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| **CRITICALLY APPRAISED TOPIC** |

**FOCUSED CLINICAL QUESTION**

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| In patients suffering from headaches secondary to post-concussion syndrome (PCS), will they have better improvement from manual interventions and exercise versus therapeutic exercise alone at decreasing their headache symptoms (decreased frequency, duration, or intensity) within one year.  |

**AUTHOR**

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| **Prepared by** | Robbey Lindstedt | **Date** | 11/30/2021 |
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**CLINICAL SCENARIO**

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| The patient is a 29-year old who suffered a concussion after hitting his head on the ground during a recreational soccer game. Patient did not lose consciousness but was stunned for 20-30 seconds. Patient has rarely had any issues with headaches in the past, but now is having headaches secondary to sustaining a concussion. Patient underwent imaging and there were no notable issues with his brain nor cervical spine. The patient is limited in his ability to participate at work and recreational activities because his headache symptoms are debilitating. In attempting to provide the best evidenced-based interventions to reduce his headaches, I would like to know which treatment style, manual intervention with exercise or exercise alone, has better outcomes at decreasing headaches symptoms (frequency, duration, or intensity). Regarding post-concussion syndrome, there is not a lot of research specific to this condition. There is a clinical practice guideline (CPG) that was developed and published in 2020, but there are numerous conflicting opinions and limited high quality research about the best options for various symptoms secondary to PCS. Furthermore, with respect to headaches that resulted from PCS, there is almost no high quality RCT research that tries to establish the best protocol for this situation. Therefore, it is critical that we begin to fund research around PCS because the CDC estimates that there are 1.5 to 3 million sport concussions and motor vehicle accident concussions each year. With that, 10-15% of these people can have lingering, chronic symptoms that be impact their quality of life. Headaches are a critical symptom to address because these can be associated with or even cause reduced concentration, attention, and memory, and cause negative behavioral problems such as anxiety, depression, or irritability. Thus, if we can find evidenced-based therapeutic interventions that can reduce headache symptoms, then we can provide vital services to improve the quality of life of people who have suffered a concussion.  |

**SUMMARY OF SEARCH**

[Best evidence appraised and key findings]

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| Eight studies met the inclusion criteria including 2 systematic reviews, 4 RCTs, 1 journal article review, and 1 case study. * There are no set dosage or timing for PCS symptom management at this time, so clinicians must use their clinical judgement to implement physiological, vestibulo-ocular, and cervicogenic interventions appropriate to the patient presentation.3
* Upper cervical spine mobilization has greater clinical benefit than massage therapy at improving headache pain parameters in patients with cervicogenic headches.4
* Cervical and vestibular interventions in combination with progressive exercise compared to progressive exercise alone are nearly 10x more likely to receive medial clearance to return to sport within an 8-week treatment program.6
* Cervical manipulation and exercise in patients with neck pain was most effective at reducing headache frequency, duration, severity, and improving headache disability. 7
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**CLINICAL BOTTOM LINE**

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| Patients who are recreationally active and sustain a sport-related concussion can have persistent symptoms such as dizziness, headaches, and/or neck pain. There is no standardized protocol to manage these patient symptoms, but research around this subject has provided vital information. Incorporating a plan of care that combines exercise and manual therapy, specifically cervical mobilization techniques, has shown to improve patient’s headaches associated with concussions and other pathologies. Manual interventions can be therapeutic for all patients, but pain relief may be temporary. Furthermore, for patients who have a sport-related concussion diagnosis, improvements in the SCAT2 and DHI scores are associated with increased likelihood of medical clearance from a physician to return to sport within 8 weeks of initial treatment.  |

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| ***This critically appraised topic has been individually prepared as part of a course requirement and has been peer-reviewed by one other independent course instructor*** |

*The above information should fit onto the first page of your CAT***SEARCH STRATEGY**

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| **Terms used to guide the search strategy** |
| **P**atient/Client Group | **I**ntervention (or Assessment) | **C**omparison | **O**utcome(s) |
| Post-concussion syndromeMild TBImTBI concussion traumatic brain injury acute injury | Manual intervention MassageJoint mobilization Muscle energy technique METJoint manipulation Stretching Trigger pointDry needling  | Cervical exercisesCervical isometrics Cervical proprioceptive training Thoracic musculature exercisesConcentric Eccentric Progressive overloading   | Improve\* headache (decrease intensity, frequency, duration) Cervicogenic headache Migraine  |

**Final search strategy (history):**

*Show your final search strategy (full history) from PubMed. Indicate which “line” you chose as the final search strategy.*

**Sadly, I lost all my MeSH terms and results associated with my research after an excel document crashed. Therefore, at the time of submitting this assignment, my professor was understanding and let me utilize the information I still had access to. I will make sure to have this information for the article write up in the future.**

**PudMed:**

((headache\*) AND (exercis\*)) AND (manual intervention\* OR massage OR trigger point) Filters: Full text, Randomized Controlled Trial. (Results 18)

Search: ((post-concussion syndrome OR mTBI OR concussion) AND (headache\* OR migraine OR tension headache) AND ((fft[Filter]) AND (1995:2022[pdat]))) AND (therapeutic exercise OR rehab OR exercise OR physical therapy) Filters: Full text, Randomized Controlled Trial. (Results 335)

(post-concussion syndrome OR mTBI OR concussion) AND (headache\* OR migraine OR tension headache) Filters: Full text, from 1995 – 2022. (Results 917)

Search: (post-concussion syndrome OR mTBI OR concussion) AND (headache\* OR migraine OR tension headache) Filters: Full text. (Results 981)

Search: (post-concussion syndrome OR mTBI OR concussion) AND (headache\* OR migraine OR tension headache). (Results 1128)

**Search: ((post-concussion syndrome OR mTBI OR concussion) AND (headache\* OR migraine OR tension headache) AND ((fft[Filter]) AND (1995:2022[pdat]))) AND (therapeutic exercise OR rehab OR exercise OR physical therapy) Filters: Full text, Randomized Controlled Trial. (Results 10)**

**CINHAL:**

MeSH terms I utilized in various orders:

* headaches or migraine or tension headache
* mtbi or mild traumatic brain injury or concussion
* therapeutic exercise or rehab or exercise or physical therapy
* Isometric OR Concentric OR Eccentric
* Whiplash
* manual therapy or mobilization or manipulation
* Isometric exercise
* Isometric OR concentric OR eccentric contraction
* massage OR manual intervention OR trigger point therapy
* therapeutic exericis\*
* Cervical exercise

**(mtbi or mild traumatic brain injury or concussion ) AND ( therapeutic exercise or rehab or exercise or physical therapy ) AND ( headaches or migraine or tension headache ). (Results 25)**

**PEDro:** Variations of these inputs

Abstract and Title: concussion headaches, post concussion headaches, headaches, concussion

Therapy: stretching, mobilization, manipulation, massage

Problem: pain

Body part: head or neck

Topic: Chronic pain, whiplash

Publish date: 1995

Method: none, clinical trails,

When searching: Match all terms with (AND), Match all terms with (OR)

*In the table below, show how many results you got from your search from each database you searched.*

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| **Databases and Sites Searched** | **Number of results** | **Limits applied, revised number of results (if applicable)** |
| PubMEDCINHALPEDro  | 10250-60 | Filters: Full text, Randomized Controlled Trial.  |
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## INCLUSION and EXCLUSION CRITERIA

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| **Inclusion Criteria** |
| 18 years old <X< 65 years old mTBI, post-concussion syndrome 1980-present Published in English RCTs, Controlled trails, Uncontrolled trails, Systematic reviewed, Meta-analysis  |
| **Exclusion Criteria** |
| Anything grader than a mild TBI Abstracts, conference proceedings, dissertations, and letters to the editors Studies that involve adults with confounding co-morbidities such as strokes, SCI, or pre-existing moderate to severe traumatic brain injury |

**RESULTS OF SEARCH**

**Summary of articles retrieved that met inclusion and exclusion criteria**

*For each article being considered for inclusion in the CAT, score for methodological quality on an appropriate scale, categorize the level of evidence, indicate whether the relevance of the study PICO to your PICO is high/mod/low, and note the study design (e.g., RCT, systematic review, case study).*

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| **Author (Year)** | **Risk of bias (quality score)\*** | **Level of Evidence\*\*** | **Relevance** | **Study design** |
| Johna K. Register-Mihalik (2018)[1](https://sciwheel.com/work/citation?ids=6613050&pre=&suf=&sa=0&dbf=0) | AMSTAR 2: Critically Low  | Level 3A | Downgrade to Minimal—does not go into details about specific PT interventions exercises and modalities for headaches  | Journal Article Review  |
| Niels Nilsson (1995)[2](https://sciwheel.com/work/citation?ids=11703571&pre=&suf=&sa=0&dbf=0) | PEDro: 7/11 Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: No; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: Yes; Key outcome obtained from more than 85% obtained subjects: Yes ;Intention-to-treat analysis: No; Between-group comparisons: Yes; Point estimates and variability: Yes. | Level 1B | Moderate | RCT |
| Quatman-Yates et al (2016)[3](https://sciwheel.com/work/citation?ids=2527055&pre=&suf=&sa=0&dbf=0)  | AMSTAR 2: High  | Level 1A | High/Moderate  | Systematic Review  |
| Youssef et al (2013)[4](https://sciwheel.com/work/citation?ids=7365650&pre=&suf=&sa=0&dbf=0)  | PEDro: 7/11 [Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: No; Adequate follow-up: Yes; Key outcome obtained from more than 85% obtained subjects: Yes ; Intention-to-treat analysis: No; Between-group comparisons: Yes; Point estimates and variability: Yes. Note: Eligibility criteria item does not contribute to total score]  | Level 2B | Moderate  | RCT  |
| Leddy et al (2017)[5](https://sciwheel.com/work/citation?ids=6098514&pre=&suf=&sa=0&dbf=0) | AMSTAR: Low  | Level 1A | Moderate  | Systematic Review |
| Schneider et al (2014)[6](https://sciwheel.com/work/citation?ids=1102375&pre=&suf=&sa=0&dbf=0)  | PEDro: 9/11 [Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: Yes; Key outcome obtained from more than 85% obtained subjects: Yes ;Intention-to-treat analysis: Yes; Between-group comparisons: Yes; Point estimates and variability: Yes.] | Level 1A  | Moderate  | RCT |
| [Corum](https://www-sciencedirect-com.libproxy.lib.unc.edu/science/article/pii/S1744388121000189?via%3Dihub" \l "!) et al (2021)[7](https://sciwheel.com/work/citation?ids=11569265&pre=&suf=&sa=0&dbf=0)  | PEDro: 8/11 [Eligibility criteria: Yes; Random allocation: Yes; Concealed allocation: Yes; Baseline comparability: Yes; Blind subjects: No; Blind therapists: No; Blind assessors: Yes; Adequate follow-up: Yes; Key outcome obtained from more than 85% obtained subjects: Yes ; Intention-to-treat analysis: No; Between-group comparisons: Yes; Point estimates and variability: Yes. | Level 1B  | High/Moderate | RCT |
| Hunt (2018)[8](https://sciwheel.com/work/citation?ids=11703890&pre=&suf=&sa=0&dbf=0) | Downs and Black: 5/31 | Level 4 | Low  | Case Study |

\*Indicate tool name and score

\*\*Use Portney Table 36-1: Summary of Levels of Evidence (2020). If downgraded, indicate reason why.

**BEST EVIDENCE**

The following 2 studies were identified as the ‘best’ evidence and selected for critical appraisal. Rationale for selecting these studies were:

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| * Quatman-Yates et al (2016)[9](https://sciwheel.com/work/citation?ids=11703631&pre=&suf=&sa=0&dbf=0) is an article that provide the “best” evidence to answer my PICO because it has an AMSTAR 2 score of High which was the only systematic review which scored this well due to comprehensive literature search strategy, a satisfactory technique for assessing risk of bias (RoB), and details about inclusion/exclusion criteria. Additionally, this systematic review specifically focuses on my population, mTBI. They accessed varies interventions individually such as physiological and cervico-vestibular, which is relevant to my PICO question. Therefore, this gives us more confidence to relate this systematic review results to my specific population at question.
* Schneider et al (2014)[6](https://sciwheel.com/work/citation?ids=1102375&pre=&suf=&sa=0&dbf=0) is the best evidence to help understand my PICO because it has an 9/11 in the PEDro score for RCT. Since it’s a RCT, This specifically targets post-concussion patients and heavily implements cervical interventions to help with headaches. 14/15 of the treatment group and 15/16 of the control group had baseline characteristics of headaches which establishes that the majority of the participants where symptomatic, so this establishes a homogenous scenario with my clinical question. This article also implements manual and exercise interventions which is critical to my PICO. Additionally, this article evaluates speed of medical clearance in individuals which is indicative of concussion symptom management and reduced symptoms.
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**SUMMARY OF BEST EVIDENCE**

**(1) Description and appraisal of (Physical Rehabilitation Interventions for Post-mTBI Symptoms Lasting Greater Than 2 Weeks: Systematic Review) by (Quatman-Yates et al., 2016)**

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| **Aim/Objective of the Study/Systematic Review:** |
| Quatman-Yates et al. conducted a systematic review of literature to identify possible rehabilitation interventions that are safe, feasible, and within the scope of practice for physical therapists (PTs) to utilize with patients who have persistent post-mTBI symptoms. The authors concluded that there are numerous physical therapy interventions that can be utilized on patient who have suffered a mTBI with minimal risk for adverse outcomes. However, there is limited suggestions for ideal dosing parameters for these interventions because there are a small number of studies (8), heterogenous intervention protocols, and low levels of study designs.  |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| This study is a systematic review of RCT, quasi-experimental, and case series.**Search Strategy:** The authors performed a literature search using the following multiple search terms to capture all possible interventions. They used a two-stage process to improve the search which the first stage consisted of screening articles titles and abstracts. The second stage consisted of reviewing the full texts of articles from the first stage and adding more articles due to this stage being implemented 17 months later. They screened a total of 3,337 articles, but simply considering full text articles, the number of articles reduced to 38. **Selection Criteria:** RCTs, quasi-experimental, and case series that were relevant to mTBI were evaluated by a 2 person team, but if any discrepancies occurred between them, then a 3rd evaluator would partake in the evaluation process. All three members must have an unanimous consensus to consider the article. Inclusion criteria consisted of physical rehabilitation intervention studies, published in English in a peer-reviewed format, human participants with a biomechanical mild traumatic brain injury or concussion and with symptoms lasting at least 2 weeks, and a mean age of at least 8 years old. While exclusion criteria consisted of blast injuries, moderate or severe traumatic brain injuries, psychosis, and case reports with fewer than 10 participants. The two-stage approach yielded 8 articles after all inclusion and exclusion criteria were considered.**Methods:** An online search was performed by the authors on electronic databases PubMed, Cochrane Library, CINHAL, Scopus, SPORTDiscus, and Web of Science were methodically searched from inception until June 28, 2015. The process of screening each article consisted of evaluating the title and abstract first, then transitioning to content in each article to make the final decision on what would be included versus excluded. After full-text review by the same 2 members and verified by the 3rd member, studies were classified into three categories based on the intervention because each type correlated with different PCS/PCD (Post-concussion disorders). These categories consisted of physiological interventions, vestibulo-ocular interventions, and cervicogenic interventions. Each article was quality appraised via the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach. This quality assessment allowed the authors to rate each article into high, moderate, low, and very low. Furthermore, each study was evaluated via the Cochrane Risk of Bias tool to objectively qualify them based on specific features. Based on this process, the authors were able to provide an objective conclusion about physical rehabilitation interventions for mTBI symptoms.  |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| The systematic review did not specify what setting each of the articles were in. However, they utilized physical therapists and patients with symptoms consisting of at least two weeks, so I would infer that the primary setting for these will be an out-patient clinic. This is critical to consider because it will relate to the relatability of the results to my patient population.  |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| Out of the 8 articles reviewed, there were a total of 312 participants. All of these articles met the inclusion and exclusion criteria stated above. 3 of the 8 articles focused on children (n= 57) with a mean age of around 15 years old. The other 5 articles mean age was around 30 years old with one of the articles splitting their pooled participants into two age groups (8-18 and 19-73). Each of the articles were focusing on either physiological intervention, vestibulo-ocular intervention, and/or cervicogenic intervention. Also, these authors focused on length of time between initial concussion injury/mTBI and the initial evaluation which ranged from 33 days to 270 days (9 months). However, one article did take participants up to 71 months after initial injury. The final GRADE rating for 5 of the 8 articles were very low, one article was graded as low, and two were graded as High. Overall, the authors did not go into great depth about the participants of each article, rather they focused on outcome measures and results.  |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| Physiological studies: These studies focused on a form or multiple forms of progressive exercise treatment, which could be aerobic or anaerobic in nature. Leddy et al. utilized a healthy group of individuals to compare results of fMRI activation patterns. Schneider et al. utilized all three intervention types and how they structured the study was by making the control and experimental group partake in exercise treatment. Leddy et al. performed another study focusing on sub-symptomatic threshold exercise, which was a prospective cohort study utilizing 6 athletes and 6 non-athletes whom all were on average 19 weeks postinjury. Gagnon et al. performed 2 case series that were utilized in this systematic review. The first implemented a graded exercise program at 50% to 60% max capacity on a treadmill or bike for 16 children. The follow-up case series utilized 10 children following the same exercise protocol.Vestibulo-ocular studies: This intervention category consisted of 2 studies which implement some form of vestibular rehabilitation. Schneider et al. utilized vestibular interventions in their study and the control simply performed exercise treatment. Alsalaheen et al. performed a case study on 114 consecutive patients from a teritary balance center for vestibular rehabilitation after a concussion and since this was a case study, there was no control. Cervicogenic studies: Jensen et al. utilized a RCT method for their study and utilized cold packs on the patient’s neck for 15-20 minutes as their control. All 19 patients had a confirmed concussion diagnosis and time since injury ranged from 302 to 423 days. 9 of the 19 were the control and 10 of the 19 were in the experimental group. Jensen et al. treatment focused on posttraumatic headaches from mild head injuries. The other study in this group is Schneider et al. which their study has been previously explained.  |
| *Experimental* |
| Physiological studies: Baker et al. utilized a progressive exercise protocol (unidentified in this systematic review) and 41/57 participants completed the program and returned to full daily functioning based on this physiological based PCS group. Leddy et al. utilized 2 experimental groups which consisted of a placebo stretching group and an exercise group. These authors performed an experiment with fMRI activation patterns during a cognitive task, exercise capacity, and change in PCS symptoms. The intervention group exercised for 20 minutes a day with a heart rate monitor for 6 days/week and adjusted the heart rate threshold as symptom exacerbation increased. The stretching group was given a standard, progressive 12-week program consisting of low impact breathing and stretching. Leddy et al.’s other study focusing on sub-symptomatic threshold exercise used a standard Balke protocol on a treadmill to the first sign of symptom exacerbation. These 12 participants were tested at baseline and after a 2-3 week period. Once they performed the second exercise test, the participants executed an erobic exercise for the same duration that they achieved during the prior treadmill test, but at an intensity of 80% of their max treadmill heart rate once per day for 5-6 days/week. Treatment period lasted from 11 to 112 days depending on the participant. Gagnon et al.’s first case series applied a protocol where children participated in 5 to 15 minutes of aerobic activity at their initial visit before symptom exacerbation. Each bout of exercise would gradually increase overtime as symptoms exacerbation would allow. The mean duration of intervention was 4.4 weeks. Gagnon et al’s second case series utilized a similar intervention protocol and the intervention period lasted a mean of 6.8 weeks. An independent study evaluator was utilized to access all adolescents twice at approximately 6 weeks apart. Vestibulo-ocular studies: Schneider et al. treated the intervention group once weekly for 8 weeks or until medical clearance for return to sport. Alsalaheen et al. interventions were individualized programs for each patient’s impairments and limitations related to dizziness, ocular-motor function, gait dysfunction, and balance issues. Ultimately, this case study utilized “gaze stabilization, standing balance exercises, walking with balance challenges, and, in a few cases, canalith reposition” (pg. 1761). Cervicogenic studies: Jensen et al. utilized various treatment techniques consisting of mobilization, manipulations, and MET to the cervical and thoracic spine. No explanation of treatment length or other details relevant to interventions strategies.  |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| Physiological studies: Baker et al. utilized a composite classification system of full recovered, partially recovered, or not recovered. Leddy et al. first study with a stretching group and an exercise group’s fMRI assessed outcome measures associated with the fMRI, exercise HR, symptoms, and cognitive performance. Leddy et al.’s other study focusing on sub-symptomatic threshold exercise evaluated outcome measures associated with more exercise such as exercise duration, BP, HR, perceived exertion, oxygen consumption, and symptoms. Gagnon et al.’s first case series implemented outcome measures focusing on duration tolerance of aerobic activity and self-report of symptoms. Gagnon et al 2nd series also utilized self-report of symptoms, but additional outcomes of mood, energy level, cognitive functioning, balance, and coordination.Vestibulo-ocular studies: Schneider et al. performed a RCT that was associated with all 3 categories of studies and utilized outcome measure that can be beneficial to understand in each category’s implications on PCS symptoms. This group of authors utilized number of days until medical clearance to return to sports, pain, balance confidence scale, dizziness handicap index, SCAT 2, dynamic visual acuity, head trust test, modified motion sensitivity test, FGA, cervical flexor endurance, and joint position error test. Alsalaheen et al. utilized multiple outcome measure consisting of self-reports of dizziness, balance confidence, and disability. Furthermore, these authors utilized DGI, FGA, TUG, 5x STS, and posturography. Cervicogenic studies: Jensen et al. outcome measures were cervical ROM, pain index, and symptoms. Schneider et al. outcome measures as stated above can be utilized in this category to understand cervicogenic intervention effectiveness.  |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. You may summarize results in a table but you must explain the results with some narrative.] |
| Physiological studies: Baker et al. found that 72% of all participants who participated in the exercise intervention group returned to full daily functioning. Only 1 of the 6 who declined the intervention returned to full function. No adverse effects were noted with their interventions. Leddy et al. first study with a stretching group had no adverse effects and that the exercise group and healthy cohort had similar findings in their fMRI, but the stretching group had greater activation of certain parts of the brain. Additionally, the exercise group showed increase capacity to exercise with fewer symptoms. Leddy et al.’s other study focusing on sub-symptomatic threshold exercise had statistically significant improvements in peak HR during exercise, peak BP during exercise, and symptoms with exercise time compared to the control. Gagnon et al.’s first case series showed that all participants had improvement in duration tolerance and in symptoms. Gagnon et al. 2nd series participants demonstrated significant improvements in energy, mood, cognitive processing speed, and symptoms. Specifically, Gagnon et al found that PCS symptoms significantly decreased from initial assessment to second assessment with a Cohen d value of 1.83. Additionally, these same participants had a statistically significant improvement in fatigue levels and depression scores with a Cohen d value of 0.48 to 2.44. Furthermore, cognitive processing speed improved for the participants with a Cohen d score of 0.54. In conclusion of all the data presented for physiological studies, it can be determined that improvements in self-report symptoms and function can all be improved with the completion of various protocol interventions. Furthermore, patient who have suffered a concussion and have lingering symptoms can have their duration and/or tolerance to aerobic exercise improved, cardiovascular capabilities improved, mood and energy levels improved. Another important component to this category is balance improvements. Gagnon et al showed no significant changes in balance and coordination, but Schneider et al did show improvements in balance and coordination specific to the group that received manual therapy and vestibular therapy. Therefore, this implies to create improvements in balance and coordination, then we should focus on vestibular therapy and manual therapy over exercise interventions. Sadly, minimal statistical data is provided about these articles in regard to the outcome measures. Vestibulo-ocular studies: Schneider et al. found that after an 8-week program that 73% of the treatment group was medically cleared to return to play, while the control group only had 7% return to play. Furthermore, with an intension-to-treat analysis, they determined the treatment group was nearly 4x more likely to be medically cleared to return to sport by 8 weeks and no adverse events were reported to the team. Alsalaheen et al. observed significant improvements for all self-report, gait, and balance measures. No adverse effects were noted relative to this intervention. Specific to vestibulo-ocular studies, both studies proved that self-report of symptoms and function, balance, gait, and motion sensitivity assessment will all improve with vestibulo-ocular interventions. Schneider et al. showed those receiving vestibulo-ocular interventions would get medical clearance to return to activities faster. They also found that significant treatment interaction between the treatment and age because children had greater improvement in dizziness severity reports and balance performance over the course of treatment. While all other outcome measures were similar between younger and older cohorts. Cervicogenic studies: Jensen et al. found that the manual therapy group had a 43% decrease in pain index compared to their pretreatment scores. No adverse effects were noted with this group’s interventions, however they noted that the pain relief may be temporary. Schneider et al. again proved that these patients receiving interventions can get medical clearance faster and return to activity. Both studies in this category showed improvements in symptoms, but Jensen et al. noted that these can be temporary. Jensen et al. also noted that the most prominent symptom for their participants were headaches, thus all participants benefited from manual therapy.  |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| To reiterate, the purpose of this systemic review was to find if interventions for PTs are safe, feasible and appropriate for patients who have suffered from post-mTBI symptoms. Ultimately, there is minimal evidence for each intervention category, but evidence is supporting that the benefit of treatments will outweigh potential risk for adverse effects. The highest evidenced based intervention implemented was manual therapy to the “cervical and thoracic regions when patients reported headaches and dizziness” (pg. 1761). Vestibular treatments may benefit patients suffering from persistent symptoms but may be most beneficial to a subset of patients. However, there is no clear differentiation between those who are in this specific subset. Furthermore, the authors stated that progressive exercise training consisting of aerobic, anerobic, and coordination exercises can offer a good opportunity for PTs to support their patient’s recovery. We need additional studies to determine efficacy, dosing, and essentially understand significant variables associated with progressive exercise. The authors acknowledge that many of the studies in this systematic review have several, large limitations for the conclusions they draw which include small sample sizes, low study designs, and sample compositions. Many of the articles have heterogenic outcomes which makes standardizing a protocol or comparing results difficult. Since many of the articles utilized a self-report measure, this adds another dimension of subjectivity because people may not notice subtle changes, they may ignore or exaggerate symptoms, and they may not understand the various increases in symptoms to achieve therapeutic benefits. There is little to no information about how to optimize treatments by focusing on specific interventions in a chronological or systematic order, so PTs must use their clinical expertise to individualize plans. Lastly, the large difference in intervention initiation was significant in these articles because it ranged from 33 days to 71 months post injury which drastically impacts chronicity of symptoms and how likely they’re to resolve.  |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| The article itself did a good job trying to improve the legitimacy of article synthesis. They did a thorough job with implementing objective methods and engulfing a large amount of research article potentials. They scaffolded their research design by performing 2 large research strategies on Jan. 18, 2014 and June 28, 2015. They utilized 2 members to screen all articles and a 3rd to help resolve discrepancies between the two reviewers. Furthermore, they utilized two quality assessment strategies, which each study was appraised by the Grades of Recommendation, Assessment, Development, and Evaluation (GRADE) approach. The 2nd assessment attempted to minimize any potential biases by utilizing the Cochrane Risk of Bias Tool which makes a quality judgement based on criteria that address specific features of a study. The weaknesses of this systematic review were due to limited evidence about mTBI interventions. Furthermore, their ability to analyze data is weak because of the large variation in intervention protocols and low levels of study design. Furthermore, the article did to provide statistical data, even on themselves. They did not perform an internal consistency assessment consisting of intrarater and interrater reliability. Also, the authors commented on limitations that they are aware of. The first being their key word searches because the database search is inherently limited by each websites algorithm. The second is acceptance that the group of reviewers may have misunderstood the findings in a study. Lastly, the use of the GRADE approach has subjectivity to it so a different set of reviewers may have judged the evidence differently. Overall, I think the authors did a good job trying to manage the variables they could with the diverse articles that fit the inclusion/exclusion criteria. They utilized two screeners to increase the validity of each article utilized which improves the consistence and trustworthiness of their analysis. If any discrepancies did occur, then they utilized a 3rd screener which all three had to have an unanimous agreement to utilize the article. The authors attempted to apply safeguards to their review, but limitations do occur. Ultimately this systematic review is valid and provides the best, up-to-date, and unbiased opinion about rehabilitation interventions for patient who have post-mTBI symptoms.  |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| The critical components from this systematic review about rehabilitation interventions for patients who have suffered a concussion and have linger symptoms are that physiological, vestibulo-ocular, and cervicogenic strategies can be implemented in any patient’s plan of care to have a therapeutic effect. Depending on the symptoms presented by the patient, certain techniques may be better suited for them. If an athlete is struggling with aerobic activity tolerance, fatigue levels, cognitive functioning, cardiovascular capabilities, and/or duration of activity, then physiological interventions can be beneficial. There are no set timing, dosing, and other parameters are this point in time so it’s best to use clinical judgement. Vestibulo-ocular techniques will best benefit patients who are suffering from balance and coordination dysfunctions. This subgroup of patients with vestibular issues will been most from these techniques versus utilizing these vestibulo-ocular interventions on all patients. Cervicogenic interventions can create improvements in symptoms, but these may be only temporary benefits. However, nearly all participants did benefit from manual therapy though which is a technique almost all PTs are trained in. All intervention types have been found to have therapeutic benefits that outweigh any adverse effects because all authors of the 8 articles included in this systematic review reported that they did not have any patient issues. Therefore, it is safe to implement any appropriate intervention that addresses patient symptoms or issues secondary to having a mild TBI injury.  |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| The systematic review does a good job including all ages that an out-patient clinic would see because they incorporate articles that have participants ranging from 8 years old to 73 years old. Additionally, they include athletes and non-athletes which makes this more relatable to the general population. Specific to my PICO question, Jensen et al.’s study relates most because the mean age of the 23 participants was 31.6 years old and they focused on neck ROM, pain index, and various symptoms, but most notably headaches. The feasibility of the various interventions implemented seem to be practical and feasible besides the fMRI study by Leddy et al.. Furthermore, the outcome measures utilized in all the articles are applicable because many are already used in the clinic such as TUG, DGI, FGA, 5x STS, self-report measures, neck ROM, exercise HR and BP, dynamic visual acuity test, and joint position error test. Therefore, this systematic review is highly applicable to the clinical scenario because it provides vital information about headache management, but it goes provide extra detail about other PCS symptoms.  |

**(2) Description and appraisal of (Cervicovestibular rehabilitation in sport-related concussion: a randomised controlled trail) by (Schneider et al, 2014)**

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| **Aim/Objective of the Study/Systematic Review:** |
| Concussion is the most common injury in sports and most individual recover organically over 7-10 days, but some have persistent symptoms that will be debilitating. Therefore, the aim of the study is to determine if vestibular rehab and the combination of cervical oriented therapy by a PT will decrease the time it takes to get medical clearance in individuals with prolonged PCS.  |
| **Study Design**[e.g., systematic review, cohort, randomised controlled trial, qualitative study, grounded theory. Includes information about study characteristics such as blinding and allocation concealment. When were outcomes measured, if relevant]Note: For systematic review, use headings ‘search strategy’, ‘selection criteria’, ‘methods’ etc. For qualitative studies, identify data collection/analyses methods. |
| These authors utilized a RCT study design while utilizing consecutive patients from the University of Calgary Sport Medicine Center with persistent PCS symptoms of headaches, neck pain, and/or dizziness related to a sport concussion. This sport concussion was based on the Third International Consensus Conference on Concussion in Sport and persistent symptoms was defined as greater than 10 days. Patients were screened by a physician while they utilized the Sport Concussion Assessment Tool 2 (SCAT 2) between Nov. 2010 and Oct. 2011. If clinical examination was suggestive of vestibular and/or cervical spine involvement, participants were referred to a PT. Once referred, patient consented to participant and where randomly allocated to control or intervention group. A computer-generated randomisation sequence was performed by a biostatistician not directly involved in the study to ensure balanced groups. The primary outcome was medical clearance to return to sport (days), which was determined by a sport medicine physician who was blinded to the study treatment grouping of patients. One study PT assessor evaluated the secondary outcome measures and was masked to the treatment grouping at time of assessment and reassessment. Subjects and PT who performed interventions were not blinded. These authors provided adequate follow up and the key outcome measure, medical clearance to return to sport after 8 weeks of treatments, was obtained for more than 85% of the subjects. |
| **Setting**[e.g., locations such as hospital, community; rural; metropolitan; country] |
| This RCT was performed at University of Calgary Sport Medicine Center which is in Alberta, Canada. This is a metropolitan area.  |
| **Participants**[N, diagnosis, eligibility criteria, how recruited, type of sample (e.g., purposive, random), key demographics such as mean age, gender, duration of illness/disease, and if groups in an RCT were comparable at baseline on key demographic variables; number of dropouts if relevant, number available for follow-up]Note: This is not a list of the inclusion and exclusion criteria. This is a description of the actual sample that participated in the study. You can find this descriptive information in the text and tables in the article. |
| All participants were required to be evaluated by a physician and receive a diagnosis of sport-related concussion and have persistent symptoms (>10 days) of dizziness, neck pain, and/or headaches. There were 48 individuals referred for participation, but 12 did not meet the inclusion criteria, 1 declined to participate, and 14 did not respond. 2 control participants withdrew from the study and the two that withdrew who similar baseline characteristics to the other participants in the study. Therefore, there were 18 males and 13 females that aged from 12-30 years old. They were recruited consecutively but randomized to the control or intervention group. Majority of the participants had vestibular involvement (12/15 of treatment group and 14/16 in the control group) and all had cervical spine involvement at baseline. Additionally, at baseline, headache complaints were 14/15 and 15/16 for the treatment group and intervention group respectively. The time since initial concussion injury was on average 53 days (8-276 days) for the treatment group and on average 47 days (31-142 days) for the intervention group. Both groups had an average age of 15 years old with a range of 12-27 and 13-30 for the treatment group and intervention group respectively. Another consideration for the participants characteristics is if they had a previous concussion, which 55.3% (8/15) of the control group had a previous concussion and 75% (12/16) of the control group did as well. Overall, both groups were comparable and had similar characteristics at baseline.  |
| **Intervention Investigated**[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided] |
| *Control* |
| After a sport-related concussion diagnosis from a physician, participants who consent to the study were randomly allocated to a group. Once in the control group, participants were seen once a week for 8 weeks by a PT or until medial clearance. This control group performed non-provocative ROM exercises, stretching, postural education, and current standard of care protocol for sport related concussion which is rest until symptom free. Once symptom free, then the PT implemented graded exertion. Participants were ask to keep a daily diary for their HEP. The treating PT had 13 years of clinical experience and expertise in MSK and vestibular rehabilitation.  |
| *Experimental* |
| The same process occurred for the experimental/intervention group. Once randomly allocated to this group, they did receive individualized rehabilitation consisting of cervical spine PT and vestibular therapy once a week for 8 weeks or until medically cleared. The plan of care for each individual was reassessed by the treating PT every clinical visit and were determined following a clinical pathway program (unable to access this document). Cervical spine interventions included joint mobilization on cervical and thoracic spine, cervical neuromuscular retraining exercises (craniovertebral flexors and extensors), and sensorimotor retraining exercises. Vestibular rehabilitation included habituation, gaze stabilization, adaptation exercises, standing balance exercises, dynamic balance exercises, and canalith repositioning manoeuvres. A general rule of thumb for the treating PT was that symptoms of headaches must be controlled prior to initiation of vestibular adaptation and habituation exercises. Therefore, individuals were treated first with neuromotor retraining exercises, manual therapy, and sensorimotor retraining exercises prior to vestibular rehab.  |
| **Outcome Measures**[Give details of each measure, maximum possible score and range for each measure, administered by whom, where] |
| The primary outcome these authors focused on was number of days from treatment initiation until medical clearance to return to sport by a sport medicine physician. The secondary outcome measures consisting of 11-point Numberic Pain Rating Scale score, ABC scale, Dizziness Handicap Index (DHI), SCAT2, Dynamic Visual Acuity (DVA), Head Thrust Test, modified Motion Sensitivity Test (MSQ), Functional Gait Assessment FGA, Cervical Flexor Endurance (CFE), and Joint Position Error (JPE) test. Baseline questions and objective examination tests were recorded on a standardize form. The secondary outcomes were evaluated at baseline and at the time of medical clearance to return to sport or 8 weeks following initial intake (if the participant was not medically cleared by 8 weeks) by one study PT who was blinded to treatment grouping. The Number Pain Rating Scale focused on the neck/cervical region. The ABC scale is measured via a 0-100% scale and the higher number (100%) correlates with more impairments. DHI is scored 0-100 but has 3 categories within in which consist of physical (0-24), functional (0-36), and emotional (0-40). The SCAT2 is scored 0-100 and higher scores correlate with better function. DVA is based on lines on the Snellen visual eye chart and the more lines a patient can read while performing a dynamic activity, then that correlates with better visual function. Head thrust is determining a patient’s irritability to jolting motions of the cervical region. MSQ is on a scale 0-40 and a lower value correlates with less provoked dizziness with quick head or body motions. FGA is scored out of 30 and a higher score means a person has better gait and balance abilities. CFE is a timed test and the longer a person can hold these tests, then this correlates with better motor and neuromuscular function. Lastly, JPE is a test consisting of 3 trails in the left and right direction. The participant is trying to get within 7.1cm from the center to pass the test and the scoring correlates with the number of trails it takes to accomplish this. |
| **Main Findings**[Provide summary of mean scores/mean differences/treatment effect, 95% confidence intervals and p-values etc., where provided; you may calculate your own values if necessary/applicable. Use a table to summarize results if possible.] |
| The primary outcome being medical clearance to return to sport, 11/15 (73.3%) of the individuals in the treatment group achieved medical clearance within 8 weeks of treatment. While 1/14 (7.1%) of the individuals in the control group was medically cleared within 8 weeks of treatment. Thus, we can see that a large number of individuals were cleared in the treatment group compared to the control group, 66.2% with 95% CI of 40 to 92.3; p<0.001. Of those who completed the study, the treatment group individuals were 10.27x, 95% CI 1.51 to 69.56, more likely to be medically cleared within 8 weeks than the control group participants (χ2=13.08, p<0.001). Furthermore, if adding in the 2 individuals who dropped out of the control group into the analysis, then we can do more data analysis. If assuming these 2 were medically cleared to return to sport, then 3/16 (18%) were medically cleared. Thus, 55% (95% CI 25 to 84, p=0.002) more of the participants in the treatment group were medically cleared in 8 weeks than the control group. Of note, the 1 participant in the control group who was medically cleared was female and reported a history of 6 or more previous concussions. In regards to secondary outcomes, all participants who were medically cleared reported feeling 100% functionally and no symptoms of headaches or dizziness. Furthermore, 64% of the medically cleared individuals reported no neck pain. In the intervention group, individuals who were medically cleared to return to sport had greater improvement in SCAT2 (p=0.009) and DHI (p=0.019) than those in the intervention group not medically cleared.  |
| **Original Authors’ Conclusions**[Paraphrase as required. If providing a direct quote, add page number] |
| These authors determined that a greater percentage of adolescents and young adults will be medically cleared to return to sport by 8 weeks if the treatment protocol includes a combination of cervical treatment and vestibular rehabilitation in addition to progressive exercise. They suggest that future research focus on time since initial injury, age, mechanism of injury, and neurocognitive status on treatment effect. For athletes with persistent symptoms of dizziness, neck pain, and/or headaches following a sport-related concussion, a plan of care compromised of a sports medicine physician and a PT are warranted to improve function and return to sport sooner.  |
| **Critical Appraisal** |
| **Validity**[Summarize the internal and external validity of the study. Highlight key strengths and weaknesses. Comment on the overall evidence quality provided by this study.] |
| This is a high quality RCT consisting of a PEDro score of 9/11. They blinded evaluators to intervention and control group allocation. Each participant was randomly allocated to a group via a predetermined algorithm. The authors compared baseline characteristics to verify consistency between groups and their key outcome was obtain for more than 85% of their subjects. Furthermore, they performed an intention-to-treat analysis, between group comparisons, point estimates and variability testing which all indicate high-quality RCT. Another strength to this study is the outcomes utilized because many of these are already used in the clinic and many of the outcomes such as SCAT2, DVA, JPE, and DHI are already utilized in this population.Notable weaknesses are that these researchers gained participants by consecutive patients over a year at the same facility, did not blind participants nor treating clinicians, and had a large range of days following initial injury (8 days to 276 days). Other considerations are that the participants did not have proper neuropsychological testing nor vestibular functional testing, which could impact performance on the primary and secondary outcomes. Additionally, there was a relatively small sample size of 31 participants who finished the whole study. Lastly, this study only included 12-30 year olds, which it’s unknown if the same results will occur in other age groups. Overall this article is valid and has clinical applications for my PICO question because it’s a well developed and implemented RCT, gives 95% CI and p-values, provides thorough information on outcomes, blinded pertinent evaluators and accessor, and utilized a primary outcome measure that is safe, feasible, and reliable. |
| **Interpretation of Results**[This is YOUR interpretation of the results taking into consideration the strengths and limitations as you discussed above. Please comment on clinical significance of effect size / study findings. Describe in your own words what the results mean.] |
| This is a strong article that provides valuable information about PCS symptoms and how to properly manage them in the most efficient way. In the clinic, it seems that utilizing the SCAT2 and DHI will provide the most benefit in understanding a patient’s ability to get medical clearance to return to sport or recreational activity. There is no specific time frame from the initial injury when therapy will be most effective, but if a patient is having persistent symptoms post injury (>10 days) then they may have better or quicker resolution of symptoms (<8 weeks) to be able to return to recreational activities. Exercise alone does not seem to be enough in managing persistent PCS symptoms, so the combination of cervical and vestibular interventions is critical to succeed at reducing symptoms. Also, athletes will generally return to sport sooner if a PT does incorporate cervical and vestibular interventions into the plan of care, rather than solely relying on physiological progressive exercise. The authors provided details information on outcome changes from baseline to post intervention within groups and between groups, which allows for better data analysis.  |
| **Applicability of Study Results**[Describe the relevance and applicability of the study to your clinical question and scenario. Consider the practicality and feasibility of the intervention in your discussion of the evidence applicability.] |
| This study has significant clinical relevancy because it takes into consideration athletes 12-30 years old who sustained a sport-related concussion and has persistent symptoms of dizziness, neck pain, and/or headaches which directly relates to the PICO question/clinical scenario. The interventions implemented in this study are already used in the clinical setting and does not require any extra equipment (for the most part). The amount of outcome measures this study utilized is excessive for the clinical setting though, so it would be critical to focus on a few of the outcomes used. For instance, focusing on the primary outcome, medical clearance to return to sport, and secondary outcomes of SCAT2, DHI, headache pain score, and perceived feeling of 100% function will provide valuable information about the patient, but not overwhelm the clinician nor patient with numerous tests. I do think further research needs to evaluate variables such as age, time since initial injury, cognitive function, and history of concussions to understand how they impact the plan of care and the person’s ability to heal.  |

**SYNTHESIS AND CLINICAL IMPLICATIONS**

[Synthesize the results, quality/validity, and applicability of the two studies reviewed for the CAT. Future implications for research should be addressed briefly. Limit: 1 page.]

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| Both studies incorporated in the CAT attempt to understand how various interventions can improve persistent PCS symptoms. Both articles do provide supplemental information to other interventions not in question by the PICO. For instance, both the systematic review and RCT implement vestibular rehabilitation into the study which makes it difficult to differentiate what intervention was most effective. However, what we can take from the systematic review that is pertinent to the PICO question is that all participants can benefit from manual therapy, but it may be a temporary benefit. The benefits of utilizing this technique in addition to exercise has no to minimal adverse effects, so it should be implemented into the plan of care. Additionally, the RCT by Schneider et al. informs us that exercise alone is not more efficient to managing PCS symptoms such as dizziness, neck pain, and/or headaches compared to utilizing cervical and vestibular intervention. Cervical interventions did include manual techniques such as joint mobilizations of the cervical region. Additionally, Schneider et al.’s control group and intervention group had a mean value of 4/10 for headaches with a range of 0-8/10 and 0-7/10 for the control group and intervention group respectively. The treatment group who was medically cleared had a mean reduction of -3/10 with a range of -8 to 0/10. Something to note specific to headache pain, for those who were not medically cleared in the control group and intervention group is that both changed by -2.5/10, but the control group did have a range of -7 to 1/10 indicating that headaches did get worse for some while the intervention group had -4 to 0/10 indicating no one’s headaches got worse. Therefore, one could infer that cervical and vestibular interventions can manage or reduce headaches for patients who are suffering from post-concussion symptoms. The quality of both articles is high and relevant to the PICO question, but both have limiting factors to them. Furthermore, both articles have applicable components to the question at hand, but nothing specifically answer the question because there have not been any studies that focus on this population and comparing interventions of exercise and manual skills to them. However, an article to consider is by Corum et al.[7](https://sciwheel.com/work/citation?ids=11569265&pre=&suf=&sa=0&dbf=0) because they performed a RCT on patients with tension-type headaches and effects of spinal manipulation, myofascial release, and exercise in managing these patients. These patients do not have a diagnosis of PCS or anything related to a mTBI, however, they found that upper cervical spinal manipulation and exercise in these patients with neck pain were effective at “reducing headache frequency, severity and duration, improving headache disability and increase PPT [pressure pain threshold] posttreatment and at the third month follow up.”[7](https://sciwheel.com/work/citation?ids=11569265&pre=&suf=&sa=0&dbf=0)Therefore this reiterates the importance of utilizing both manual interventions and exercise to manage headache frequency, duration, and intensity in patients. Based on this information, future research needs to focus on persistent PCS symptoms that are debilitating to daily function and a patient’s ability to return to recreational activities. Many variables need to be isolated and analysed to generate a standardized protocol. For instance, specific scenarios of exercise versus manual intervention and exercise or vestibular versus manual interventions or dosage of exercise or frequency of exercise or initiation of rehabilitation after initial injury all need to be better understood.  |

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Attach a copy of the **2 articles** you critiqued (full text PDF) in your CAT when you submit your assignment.