the current and relevant literature regarding the effect of concussion on vestibular function, the impairments caused by such, assessment used to diagnose, and the strategies used to treat/manage these functional issues and impairments.

**Methods**

Database search on Medline, CINAHL, Sport Discus, and the Cochrane Database of SR through Oct 2013. Subjects include anything related to vestibular impairments following concussion, oculomotor and balance assessments, and treatment or rehab for vestibular impairments. The anatomy and physiology were discussed, and then elaborated on to discuss how each of the impairments caused symptoms. Each symptom's etiology and assessment were described in detail. From there, the proper treatment for each was discussed and evaluated. At the end, a summary of the current recommendations were given with directions to go for future studies.

**Results**

The potential for a concussion to affect vestibular function is quite large. According to the most recent guidelines from the Concussion in Sport Group, gait and balance should be included in a concussion assessment, especially within the first 72h post-concussion and when

symptoms include balance issues or dizziness. Dizziness in the first hours post-concussion may be an important prognostic indicator for the chronicity of post-concussive symptoms. The small pool of literature currently available on using VRT for vestibular and balance issues suggest it may be useful in improving symptoms and improving patient outcomes.

**Critique/Bottom Line**

This was a very in-depth summary and review of what classifies as vestibular dysfunction and the assessments that accompany it. It was a very helpful article for me to understand the anatomy and physiology behind post-concussion vestibular issues. The authors also gave a simple and short summary of what recommendations they had and what areas need to be more thoroughly addressed in future studies.

## SECTION 4: DISCUSSION

The purpose of this review was to answer: *In patients with post-concussion symptoms, does vestibular rehabilitation training improve balance and dizziness?* As is often the case on topics with little high-level evidence, there cannot be a definitive answer in either direction. There is still a lot to learn about mTBI in general, much less how they affect each individual and which intervention is best. Therefore, the simple answer is that while the evidence supporting VRT for post-concussion dizziness and balance is small, there have not been any negative side effects from doing VRT. The intervention does not cause harm and may be helpful to decrease patient symptomology and improve outcomes, so it comes down to clinical judgment and whether or not it is determined that this intervention will help achieve the goals of the patient and therapist. All of the eight articles selected agree that VRT is a promising therapy, but needs more high-level trials done. This is a new area of study and that database of knowledge will improve with more well-designed clinical trials.

The two clinical trials by Alsaheen, et al. (2010) and Schneider, et al. (2014) suggest that both dizziness and balance are common symptoms addressed by VRT. Alsaheen, et al. (2010), found that both symptoms had a statistically significant improvement, while Schneider, et al. (2014), only found that dizziness was significantly improved. The other six articles were reviews of the available literature at the time. Aligene and Lin (2013); Gurley, et al. (2013); Hoffer, et al. (2015); Murray, et al. (2017); and Valovich-McLeod and Hale (2015) found that VRT was shown to be effective in treating balance and dizziness.

Aligene and Lin (2013); Alsaheen, et al. (2013); and Gurley, et al. (2013) note that the current standard of practice for VRT is a problem-oriented and individualized program. The

patient also shouldn't be progressed in the program unless they are asymptomatic at that level and the new level doesn't greatly exacerbate symptoms. Aligene and Lin (2013), emphasize the need for a multi-professional approach to provide the best patient care and that only certain providers are allowed to release someone to return to sport or work.

Several evaluation tools are used to diagnose both the symptoms and symptom severity of a mTBI. As noted by Hoffer, et al. (2015), balance is one of the most common symptoms. Tests for balance include the Activities-specific Balance Confidence Scale (ABCs), Functional Gait Assessment (FGA), Balance Error Scoring System (BESS), Clinical Test of Sensory Interaction and Balance (CTSIB), Timed Up and Go (TUG), Five time sit to stand (FTSTS), Romberg, and other testing.

Balance issues and dizziness can be caused by impairments in the vestibular system, and assessing the vestibular system was discussed in-depth by Valovich-McLeod and Hale (2015). Common tests include the vestibular-ocular reflex (VOR), saccades, cranial nerve testing, smooth pursuit, convergence, dynamic visual acuity, sensory organization test (SOT), the dizziness handicap inventory (DHI), and the vestibular disorders of activities of daily living (VDADL).

Alsalaheen, et al. (2010); Hoffer, et al. (2015); Schneider, et al. (2014); and Valovich-McLeod and Hale (2015) all discussed using computer generated versions of the SCAT2, ImPACT testing, and/or dynamic computerized posturography to help determine symptoms and symptom severity.

All the articles discussed different treatment techniques and interventions. This is something that most articles agreed on needs to be addressed in future studies. The overall

treatment technique is VRT, but each VRT program consisted of something different. The two research studies analyzed, Alsalaheen, et al. (2010) and Schneider, et al. (2014), had VRT as the primary treatment. However, in Schneider, et al. (2014), the VRT was not differentiated from the cervical therapy in the outcomes, so separating the outcomes based on which therapy is not possible. Either way, both studies showed a positive outcome from their chosen treatment techniques.

According to review on exercises prescription patterns by Alsalaheen, et al. (2013), the most commonly prescribed exercise types are eye-head coordination exercises, standing static balance, and ambulatory exercises that are then modified to progress the patient. As mentioned earlier, it is important to treat each individual based on his/her specific impairments (Gurley, et al., 2013).

Not addressed in this review, but also pertinent is the cervical involvement that can be present and influence post-concussive dizziness and balance. Schneider, et al. (2014), found that a combination of cervicospinal therapy with VRT can improve patient outcomes.

This leads to the clinical bottom line, that while VRT does not yet have a large base of high-evidence support data, it has been shown to aid in a patient's recovery when it comes to balance and dizziness post-concussion. No harmful effects have been reported in any of the studies or the reviews.

### **Conclusion/Bottom Line:**

The purpose of this above discussion regarding the use of VRT for balance and dizziness problems post-concussion was inspired by this male patient at an outpatient orthopedics

clinical setting. A brief review of the evaluation details a young athletic male reporting persistent dizziness and balance issues following a fall during football with his friends where he hit his head. Common symptoms of a concussion include dizziness, balance issues, headache, memory-issues, and nausea/vomiting. While the patient only reported a headache after the incident, a couple of days later he developed dizziness and balance issues. Upon seeing his provider, he was told to rest, and when that did not relieve his symptoms, he was referred to physical therapy. As noted by the AANS (2017), current management include daily monitoring while the patient rests and then is introduced to graded physical exertion. Physical therapy is not in the current standard of treatment, but when a patient is referred to physical therapy, VRT is the selected method of treatment (Murray, et al. (2017).

VRT is not a large part of most physical therapy school programs, and the therapist that was evaluating this patient was not a certified vestibular specialist, nor were there any available at the clinic. The research published for standard of treatment by the APTA is rather general, giving the directive to prescribe rest, an appropriate recovery program, restore strength and endurance, reduce symptoms, and get the patient back to work/school/activities (Move Forward, 2017). With little research and no set protocols for evaluation or treatment, the therapist had to figure out the best way to evaluate and treat this patient.

The problem with not having guidelines for evaluation and treatment is that each physical therapist will approach it in a different way. While this is not inherently bad, this may lead to impairments being missed in the patient that comes in with post-concussive symptomology and possibly an important referral to another provider. This is especially true as there are few physical therapists that have a vestibular specialization and the presence of this

information in a physical therapist's education is small. In addition, mTBIs are becoming more common and it is very likely that physical therapist without much exposure to persistent symptoms post-concussion will see this patient. While the physical therapist did his/her best to utilize the information at hand, there was very little of it, and this could have lead to the patient not receiving optimal care. This situation shows the need to have recommendations for evaluation and treatment of patients that come in with persistent symptoms following a concussion.

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## REFERENCE TABLE: IN-DEPTH ARTICLE ANALYSIS

Table 4. Part I Results / Article Summaries

	Study & Origin	Oxford Level of Evidence	Purpose of Study	Outcome Measures	Results	Accept Results to Answer Clinical Question
<b>1</b>	Aligene, K. & Lin, E. (2013) USA	2b Decision Analysis	Discuss current clinical management of vestibular and balance dysfunction in an athlete due to a concussion including diagnosis, initial eval, and management.	None original to the study as it was a discussion.	The current evidence suggests that balance issues and other post-concussive symptoms usually resolve by 10 days without much intervention. However, in people with longer lasting symptoms, there are certain techniques such as habituation, adaptation, substitution, balance exercises, and aerobic exercises that can help address symptoms. There's no set time for an individual to return to sport, but there is a 6 step program that uses time and activity w/o exacerbation of symptoms to help decide return to sport. The athlete must be looked at by certain medical professionals in order to return.	Yes
<b>2</b>	Alsalaheen, B.A., et al. (2010) USA	2b Prognosis	Examine the severity of dizziness symptoms, gait dysfunction, and balance issues of people that were referred for vestibular rehab post concussion.	-self reported dizziness, activity-specific balance confidence scale, dizziness handicap inventory -dynamic gait index, gait speed, sensory organization test, functional gait assessment, TUG, 5 times sit to stand -dynamic computerized posturography	-All outcome measures were analyzed with the level of significance of alpha=0.05 -Improvement in all areas for both children and adults -Children had a significantly improved 5 times sit to stand over adults. -Of the outcomes there was a significant interaction between treatment and age for dizziness severity. -Adult group had no significant difference in dizziness severity from pre to post treatment	Yes

					-For patients who received vestibular rehabilitation therapy, there was a significant improvement for all self-report and performance measures.	
<b>3</b>	Alsalaheen, B.A., et al. (2013) USA	2b Decision Analysis	To describe exercise prescription patterns in patients treated with vestibular rehabilitation exercises	None as this was a review of exercise prescriptions.	It's currently standard practice for the PT to use a problem-oriented approach focus on impairments and functional limitations. Then prescribe customized exercises to address these specific issues while accounting for the pathology and other comorbidities. The top three most commonly prescribed exercise types are eye-head coordination exercises, standing static balance, and ambulatory exercises. Each of these can be modified to progress the patient.	Yes
<b>4</b>	Gurley, J.M., et al. (2013) USA	2b Decision Analysis	To review the current and accepted methods available to quantify and treat vestibular issues following a concussion.	Subjective outcome measures discussed included: dizziness handicap inventory, activities-specific balance confidence scale, post-concussion symptom scale, visual vertigo scale	There are different tests and treatments you can use to address the causes of post-concussion dizziness and balance issues. It's important to differentiate what is the exact cause so you can choose the proper treatment. Treatment is progressed when the patient is asymptomatic at the current level. Overall, vestibular rehab can decrease dizziness/vertigo and improve static/dynamic balance if it is tailored to the specific individual's impairments.	Yes
<b>5</b>	Hoffer, M.E., et al. (2015) USA	2b Decision Analysis	To review prevalence of mTBI, discuss clinical evidence indicative of balance disorders, examine the recent dx trends, discuss the	None were used as it was a review, but tests discussed were: Videonystagmography, optokinetic and vestibular reflexes, saccade testing, vestibular performance, smooth	Balance issues post a mTBI are unique due to their high level of occurrence. Though often under-recognized, mTBI is a common public health issue that can lead to chronic issues if not diagnosed and treated properly. Vestibular rehabilitation from a physical therapist is the current standard treatment	Yes

			neurosensory disorders, and give a brief overview of vestibular rehab for mTBI.	pursuit performance, self-reported measures, SCAT-2, ImPACT test, King-Devick test	for treating dizziness and balance issues. Clinical trials regarding the effectiveness of pharmaceutical management is lacking and there needs to be more clinical trials in regard to vestibular rehabilitation.	
<b>6</b>	Murray, D.A., et al. (2017) Ireland	3a- Therapy Prevention Etiology Harm	Evaluate published evidence supporting the use of VRT in mTBI and to determine if specific outcome measures, prescription/prog patterns could be identified.	Systematic Review with these outcome measures included: Self-reported symptoms, ABC scale, DHI, TUG, FTSTS, SOT, FGA, ImPACT, BESS, ROM, RIM, Romberg, Dix-Hallpike, VOR testing, MCT, GST, DVA, TA, TF, GST, return to work, HiMAT, HADS, QOLIBRI, 4 square step test, time to medical clearance	Very few articles met the inclusion criteria and all but two were low evidence. Basically, they found there's very little evidence of the use of VRT in mTBI, but what little evidence there is concludes it can lead to improved outcomes and there's no known risk involved. The authors also found that there is a clear lack of consistency in the outcome measures, treatments, and how to progress a patient.	Yes
<b>7</b>	Schneider, K.J., et al. (2014) Canada	1b Therapy Prevention Etiology Harm	To determine if a combo of vestibular and cervical spine PT decreased the time till medical clearance in people w/post-concussion symptoms.	-Time to medical clearance for return to sport -Secondary: 11-point Numeric Pain Rating Scale score, <sup>35-37</sup> Activities-specific Balance Confidence Scale, <sup>38</sup> Dizziness Handicap Index, <sup>39-43</sup> SCAT2, <sup>30</sup> Dynamic Visual Acuity, <sup>44-46</sup> Head Thrust Test, <sup>47 48</sup> modified Motion Sensitivity Test, <sup>49</sup> Functional Gait Assessment, <sup>50</sup> Cervical Flexor Endurance (CFE) <sup>51 52</sup> and Joint Position Error (JPE) test	-Statistically significant return to sport in intervention group. 3.91times more likely for intervention group to return to sport -In secondary outcomes, statistically significant difference in SCAT2 total score and the DHI. -All other outcomes lacked statistical significance.  ****did not differentiate between vestibular and cervical therapy	No

<p><b>8</b></p>	<p>Valovich-McLeod, T.C. &amp; Hale, T.D. (2015)  USA</p>	<p>2b  Decision Analysis</p>	<p>“To review relevant literature regarding the effect of concussion on vestibular function, impairments, assessments, and management strategies.”</p>	<p>None were original as it was a review, but tests reviewed included: VOR, VSR, VCR, Saccades, Cranial Nerve Testing, Smooth Pursuit, Convergence, Dynamic Visual Acuity, Sensory Organization Test (SOT), Clinical Test of Sensory Interaction and Balance (CTSIB), Balance error scoring system (BESS), SCAT2, DHI, Vertigo Handicap Questionnaire (VHQ), Vestibular Disorders ADLS (VADL)</p>	<p>The vast majority of patients with post-concussion symptoms spontaneously recover in 7-10 days. Those with chronic symptoms can be treated with counselling, medication, VRT, canalith repositioning, and HEPs. The biggest challenge is choosing which option or combination of options to use. The use of VRT is shown, so far, to be the most common and effective form of treatment for chronic vestibular patients. This is especially true if the VRT is customized to the needs of each individual and carried out by an experienced and trained therapist. However, there is very little literature available and there needs to be more high quality studies.</p>	<p>Yes</p>
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## APPENDIX A: EVIDENCE APPRAISAL WORKSHEETS

### Intervention – Evidence Appraisal Worksheet

#### Citation:

Aligene, K. & Lin, E. (2013). Vestibular and Balance Treatment of the Concussed Athlete. *NeuroRehabilitation*, 32(3), 543-553. doi: 10.3233/NRE-130876.

<b>Is the purpose and background information sufficient?</b>	
<b>Appraisal Criterion</b>	<b>Reader's Comments</b>
<p><b>Study Purpose</b> Stated clearly? Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>The purpose of this study was to go over current information and look at what was being used to assess, treat, and manage post-concussive symptoms in an athletic population. This article was put forth as a guide to help with clinical decision making to treat the post-concussive athlete.</p>
<p><b>Literature</b> Relevant background presented? A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic. Describe the justification of the need for this study</p>	<p>The article is basically entirely background information and its interpretation.</p>

<b>Does the research design have internal validity?</b>	
<b>Appraisal Criterion</b>	<b>Reader's Comments</b>
<p>➤ <b>Discuss possible threats to internal validity in the research design.</b> <b>Include:</b></p> <ul style="list-style-type: none"> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> </ul>	<p>As it is a discussion, there is little risk for internal validity issues. The biggest issues could be some bias and leaving out information that did not fit.</p>

<ul style="list-style-type: none"> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	
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<b>Are the results of this therapeutic trial valid?</b>	
<i><b>Appraisal Criterion</b></i>	<i><b>Reader's Comments</b></i>
<p><b>1. Did the investigators randomly assign subjects to treatment groups?</b></p> <ul style="list-style-type: none"> <li>a. If no, describe what was done</li> <li>b. What are the potential consequences of this assignment process for the study's results?</li> </ul>	<p>Not a clinical trial</p>
<p><b>2. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b></p> <ul style="list-style-type: none"> <li>a. If they were not similar – what differences existed?</li> </ul>	<p>Not a clinical trial</p>
<p><b>3. Did the subjects know to which treatment group they were assign?</b></p> <ul style="list-style-type: none"> <li>a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</li> </ul>	<p>Not a clinical trial</p>
<p><b>4. Did the investigators know who was being assigned to which group prior to the allocation?</b></p> <ul style="list-style-type: none"> <li>a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</li> </ul>	<p>Not a clinical trial</p>
<p><b>5. Were the groups managed equally, apart from the actual experimental treatment?</b></p>	<p>Not a clinical trial</p>

<p>a. If not, what are the potential consequences of this knowledge for the study's results?</p>	
<p>6. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>Not a clinical trial</p>
<p>7. Did all the subjects originally enrolled complete the study?                  a. If not how many subjects were lost?                  b. What, if anything, did the authors do about this attrition?                  c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</p>	<p>Not a clinical trial</p>
<p>8. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?                  a. If not, what did the authors do with the data from these subjects?                  b. If the data were excluded, what are the potential consequences for this study's results?</p>	<p>Not a clinical trial</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p>9. What were the statistical findings of this study?                  a. When appropriate use the calculation forms below to determine these values                  b. Include: tests of differences? With p-values and CI</p>	<p>No original values due to nature of the article.</p>

<p>c. Include effect size with p-values and CI                  d. Include ARR/ABI and RRR/RBI with p-values and CI                  e. Include NNT and CI</p> <p>10. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</p>	
<p>11. Do these findings exceed a minimally important difference?                  a. If not, will you still use this evidence?</p>	<p>Not a clinical trial</p>
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p>12. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</p>	<p>The interventions discussed in the article are all clinically appropriate, have very little cost, and improve patient outcomes.</p>
<p>13. Are the study subjects similar to your patient/client?                  a. If not, how different? Can you use this intervention in spite of the differences?</p>	<p>This article was general when it came to patient population. It was basically anyone that had a traumatic concussion. This will be similar to what I see in clinic.</p>
<p>14. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</p>	<p>There is very little risk associated with vestibular rehabilitation training. It may momentarily worsen symptoms, but that was the only negative outcome mentioned.</p>
<p>15. Does the intervention fit within your patient/client's stated values or expectations?                  a. If not, what will you do now?</p>	<p>Yes. It does not require an extra cost, dangerous situations, and it improves the symptoms.</p>

<p><b>16. Are there any threats to external validity in this study?</b></p>	<p>Not for patients that have a non-traumatic concussion.</p>
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**What is the bottom line? What pedro score would you give this trial?**

Bottom line is that the article gave updated information on current treatment diagnosis, treatment, and management. It gave the pros and cons of the treatments and called for further research into the area. It is also a good resource to explain different treatments and mechanisms of injury. As this is not a RCT, I wouldn't assign it a pedro score.

## Intervention – Evidence Appraisal Worksheet

**Citation:**

Alsalaheen, B.A, Mucha, A., Morris, L.O., Whitney, S.L., Furman, J.M., Camiolo-Reddy, C.E., Collins, M.W., Lovell, M.R., & Sparto, P.J. (2010). Vestibular Rehabilitation for Dizziness and Balance Disorders After Concussion. *Journal of Neurological Physical Therapy*, 34(2), 87-93. doi: 10.1097/NPT.0b013e3181dde568

<p><b>Is the purpose and background information sufficient?</b></p>	
<p><b>Appraisal Criterion</b></p>	<p><b>Reader's Comments</b></p>
<p><b>Study Purpose</b>                      Stated clearly?                      Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>Yes.                       "The purpose of this retrospective study was to examine the severity of dizziness symptoms and gait and balance dysfunction reported by people who were referred for vestibular rehabilitation after concussion. Furthermore, this study investigated the effect of vestibular rehabilitation on reducing dizziness and gait and balance dysfunction, and whether the amount of recovery during vestibular rehabilitation was different between adults and children."</p>
<p><b>Literature</b>                      Relevant background presented?                      A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic.</p>	<p>There was a brief, but thorough review on concussions, the physical findings, the symptoms, what evidence there is for treatment, and the role treatment can play in recovery.                       There's currently not a lot known about how each person is individually affected by a concussion and how we should approach</p>

Describe the justification of the need for this study	treatment. There is also not a lot of information about the symptoms and symptom severity differences between adults and children.
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<b>Does the research design have internal validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design.</b> <b>Include:</b></li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>Assignment: no group assignments as all with the dx were selected</p> <p>Attrition: 24 subjects due to not having further rehab indicated, pts lived far away, and noncompliance.</p> <p>History: unknown</p> <p>Instrumentation: some of the outcome measures were not validated on children, 8 different therapists</p> <p>Maturation: children have more brain growth than adults.</p> <p>Testing: Same pre and post testing</p> <p>Compensatory: a retrospective study, so unlikely</p> <p>Stat Reg: None reported</p>

<b>Are the results of this therapeutic trial valid?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>17. Did the investigators randomly assign subjects to treatment groups?</b></p> <ul style="list-style-type: none"> <li>a. <b>If no, describe what was done</b></li> <li>b. <b>What are the potential consequences of this assignment process for the study's results?</b></li> </ul>	<p>No. All pts w/dx selected. This lead to a lack of comparison between treatment and rest.</p>
<p><b>18. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b></p>	<p>Only one group</p>

<p><b>a. If they were not similar – what differences existed?</b></p>	
<p><b>19. Did the subjects know to which treatment group they were assign?</b>  <b>a. If yes, what are the potential consequences of the subjects’ knowledge for this study’s results</b></p>	<p>Pts were referred for therapy, but did not know they were selected for the study.</p>
<p><b>20. Did the investigators know who was being assigned to which group prior to the allocation?</b>  <b>a. If they were not blind, what are the potential consequences of this knowledge for the study’s results?</b></p>	<p>The investigators picked all pts that had a concussion and were referred for therapy at the facility.                   May have perceived the results as more favorable.</p>
<p><b>21. Were the groups managed equally, apart from the actual experimental treatment?</b>  <b>a. If not, what are the potential consequences of this knowledge for the study’s results?</b></p>	<p>All one group.</p>
<p><b>22. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b>  <b>a. If not, what are the potential consequences of this knowledge for the study’s results?</b></p>	<p>The follow up was fairly short in the retrospective study. Discharge times were shorter than usual, but the authors of the study did not follow up with these patients.</p>
<p><b>23. Did all the subjects originally enrolled complete the study?</b>  <b>a. If not how many subjects were lost?</b>  <b>b. What, if anything, did the authors do about this attrition?</b>  <b>c. What are the implications of the attrition and the way it was handled with respect to the study’s findings?</b></p>	<p>No. 24 subjects did not return for therapy.                   They only used subjects that had at least 2 visits.                   It does not let us see if all subjects improved. As for the handling, since it was a retrospective study, there wasn’t a lot they could do.</p>
<p><b>24. Were all patients analyzed in the groups to which they were</b></p>	<p>No intention to treat analysis. The data was not included in the analysis. This may have</p>

<p><b>randomized (i.e. was there an intention to treat analysis)?</b></p> <ul style="list-style-type: none"> <li>a. <b>If not, what did the authors do with the data from these subjects?</b></li> <li>b. <b>If the data were excluded, what are the potential consequences for this study's results?</b></li> </ul>	<p>biased the study toward more positive results</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><b><i>Appraisal Criterion</i></b></p>	<p><b><i>Reader's Comments</i></b></p>
<p><b>25. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. <b>When appropriate use the calculation forms below to determine these values</b></li> <li>b. <b>Include: tests of differences? With p-values and CI</b></li> <li>c. <b>Include effect size with p-values and CI</b></li> <li>d. <b>Include ARR/ABI and RRR/RBI with p-values and CI</b></li> <li>e. <b>Include NNT and CI</b></li> </ul> <p><b>26. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</b></p>	<p>All had better scores on DGI, TUG, FTSTS, and self-reported activity-specific balance confidence score.</p> <p>Self-reported, gait, and balance measures p&lt;0.05</p> <p>Children improved in dizziness severity (p=.005) and sensory organization test (p&lt;0.025) more so than adults</p> <p>A mixed-factor repeated-measure analysis of variance was used to test vestibular rehab effect and the effect of age on outcome measures.</p> <p>independent sample t test: Mann-Whitney U test.</p> <p>No CI given.</p> <p>The findings show that there is improvement with rehabilitation following a concussion for both children and adults that have residual symptoms that do not disappear with rest.</p>
<p><b>27. Do these findings exceed a minimally important difference?</b></p> <ul style="list-style-type: none"> <li>a. <b>If not, will you still use this evidence?</b></li> </ul>	<p>The only three outcome measures that had established MCIDs were the dizziness handicap index, gait speed, and the sensory organization test, and those were all met.</p>

	<p>“the average magnitude of change was greater than the minimal clinically important difference established for the DHI <a href="#">26</a> (18 points), gait speed <a href="#">37</a> (0.1 m/s), and SOT composite score <a href="#">38</a> (10 points).”</p>
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader’s Comments</i></p>
<p><b>28. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b></p>	<p>As the treatment doesn’t necessarily require any special equipment or systems, it’d be appropriate for my patients and clinic.</p>
<p><b>29. Are the study subjects similar to your patient/ client?</b>                  a. If not, how different? Can you use this intervention in spite of the differences?</p>	<p>The study included multiple ages and reasons for being concussed therefore it’d be similar to a typical clinical setting.</p>
<p><b>30. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b></p>	<p>No major risks were discussed, nor were any major risks obvious, so I would say the benefits outweigh the risks.</p>
<p><b>31. Does the intervention fit within your patient/client’s stated values or expectations?</b>                  a. If not, what will you do now?</p>	<p>Assuming they expected balance exercises and were willing to try postural changes/repositioning to treat their symptoms, I would say yes. If not I can explain the therapy and we can proceed (or not) from there.</p>
<p><b>32. Are there any threats to external validity in this study?</b></p>	<p>According to the study, the patients in this study had higher initial scores than are usually seen so that may affect the generalization to other populations.</p>

**What is the bottom line? What pedro score would you give this trial?**

Bottom line is I think that this article is good evidence to give rehabilitation post concussion, especially if the symptoms don’t resolve with rest.

Pedro score: 3/10, due to lack of control group, inability to blind, etc...

## Intervention – Evidence Appraisal Worksheet

### Citation:

Alsalaheen, B.A., Whitney, S.L., Mucha, A., Morris, L.O., Furman, J.M., & Sparto, P.J. (2013). Exercise Prescription Patterns in Patients Treated with Vestibular Rehabilitation After Concussion. *Physiotherapy Research International*, 18(2), 100-108. doi: 10.1002/pri.1532

<b>Is the purpose and background information sufficient?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>Study Purpose</b> Stated clearly? Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>Yes.  “the purpose of this study is to describe exercise prescription patterns in patients treated with vestibular rehabilitation exercises.”</p>
<p><b>Literature</b> Relevant background presented? A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic. Describe the justification of the need for this study</p>	<p>There was plenty of background information on the current standard of practice for approaching post-concussive symptoms and their treatment. Also included was each type of treatment, common exercises used in these treatments, and how to progress the exercises. The justification is that there aren't necessarily any set protocols for exercises post-concussion and how to progress these exercises. There have been very few reports of how vestibular rehab therapists actually put these principles into practice.</p>

<b>Does the research design have internal validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>

<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design.</b> Include:</li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>As this was a retrospective review of the HEPs used so the threats to the left weren't necessarily components.</p>
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<b>Are the results of this therapeutic trial valid?</b>	
<i><b>Appraisal Criterion</b></i>	<i><b>Reader's Comments</b></i>
<p><b>33. Did the investigators randomly assign subjects to treatment groups?</b>                      a. <b>If no, describe what was done</b>                      b. <b>What are the potential consequences of this assignment process for the study's results?</b></p>	<p>There were two groups. One that had all their HEPs documented, and a group that was missing some of their HEPs, though it was presumed that the visits missing HEPs were probably because they were using the same HEP from the previous visit.</p>
<p><b>34. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b>                      a. <b>If they were not similar – what differences existed?</b></p>	<p>Yes, specifics weren't given, but it was noted that demographics weren't significantly different in each group.</p>
<p><b>35. Did the subjects know to which treatment group they were assign?</b>                      a. <b>If yes, what are the potential consequences of the subjects' knowledge for this study's results</b></p>	<p>No, because the report was done post-treatment.</p>
<p><b>36. Did the investigators know who was being assigned to which group prior to the allocation?</b>                      a. <b>If they were not blind, what are the potential</b></p>	<p>The groups existed due to whether or not the patients had HEPs assigned at each visit. So it wasn't blinded, but it wasn't up to the investigators which group the patient went into.</p>

<p>consequences of this knowledge for the study's results?</p>	
<p><b>37. Were the groups managed equally, apart from the actual experimental treatment?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>Both groups were analyzed by the vestibular PTs that had at least 3 years of experience in the field.</p>
<p><b>38. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No follow up as it was a retrospective.</p>
<p><b>39. Did all the subjects originally enrolled complete the study?</b>                  a. If not how many subjects were lost?                  b. What, if anything, did the authors do about this attrition?                  c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</p>	<p>Yes, because they were all selected post-discharge.</p>
<p><b>40. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?</b>                  a. If not, what did the authors do with the data from these subjects?                  b. If the data were excluded, what are the potential consequences for this study's results?</p>	<p>There wasn't a statistical analysis, just the 8 PTs looking over the treatments.</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p><b>41. What were the statistical findings of this study?</b></p>	<p>None due to the nature of the study.</p>

<p>a. When appropriate use the calculation forms below to determine these values</p> <p>b. Include: tests of differences? With p-values and CI</p> <p>c. Include effect size with p-values and CI</p> <p>d. Include ARR/ABI and RRR/RBI with p-values and CI</p> <p>e. Include NNT and CI</p> <p>42. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</p>	<p>n/a</p>
<p>43. Do these findings exceed a minimally important difference?</p> <p>a. If not, will you still use this evidence?</p>	<p>No MCID for this study, but the results would be beneficial for clinic to help choose and progress a HEP.</p>
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p>44. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</p>	<p>Yes. The exercises are simple and do not require any additional expense.</p>
<p>45. Are the study subjects similar to your patient/ client?</p> <p>a. If not, how different? Can you use this intervention in spite of the differences?</p>	<p>Anyone that has had a concussion and has residual symptoms fits into this study.</p>
<p>46. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</p>	<p>These exercises may mildly exacerbate the symptoms at first, but will help desensitize and reset the vestibular system to lead to symptom relief.</p>
<p>47. Does the intervention fit within your patient/client's stated values or expectations?</p> <p>a. If not, what will you do now?</p>	<p>Yes, it will help them get better and doesn't require anything too far outside the norm or dangerous.</p>

<b>48. Are there any threats to external validity in this study?</b>	It was only at one rehab facility.

**What is the bottom line? What pedro score would you give this trial?**

It's a good study to see the framework used by vestibular therapists to address post-concussive symptoms and on how to progress the HEP.

Pedro score: n/a, not a RCT

## Intervention – Evidence Appraisal Worksheet

**Citation:**

Gurley, J.M., Hujsak, B.D., & Kelly, J.L. (2013). Vestibular Rehabilitation Following Mild Traumatic Brain Injury. *NeuroRehabilitation*, 32(3), 519-528. doi: 10.3233/NRE-130874

<b>Is the purpose and background information sufficient?</b>	
<i><b>Appraisal Criterion</b></i>	<i><b>Reader's Comments</b></i>
<p><b>Study Purpose</b>                      Stated clearly?                      Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>Yes.</p> <p>“The purpose of this review is to appraise the current and accepted methods available to the skilled clinician in quantifying and treating vestibular dysfunction following concussion.”</p> <p>It also reviewed the incidence of injury and the prognostic indicators including common recovery barriers.</p>
<p><b>Literature</b>                      Relevant background presented?                      A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic.                      Describe the justification of the need for this study</p>	<p>This entire article is basically background on structures affected, how they're affected, how you can address them, and how the treatments chosen influence the outcome.</p> <p>The justification is that there are several methods to address post-concussive symptoms out there and this was a review to discuss their efficacy and judgment.</p>

<b>Does the research design have internal validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<ul style="list-style-type: none"> <li>➤ Discuss possible threats to internal validity in the research design. Include:</li> <li>➤ Assignment</li> <li>➤ Attrition</li> <li>➤ History</li> <li>➤ Instrumentation</li> <li>➤ Maturation</li> <li>➤ Testing</li> <li>➤ Compensatory Equalization of treatments</li> <li>➤ Compensatory rivalry</li> <li>➤ Statistical Regression</li> </ul>	<p>None of these factors were present in the article. However, there were a few points where the authors started the sentence with, "It is our opinion," which indicates bias.</p>

<b>Are the results of this therapeutic trial valid?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>49. Did the investigators randomly assign subjects to treatment groups?</b></p> <ul style="list-style-type: none"> <li>a. If no, describe what was done</li> <li>b. What are the potential consequences of this assignment process for the study's results?</li> </ul>	<p>No, not a RCT</p>
<p><b>50. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b></p> <ul style="list-style-type: none"> <li>a. If they were not similar – what differences existed?</li> </ul>	<p>No, not a RCT</p>
<p><b>51. Did the subjects know to which treatment group they were assigned?</b></p> <ul style="list-style-type: none"> <li>a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</li> </ul>	<p>No, not a RCT</p>

<p><b>52. Did the investigators know who was being assigned to which group prior to the allocation?</b></p> <p>a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>53. Were the groups managed equally, apart from the actual experimental treatment?</b></p> <p>a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>54. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b></p> <p>a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>55. Did all the subjects originally enrolled complete the study?</b></p> <p>a. If not how many subjects were lost?</p> <p>b. What, if anything, did the authors do about this attrition?</p> <p>c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</p>	<p>No, not a RCT</p>
<p><b>56. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?</b></p> <p>a. If not, what did the authors do with the data from these subjects?</p> <p>b. If the data were excluded, what are the potential consequences for this study's results?</p>	<p>No, not a RCT</p>

<b>Are the valid results of this RCT important?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>57. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. When appropriate use the calculation forms below to determine these values</li> <li>b. Include: tests of differences? With p-values and CI</li> <li>c. Include effect size with p-values and CI</li> <li>d. Include ARR/ABI and RRR/RBI with p-values and CI</li> <li>e. Include NNT and CI</li> </ul>	<p>Not a RCT, so statistics were not included.</p>
<p><b>58. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</b></p>	<p>No statistical analysis, just a discussion on treatments, how well they're tolerated, and which treatment works with each impairment. Useful to help select which treatment to use after you've uncovered the structures involved.</p>
<p><b>59. Do these findings exceed a minimally important difference?</b></p> <ul style="list-style-type: none"> <li>a. If not, will you still use this evidence?</li> </ul>	<p>Not an RCT, but discussed the MICD for the dizziness handicap inventory (DHI). Scores necessary to predict risk where also included for the activity-specific balance confidence scale (ABC)=&lt;67.</p>
<b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>60. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b></p>	<p>The interventions discussed didn't need any additional equipment and are accessible to any PT. However, it would benefit the PT to be trained in these techniques.</p>
<p><b>61. Are the study subjects similar to your patient/ client?</b></p> <ul style="list-style-type: none"> <li>a. If not, how different? Can you use this intervention in spite of the differences?</li> </ul>	<p>This review included youth athletes, the elderly, and everyone in between. Therefore, this review is applicable to patients with post-concussive symptoms.</p>

<p><b>62. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b></p>	<p>The benefit is that they get better and the risk is they stay the same if applied properly. Therefore, the benefit outweighs the risk.</p>
<p><b>63. Does the intervention fit within your patient/client’s stated values or expectations?</b>                  a. If not, what will you do now?</p>	<p>Yes. They are receiving therapy to improve their symptoms.</p>
<p><b>64. Are there any threats to external validity in this study?</b></p>	<p>Unlikely given the review included most populations.</p>

**What is the bottom line? What pedro score would you give this trial?**

Bottom line is that this article was good for the provider in assisting them to discover which structures are affected, which techniques can be applied to these structures/impairments, and what factors should be taken into consideration for treatment and prognosis.

No pedro score as this was not a trial.

## Intervention – Evidence Appraisal Worksheet

**Citation:**

Hoffer, M.E., Schubert, M.C., & Balaban, C.D. (2015). Early Diagnosis and Treatment of Traumatic Vestibulopathy and Post-Concussive Dizziness. *Neurologic Clinics*, 33(3), 661-668. doi: 10.1016/j.ncl.2015.04.004

<b>Is the purpose and background information sufficient?</b>	
<b><i>Appraisal Criterion</i></b>	<b><i>Reader’s Comments</i></b>
<p><b>Study Purpose</b>                      Stated clearly?                      Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>Yes.                       “This article begins with a review of the prevalence of mTBI in general, and then discusses clinical evidence indicating balance disorders after mTBI and examines the most recent trends in diagnosis. Finally, it discusses the recent basic scientific hypotheses regarding the cause of mTBI-induced neurosensory disorders and provides a brief overview of vestibular rehabilitation for mTBI.”</p>

<p><b>Literature</b>                  Relevant background presented?                  A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic.                  Describe the justification of the need for this study</p>	<p>These authors were very thorough in their definition of a mTBI and the mechanism for each type of concussion they discussed. They also discuss the nature of neurosensory issues, how balance is the most common one, and how balance issues are almost universally present.</p> <p>Under-recognized issue that can lead to a decreased QOL and deteriorating balance function.</p>
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<b>Does the research design have internal validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design.</b>                      Include:</li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>None as this was a review and there was no word usage that indicated bias toward any treatment or diagnostic tool.</p>

<b>Are the results of this therapeutic trial valid?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p>65. Did the investigators randomly assign subjects to treatment groups?                      a. If no, describe what was done                      b. What are the potential consequences of this assignment process for the study's results?</p>	<p>No, not a RCT</p>

<p><b>66. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b>                  a. If they were not similar – what differences existed?</p>	<p>No, not a RCT</p>
<p><b>67. Did the subjects know to which treatment group they were assign?</b>                  a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</p>	<p>No, not a RCT</p>
<p><b>68. Did the investigators know who was being assigned to which group prior to the allocation?</b>                  a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>69. Were the groups managed equally, apart from the actual experimental treatment?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>70. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>71. Did all the subjects originally enrolled complete the study?</b>                  a. If not how many subjects were lost?                  b. What, if anything, did the authors do about this attrition?                  c. What are the implications of the attrition and the way it</p>	<p>No, not a RCT</p>

<p><b>was handled with respect to the study's findings?</b></p>	
<p><b>72. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?</b></p> <ul style="list-style-type: none"> <li>a. If not, what did the authors do with the data from these subjects?</li> <li>b. If the data were excluded, what are the potential consequences for this study's results?</li> </ul>	<p>No, not a RCT</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p><b>73. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. When appropriate use the calculation forms below to determine these values</li> <li>b. Include: tests of differences? With p-values and CI</li> <li>c. Include effect size with p-values and CI</li> <li>d. Include ARR/ABI and RRR/RBI with p-values and CI</li> <li>e. Include NNT and CI</li> </ul>	<p>No original statistics due to nature of article.</p>
<p><b>74. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</b></p>	<p>No original statistic exist, but references to trials include helpful information I can use in my practice.</p>
<p><b>75. Do these findings exceed a minimally important difference?</b></p> <ul style="list-style-type: none"> <li>a. If not, will you still use this evidence?</li> </ul>	<p>No, none were mentioned.</p>
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>

<p><b>76. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b></p>	<p>The advanced testing and treatment using a computer and special programs may not be, but traditional vestibular therapy would be appropriate.</p>
<p><b>77. Are the study subjects similar to your patient/ client?</b>                  a. <b>If not, how different? Can you use this intervention in spite of the differences?</b></p>	<p>The studies mentioned in this article included athletes, veterans, and information from an emergency department. Therefore, it should be applicable to a wide group of people.</p>
<p><b>78. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b></p>	<p>Without therapy the patient would stay the same or worsen. The benefits include resolving or lessening of symptoms, so the benefits outweigh and potential negative consequences.</p>
<p><b>79. Does the intervention fit within your patient/client’s stated values or expectations?</b>                  a. <b>If not, what will you do now?</b></p>	<p>Yes, if they are willing to do their HEP</p>
<p><b>80. Are there any threats to external validity in this study?</b></p>	<p>Most populations were included.</p>

**What is the bottom line? What pedro score would you give this trial?**

Bottom line is that this article was helpful to identify the tests that exist, including diagnostic computer programs that have not been mentioned in previous articles. In addition, it helps to define a mTBI and what treatments are available.

No pedro score as it is not a trial.

## Intervention – Evidence Appraisal Worksheet

### Citation:

Murray, D.A., Meldrum, D., & Lennon, O. (2017). Can Vestibular Rehab Exercises Help Patients with Concussion? A Systematic Review of Efficacy, Prescription, and Progression Patterns. *British Journal of Sports Medicine*, 51(5), 442-451. doi: 10.1136/bjsports-2016-096081

<p><b>Is the purpose and background information sufficient?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader’s Comments</i></p>
<p><b>Study Purpose</b></p>	<p>Yes.</p>

<p>Stated clearly? Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>“The purpose of this systematic review was twofold: first, to evaluate published evidence supporting the use of VRT in the mTBI/concussion population, and second, to determine if specific outcome measures, and prescription and progression patterns could be identified within the VRT treatment paradigm for mTBI/concussion populations.”</p>
<p><b>Literature</b> Relevant background presented? A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic. Describe the justification of the need for this study</p>	<p>There’s background on how frequently symptoms persist, documentation of impairments after concussion, current recommended treatment standards, and when VRT started.  The justification is that there’s not much evidence out there and it’s unclear on how good the evidence is for VRT</p>

<p><b>Does the research design have internal validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader’s Comments</i></p>
<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design.</b></li> <li><b>Include:</b></li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>All studies that met the inclusion criteria were selected. Risk of bias by the authors was low as it was a review and each article they used was evaluated for bias using the Cochrane Risk of Bias Tool for RCTs and the Effective Public Health Practice Project Quality Assessment Tool. All articles were also graded for the Sackett’s level of evidence.</p>

<p><b>Are the results of this therapeutic trial valid?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader’s Comments</i></p>

<p><b>81. Did the investigators randomly assign subjects to treatment groups?</b>                  a. If no, describe what was done                  b. What are the potential consequences of this assignment process for the study's results?</p>	<p>No, not a RCT</p>
<p><b>82. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b>                  a. If they were not similar – what differences existed?</p>	<p>No, not a RCT</p>
<p><b>83. Did the subjects know to which treatment group they were assign?</b>                  a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</p>	<p>No, not a RCT</p>
<p><b>84. Did the investigators know who was being assigned to which group prior to the allocation?</b>                  a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>85. Were the groups managed equally, apart from the actual experimental treatment?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>86. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b>                  a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No, not a RCT</p>
<p><b>87. Did all the subjects originally enrolled complete the study?</b></p>	<p>No, not a RCT</p>

<ul style="list-style-type: none"> <li>a. If not how many subjects were lost?</li> <li>b. What, if anything, did the authors do about this attrition?</li> <li>c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</li> </ul>	
<p><b>88. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?</b></p> <ul style="list-style-type: none"> <li>a. If not, what did the authors do with the data from these subjects?</li> <li>b. If the data were excluded, what are the potential consequences for this study's results?</li> </ul>	<p>No, not a RCT</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><b><i>Appraisal Criterion</i></b></p>	<p><b><i>Reader's Comments</i></b></p>
<p><b>89. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. When appropriate use the calculation forms below to determine these values</li> <li>b. Include: tests of differences? With p-values and CI</li> <li>c. Include effect size with p-values and CI</li> <li>d. Include ARR/ABI and RRR/RBI with p-values and CI</li> <li>e. Include NNT and CI</li> </ul> <p><b>90. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</b></p>	<p>Original statistics were not run as this was a systematic review. Findings were discussed and evaluated by authors.</p> <p>Original stats weren't ran, but each study included that has statistics were analyzed with favorable outcomes meaning it'd likely be beneficial to my patients.</p>
<p><b>91. Do these findings exceed a minimally important difference?</b></p>	<p>n/a</p>

<p><b>a. If not, will you still use this evidence?</b></p>	
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>
<p><b>92. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b></p>	<p>The SR showed that the interventions are usually affordable and appropriate.</p>
<p><b>93. Are the study subjects similar to your patient/ client?</b>  <b>a. If not, how different? Can you use this intervention in spite of the differences?</b></p>	<p>This review included people of all ages, genders, and backgrounds, so it'd be applicable to many patients.</p>
<p><b>94. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b></p>	<p>Yes, no known risks were presented.</p>
<p><b>95. Does the intervention fit within your patient/client's stated values or expectations?</b>  <b>a. If not, what will you do now?</b></p>	<p>Yes, they want to get better. However, evidence is lacking.</p>
<p><b>96. Are there any threats to external validity in this study?</b></p>	<p>Applicable to most people.</p>

**What is the bottom line? What pedro score would you give this trial?**

Helpful article in helping the provider understand the current level of evidence for VRT and why it is at this level. It's useful information regarding what diagnostic tools and treatments are used, and why.

No pedro score as this is not a RCT.

## Intervention – Evidence Appraisal Worksheet

**Citation:**

Schneider, K.J., Meeuwisse, W.H., Nettel-Aguirre, A., Barlow, K., Boyd, L., Kang, J., & Emergey, C.A. (2014). Cervicovestibular Rehabilitation in Sport-Related Concussion: A Randomised Controlled Trial. *British Journal of Sports Medicine*, 48(17), 1294-1298. doi: 10.1136/bjsports-2013-093267

<b>Is the purpose and background information sufficient?</b>	
<b>Appraisal Criterion</b>	<b>Reader's Comments</b>
<p><b>Study Purpose</b>                      Stated clearly?                      Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	<p>Yes.</p> <p>“whether a combination of vestibular rehabilitation and physiotherapy treatment for the cervical spine decreases the time until medical clearance to return to play in individuals with prolonged post-concussion symptoms of dizziness, neck pain and/or headaches.”</p>
<p><b>Literature</b>                      Relevant background presented?                      A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic.                      Describe the justification of the need for this study</p>	<p>Yes. Background included the common symptoms after a concussion, how they are usually addressed, how the cervical and vestibular impairments can affect function, and how there is “little formal investigation on treatment for persistent symptoms.”</p> <p>Very little research has been done on combination therapy.</p>

<b>Does the research design have internal validity?</b>	
<b>Appraisal Criterion</b>	<b>Reader's Comments</b>
<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design. Include:</b></li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> </ul>	<p>The assignment was random and blinded to the assessors. Attrition included 2 from the control group, but this was addressed with an Intention to Treat Analysis and they were included in the results as if they had returned to sport (even though only one other in the control group did).</p> <p>To control for history, the participants we asked to keep a journal.</p>

<ul style="list-style-type: none"> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>Instrumentation was fairly basic and the outcome used allowed for a large margin of error.</p> <p>Maturation over 2 months may have occurred, but not an issue as it wasn't a long term study.</p> <p>Testing was blinded to both the physician determining return to sport and to the PT assessor.</p> <p>Compensatory equalization was accounted for by having set procedures for the individualized programs, but it was likely still present.</p> <p>The participants participated in similar therapy and were asked to not discuss it, but that is always possible.</p> <p>No obvious regression or outliers were observed.</p>
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<b>Are the results of this therapeutic trial valid?</b>	
<i><b>Appraisal Criterion</b></i>	<i><b>Reader's Comments</b></i>
<p><b>97. Did the investigators randomly assign subjects to treatment groups?</b></p> <ul style="list-style-type: none"> <li>a. If no, describe what was done</li> <li>b. What are the potential consequences of this assignment process for the study's results?</li> </ul>	<p>Yes</p>
<p><b>98. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b></p> <ul style="list-style-type: none"> <li>a. If they were not similar – what differences existed?</li> </ul>	<p>Yes</p>
<p><b>99. Did the subjects know to which treatment group they were assign?</b></p> <ul style="list-style-type: none"> <li>a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</li> </ul>	<p>No, they were not told about the different groups, just treated.</p>
<p><b>100. Did the investigators know who was being assigned to which group prior to the allocation?</b></p>	<p>No</p>

<p>a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</p>	
<p>101. Were the groups managed equally, apart from the actual experimental treatment? a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>Yes</p>
<p>102. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research? a. If not, what are the potential consequences of this knowledge for the study's results?</p>	<p>No. They assumed 8 weeks would be sufficient, but there were participants that weren't released to return to sport.</p>
<p>103. Did all the subjects originally enrolled complete the study? a. If not how many subjects were lost? b. What, if anything, did the authors do about this attrition? c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</p>	<p>No. Two were lost, but the authors ran an Intention to Treat Analysis The two in the control group that were lost were treated as if they had returned to sport by 8wks which actually biased the study toward the control group.</p>
<p>104. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)? a. If not, what did the authors do with the data from these subjects? b. If the data were excluded, what are the potential consequences for this study's results?</p>	<p>Yes.</p>
<p><b>Are the valid results of this RCT important?</b></p>	
<p><i>Appraisal Criterion</i></p>	<p><i>Reader's Comments</i></p>

<p><b>105. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. When appropriate use the calculation forms below to determine these values</li> <li>b. Include: tests of differences? With p-values and CI</li> <li>c. Include effect size with p-values and CI</li> <li>d. Include ARR/ABI and RRR/RBI with p-values and CI</li> <li>e. Include NNT and CI</li> </ul> <p><b>106. What is the meaning of these statistical findings for your patient/client’s case? What does this mean to your practice?</b></p>	<p>73.3% of the intervention group compared to 7.1% of control group (18% w/2 that dropped) were medically cleared of the participants that finished the study.</p> <p>100% of individuals w/history of concussion in intervention group were medically cleared.</p> <p>64% of total participants who were medically cleared no longer had neck pain.</p> <p>Treatment group had a statistically significant improvement as compared to control in the SCAT2 Total Score (p=0.009) and the DHI (p=0.019)</p> <p>Basically it just means that if I have a person with a sport-related concussion, I will consider using cervical rehab in addition to the vestibular rehab to improve patient outcomes/care.</p>
<p><b>107. Do these findings exceed a minimally important difference?</b></p> <ul style="list-style-type: none"> <li>a. If not, will you still use this evidence?</li> </ul>	<p>According to the article, the MCID for time to return to sport would be 16 days (w/80% power).</p> <p>According to Figure 1, the difference in clearance from the first in the intervention group and the first in the control group was about 40 days, so the findings exceeded the MCID.</p>
<p><b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b></p>	
<p><b><i>Appraisal Criterion</i></b></p>	<p><b><i>Reader’s Comments</i></b></p>
<p><b>108. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b></p>	<p>Yes, it makes sense and abides by clinical decision-making and patient care.</p>
<p><b>109. Are the study subjects similar to your patient/ client?</b></p>	<p>Yes, I will see people post-concussion due to sports.</p>

<p><b>a. If not, how different? Can you use this intervention in spite of the differences?</b></p>	<p>I can still use this therapy for anyone that I suspect has cervical involvement</p>
<p><b>110. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b></p>	<p>Yes, the benefit is several days earlier release and resolution of symptoms.</p>
<p><b>111. Does the intervention fit within your patient/client’s stated values or expectations?</b> <b>a. If not, what will you do now?</b></p>	<p>Yes, they want to get better and it doesn’t require anything unusual or invasive.</p>
<p><b>112. Are there any threats to external validity in this study?</b></p>	<p>Small age range and specific cause.</p>

**What is the bottom line? What pedro score would you give this trial?**

Bottom line is that it was a fairly well done trial and combined two types of commonly used therapy used for this patient population. As there is no known major risks, I think this is a good guide to treatment of this population of patients.

Pedro: 8/10

## Intervention – Evidence Appraisal Worksheet

**Citation:**

Valovich-McLeod, T.C. & Hale, T.D. (2015). Vestibular and Balance Issues Following Sport-Related Concussion. *Brain Injury*, 29(2), 175-184. doi: 10.3109/02699052.2014.965206.

<b>Is the purpose and background information sufficient?</b>	
<b><i>Appraisal Criterion</i></b>	<b><i>Reader’s Comments</i></b>
<p><b>Study Purpose</b> Stated clearly? Usually stated briefly in abstract and in greater detail in introduction. May be phrased as a question or hypothesis. A clear statement helps you determine if topic is important, relevant and of interest to</p>	<p>Yes.  “To review relevant literature regarding the effect of concussion on vestibular function, impairments, assessments and management strategies.”</p>

<p>you. Consider how the study can be applied to PT and/or your own situation. What is the purpose of this study?</p>	
<p><b>Literature</b>                  Relevant background presented?                  A review of the literature should provide background for the study by synthesizing relevant information such as previous research and gaps in current knowledge, along with the clinical importance of the topic.                  Describe the justification of the need for this study</p>	<p>There is a solid introduction on all that is included in the vestibular system and what functions they play. This includes both anatomical features as well as the role of gravity.</p> <p>Update on the best practices for the assessment and treatment of vestibular function post-concussion.</p>

<b>Does the research design have internal validity?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<ul style="list-style-type: none"> <li>➤ <b>Discuss possible threats to internal validity in the research design.</b></li> <li><b>Include:</b></li> <li>➤ <b>Assignment</b></li> <li>➤ <b>Attrition</b></li> <li>➤ <b>History</b></li> <li>➤ <b>Instrumentation</b></li> <li>➤ <b>Maturation</b></li> <li>➤ <b>Testing</b></li> <li>➤ <b>Compensatory Equalization of treatments</b></li> <li>➤ <b>Compensatory rivalry</b></li> <li>➤ <b>Statistical Regression</b></li> </ul>	<p>This was a review and therefore lacked these components in their original form. No use of the words opinion or anything with the same meaning were used. If bias was included, it was from the studies selected.</p>

<b>Are the results of this therapeutic trial valid?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>113. Did the investigators randomly assign subjects to treatment groups?</b></p> <p><b>a. If no, describe what was done</b></p>	<p>No, not a RCT</p>

<p><b>b. What are the potential consequences of this assignment process for the study's results?</b></p>	
<p><b>114. Were the groups similar at the start of the trial? Did they report the demographics of the study groups?</b>  <b>a. If they were not similar – what differences existed?</b></p>	<p>No, not a RCT</p>
<p><b>115. Did the subjects know to which treatment group they were assign?</b>  <b>a. If yes, what are the potential consequences of the subjects' knowledge for this study's results</b></p>	<p>No, not a RCT</p>
<p><b>116. Did the investigators know who was being assigned to which group prior to the allocation?</b>  <b>a. If they were not blind, what are the potential consequences of this knowledge for the study's results?</b></p>	<p>No, not a RCT</p>
<p><b>117. Were the groups managed equally, apart from the actual experimental treatment?</b>  <b>a. If not, what are the potential consequences of this knowledge for the study's results?</b></p>	<p>No, not a RCT</p>
<p><b>118. Was the subject follow-up time sufficiently long to answer the question(s) posed by the research?</b>  <b>a. If not, what are the potential consequences of this knowledge for the study's results?</b></p>	<p>No, not a RCT</p>
<p><b>119. Did all the subjects originally enrolled complete the study?</b>  <b>a. If not how many subjects were lost?</b></p>	<p>No, not a RCT</p>

<ul style="list-style-type: none"> <li>b. What, if anything, did the authors do about this attrition?</li> <li>c. What are the implications of the attrition and the way it was handled with respect to the study's findings?</li> </ul>	
<p><b>120. Were all patients analyzed in the groups to which they were randomized (i.e. was there an intention to treat analysis)?</b></p> <ul style="list-style-type: none"> <li>a. If not, what did the authors do with the data from these subjects?</li> <li>b. If the data were excluded, what are the potential consequences for this study's results?</li> </ul>	<p>No, not a RCT</p>
<b>Are the valid results of this RCT important?</b>	
<i>Appraisal Criterion</i>	<i>Reader's Comments</i>
<p><b>121. What were the statistical findings of this study?</b></p> <ul style="list-style-type: none"> <li>a. When appropriate use the calculation forms below to determine these values</li> <li>b. Include: tests of differences? With p-values and CI</li> <li>c. Include effect size with p-values and CI</li> <li>d. Include ARR/ABI and RRR/RBI with p-values and CI</li> <li>e. Include NNT and CI</li> </ul> <p><b>122. What is the meaning of these statistical findings for your patient/client's case? What does this mean to your practice?</b></p>	<p>Not a RCT, so no original statistics were used.</p> <p>No original stats, but the articles used suggest individualized VRT as the best current treatment for post-concussion symptoms such as dizziness and balance issues.</p>
<p><b>123. Do these findings exceed a minimally important difference?</b></p> <ul style="list-style-type: none"> <li>a. If not, will you still use this evidence?</li> </ul>	<p>Not discussed.</p>

<b>Can you apply this valid, important evidence about an intervention in caring for your patient/client? What is the external validity?</b>	
<b><i>Appraisal Criterion</i></b>	<b><i>Reader's Comments</i></b>
<b>124. Does this intervention sound appropriate for use (available, affordable) in your clinical setting?</b>	Yes. Though some testing was expensive, there were cheaper alternatives that would get you similar results and still allow for good patient care.
<b>125. Are the study subjects similar to your patient/ client? a. If not, how different? Can you use this intervention in spite of the differences?</b>	It was all post-concussion patients with vestibular symptoms, so if my patient fits in that category, yes they are similar.
<b>126. Do the potential benefits outweigh the potential risks using this intervention with your patient/client?</b>	No known risks, so the benefits of reduced symptoms and sooner return to work/sport are greater.
<b>127. Does the intervention fit within your patient/client's stated values or expectations? a. If not, what will you do now?</b>	Yes, minus the expensive testing, but, as a mentioned, there are cheap, readily-accepted alternatives.
<b>128. Are there any threats to external validity in this study?</b>	None noted.

**What is the bottom line? What pedro score would you give this trial?**

Bottom line is that this is a very scientific and anatomic article that was beneficial for my understanding as a provider. It thoroughly explained the anatomy, physiology, testing, and treatments for vestibular rehabilitation. It also explained the incidence and frequency of different symptoms and prognosis. Overall, it is a helpful article that I will use in practice.

No pedro score as it is not a trial.

## APPENDIX B: PEDRO SCORING

Retrieved from <https://www.pedro.org.au/english/downloads/pedro-scale/>

### PEDro scale

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The PEDro scale was last amended on 21 June 1999.

This briefly explains why each item has been included in the PEDro scale. More detail on each item is provided in the [PEDro scale training program](#).

#### 1. eligibility criteria were specified

Note on administration: This criterion is satisfied if the report describes the source of subjects and a list of criteria used to determine who was eligible to participate in the study.

Explanation: This criterion influences external validity, but not the internal or statistical validity of the trial. It has been included in the PEDro scale so that all items of the Delphi scale are represented on the PEDro scale. This item is not used to calculate the PEDro score.

#### 2. subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)

Note on administration: A study is considered to have used random allocation if the report states that allocation was random. The precise method of randomisation need not be specified. Procedures such as coin-tossing and dice-rolling should be considered random. Quasi-randomised allocation procedures such as allocation by hospital record number or birth date, or alternation, do not satisfy this criterion.

Explanation: Random allocation ensures that (within the constraints provided by chance) treatment and control groups are comparable.

#### 3. allocation was concealed

Note on administration: *Concealed allocation* means that the person who determined if a subject was eligible for inclusion in the trial was unaware, when this decision was made, of which group the subject would be allocated to. A point is awarded for this criteria, even if it is not stated that allocation was concealed, when the report states that allocation was by sealed opaque envelopes or that allocation involved contacting the holder of the allocation schedule who was "off-site".

Explanation: "Concealment" refers to whether the person who determined if subjects were eligible for inclusion in the trial was aware, at the time he or she made this decision, which group the next subject would be allocated to. Potentially, if allocation is not concealed, the decision about whether or not to include a person in a trial could be influenced by knowledge of whether the subject was to receive treatment or not. This could produce systematic biases in otherwise random allocation. There is empirical evidence that concealment predicts effect size (concealment is associated with a finding of more modest treatment effects; see [Schulz et al \(1995\) JAMA 273:408-412](#)).

#### 4. the groups were similar at baseline regarding the most important prognostic indicators

Note on administration: At a minimum, in studies of therapeutic interventions, the report must describe at least one measure of the severity of the condition being treated and at least one (different) key outcome measure at baseline. The rater must be satisfied that the groups' outcomes would not be expected to differ, on the basis of baseline differences in prognostic variables alone, by a clinically significant amount. This criterion is satisfied even if only baseline data of study completers are presented.

Explanation: This criterion may provide an indication of potential bias arising by chance with random allocation. Gross discrepancies between groups may be indicative of inadequate randomisation procedures.

#### 5. there was blinding of all subjects

Note on administration: *Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.

Explanation: Blinding of subjects involves ensuring that subjects were unable to discriminate whether they had or had not received the treatment. When subjects have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to placebo effects or Hawthorne effects (an experimental artifact in which subjects' responses are distorted by how they expect the experimenters want them to respond).

#### 6. there was blinding of all therapists who administered the therapy

Note on administration: *Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.

Explanation: Blinding of therapists involves ensuring that therapists were unable to discriminate whether individual subjects had or had not received the treatment. When therapists have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to the therapists' enthusiasm or lack of enthusiasm for the treatment or control conditions.

#### 7. there was blinding of all assessors who measured at least one key outcome

Note on administration: *Blinding* means the person in question (subject, therapist or assessor) did not know which group the subject had been allocated to. In addition, subjects and therapists are only considered to be "blind" if it could be expected that they would have been unable to distinguish between the treatments applied to different groups. In trials in which key outcomes are self-reported (eg, visual analogue scale, pain diary), the assessor is considered to be blind if the subject was blind.

Explanation: Blinding of assessors involves ensuring that assessors were unable to discriminate whether individual subjects had or had not received the treatment. When assessors have been blinded, the reader can be satisfied that the apparent effect (or lack of effect) of treatment was not due to the assessors' biases impinging on their measures of outcomes.

### 8. measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups

Note on administration: This criterion is only satisfied if the report explicitly states *both* the number of subjects initially allocated to groups *and* the number of subjects from whom key outcome measures were obtained. In trials in which outcomes are measured at several points in time, a key outcome must have been measured in more than 85% of subjects at one of those points in time.

Explanation: It is important that measurement of outcome is made on all subjects who are randomised to groups. Subjects who are not followed up may differ systematically from those who are, and this potentially introduces bias. The magnitude of the potential bias increases with the proportion of subjects not followed up.

### 9. all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"

Note on administration: An *intention to treat* analysis means that, where subjects did not receive treatment (or the control condition) as allocated, and where measures of outcomes were available, the analysis was performed as if subjects received the treatment (or control condition) they were allocated to. This criterion is satisfied, even if there is no mention of analysis by intention to treat, if the report explicitly states that all subjects received treatment or control conditions as allocated.

Explanation: Almost inevitably there are protocol violations in clinical trials. Protocol violations may involve subjects not receiving treatment as planned, or receiving treatment when they should not have. Analysis of data according to how subjects were treated (instead of according to how subjects should have been treated) may produce biases. It is probably important that, when the data are analysed, analysis is done as if each subject received the treatment or control condition as planned. This is usually referred to as "analysis by intention to treat". For a discussion of analysis by intention to treat see [Hollis S & Campbell F \(1999\) BMJ 319:670-674](#).

### 10. the results of between-group statistical comparisons are reported for at least one key outcome

Note on administration: A *between-group* statistical comparison involves statistical comparison of one group with another. Depending on the design of the study, this may involve comparison of two or more treatments, or comparison of treatment with a control condition. The analysis may be a simple comparison of outcomes measured after the treatment was administered, or a comparison of the change in one group with the change in another (when a factorial analysis of variance has been used to analyse the data, the latter is often reported as a group x time interaction). The comparison may be in the form of hypothesis testing (which provides a "p" value, describing the probability that the groups differed only by chance) or in the form of an estimate (for example, the mean or median difference, or a difference in proportions, or number needed to treat, or a relative risk or hazard ratio) and its confidence interval.

Explanation: In clinical trials, statistical tests are performed to determine if the difference between groups is greater than can plausibly be attributed to chance.

### 11. the study provides both point measures and measures of variability for at least one key outcome

Note on administration: A *point measure* is a measure of the size of the treatment effect. The treatment effect may be described as a difference in group outcomes, or as the outcome in (each of) all groups. *Measures of variability* include standard deviations, standard errors, confidence intervals, interquartile ranges (or other quantile ranges), and ranges. Point measures and/or measures of variability may be provided graphically (for example, SDs may be given as error bars in a Figure) as long as it is clear what is being graphed (for example, as long as it is clear whether error bars represent SDs or SEs). Where outcomes are categorical, this criterion is considered to have been met if the number of subjects in each category is given for each group.

Explanation: Clinical trials potentially provide relatively unbiased estimates of the size of treatment effects. The best estimate (point estimate) of the treatment effect is the difference between (or ratio of) the outcomes of treatment and control groups. A measure of the degree of uncertainty associated with this estimate can only be calculated if the study provides measures of variability.

#### For all criteria

**Points are only awarded when a criterion is clearly satisfied.** If on a literal reading of the trial report it is possible that a criterion was not satisfied, a point should not be awarded for that criterion.

#### For criteria 4 and 7-11

*Key outcomes* are those outcomes which provide the primary measure of the effectiveness (or lack of effectiveness) of the therapy. In most studies, more than one variable is used as an outcome measure.

### APPENDIX C: OXFORD LEVEL OF EVIDENCE

Level	Therapy / Prevention, Aetiology / Harm	Prognosis	Diagnosis	Differential diagnosis / symptom prevalence study	Economic and decision analyses
1a	SR (with homogeneity*) of RCTs	SR (with homogeneity*) of inception cohort studies; CDR” validated in different populations	SR (with homogeneity*) of Level 1 diagnostic studies; CDR” with 1b studies from different clinical centres	SR (with homogeneity*) of prospective cohort studies	SR (with homogeneity*) of Level 1 economic studies
1b	Individual RCT (with narrow Confidence Interval” <sub>i</sub> )	Individual inception cohort study with > 80% follow-up; CDR” validated in a single population	Validating** cohort study with good” ” ” reference standards; or CDR” tested within one clinical centre	Prospective cohort study with good follow-up****	Analysis based on clinically sensible costs or alternatives; systematic review(s) of the evidence; and including multi-way sensitivity analyses
1c	All or none§	All or none case-series	Absolute SpPins and SnNouts” “	All or none case-series	Absolute better-value or worse-value analyses ” ” ” “
2a	SR (with homogeneity*) of cohort studies	SR (with homogeneity*) of either retrospective cohort studies or untreated control groups in RCTs	SR (with homogeneity*) of Level >2 diagnostic studies	SR (with homogeneity*) of 2b and better studies	SR (with homogeneity*) of Level >2 economic studies
2b	Individual cohort study (including low quality RCT; e.g., <80% follow-up)	Retrospective cohort study or follow-up of untreated control patients in an RCT; Derivation of CDR” or validated on split-sample§§§ only	Exploratory** cohort study with good” ” ” reference standards; CDR” after derivation, or validated only on split-sample§§§ or databases	Retrospective cohort study, or poor follow-up	Analysis based on clinically sensible costs or alternatives; limited review(s) of the evidence, or single studies; and including multi-way sensitivity analyses

2c	“Outcomes” Research; Ecological studies	“Outcomes” Research		Ecological studies	Audit or outcomes research
3a	SR (with homogeneity*) of case-control studies		SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies	SR (with homogeneity*) of 3b and better studies
3b	Individual Case-Control Study		Non-consecutive study; or without consistently applied reference standards	Non-consecutive cohort study, or very limited population	Analysis based on limited alternatives or costs, poor quality estimates of data, but including sensitivity analyses incorporating clinically sensible variations.
4	Case-series (and poor quality cohort and case-control studies§§)	Case-series (and poor quality prognostic cohort studies***)	Case-control study, poor or non-independent reference standard	Case-series or superseded reference standards	Analysis with no sensitivity analysis
5	Expert opinion without explicit critical appraisal, or based on physiology, bench research or “first principles”	Expert opinion without explicit critical appraisal, or based on physiology, bench research or “first principles”	Expert opinion without explicit critical appraisal, or based on physiology, bench research or “first principles”	Expert opinion without explicit critical appraisal, or based on physiology, bench research or “first principles”	Expert opinion without explicit critical appraisal, or based on economic theory or “first principles”

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