CRITICALLY APPRAISED TOPIC

FOCUSED CLINICAL QUESTION

For a 12-year-old girl with mild TBI/concussion, are physical therapy interventions- such as therapeutic exercise, vestibular interventions, or manual therapy- effective in post-concussion symptom management of headache, nausea, neck pain, and dizziness when compared to rest.

AUTHOR

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CLINICAL SCENARIO

A 12 year old girl who was admitted to the ER after falling from her horse diagnosed with a mild-TBI/concussion during my clinical rotation with UNC hospital. Upon discharge from the hospital the next day the patient continued to exhibit concussion symptoms including dizziness, sensitivity to light, cervical pain, and headache and was advised by her physician to adhere to strict physical and cognitive rest until symptoms subsided.

The question of whether physical therapy can benefit pediatric patients with persistent post-concussion symptoms – also known as Post-Concussion Syndrome (PCS)- is relevant to clinicians because aspects of concussion management are increasingly being considered within the scope of physical therapists' practice, as outlined in the APTA's position statement "The Physical Therapist's Role in Management of the Person with Concussion. (HOD P06-12-12-10)."[1] Concussion management in pediatric populations is an important topic to explore as children and adolescents make up a significant portion of yearly concussion rates and may respond differently to intervention approaches compared to adults.[2]

SUMMARY OF SEARCH

[Best evidence appraised and key findings]

- Three electronic databases were searched and eight resources were identified that met the search selection criteria for inclusion and exclusion. These resources included: two systematic reviews of predominately non-randomized studies, one qualitative literature review, one narrative review, one invited commentary, one retrospective cohort study, and two prospective cohort studies.
- The following findings emerged in these resources: a period of prescribed rest, supervised and graded aerobic activity, and multi-modal physical therapy demonstrate early promise as interventions to address PCS symptoms in children and adolescents.
- These findings are preliminary, however, because most existing studies that address the clinical question are non-randomized and often lack comparison groups, which means that there are concerns about their internal validity.
- Within the body of research addressing PCS management, there is a general lack of research directly addressing pediatric populations.

CLINICAL BOTTOM LINE

While evidence is still evolving regarding the use of physical therapy intervention in pediatric patients with PCS, current evidence contradicts the common practice of having children rest after a concussion (cognitively and physically) until they are asymptomatic. An initial period of rest is necessary in the days immediately following concussion to minimize chances of second impact syndrome, but following that, some combination of prescribed rest and intervention may lessen the severity and duration of symptoms. Individuals whose PCS symptoms include cervical pain, headache, or dizziness should be evaluated by a physical therapist and may benefit from combined interventions, including manual and vestibular therapies. Sub-maximal aerobic exercise may also be beneficial for these patients, but must be supervised and symptom-limited. In a broader sense, given the poor quality of existing evidence, therapists should utilize clinical judgment and monitor developments in the literature on this emerging topic.

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

SEARCH STRATEGY

Terms used to guide the search strategy			
Patient/Client Group	**I**ntervention (or Assessment)	**C**omparison	**O**utcome(s)
“brain concussion” Concussion* “mild traumatic brain injury” “mild TBI” “mild-TBI” MTBI Pediatric* Paediatric* Child* Adolescent*	“physical therapy” “physiotherapy” Rehabilitation “physical activity” exercise	Rest Inactivity	“post-concussion syndrome” “post-concussive symptoms” PCS Dizziness Nausea Headach* “neck pain” “cervical pain”

Final search strategy (history):

1. brain concussion [MeSH Terms] (n=6556)

2. concussion OR “brain concussion” OR “mild traumatic brain injury” OR “mild TBI” OR mild-TBI OR MTBI (n=11369)

3. Pediatric* OR Paediatric* OR Child* OR Adolescent* (n=3561201)

4. “post-concussion syndrome” OR “post-concussive symptoms” OR PCS OR Dizziness OR Nausea OR Headache* OR “neck pain” OR “cervical pain” (n=177712)

5. "physical therapy" OR "physiotherapy" OR "physical activity" OR "rehabilitation” (n=483131)

6. Rest OR Inactivity (n=152024)

7. #1 AND #3 AND #4 AND #5 AND #6 (n=19)

8. #2 AND #3 AND #4 AND #5 AND #6 (n=24)

9. #1 AND #3 AND #5 AND #6 (n=42)

10. #2 AND #3 AND #5 AND #6 (n=59)

11. **#1 AND #5 AND #6 (n=67) >>> final search**

(((brain concussion[MeSH Terms]) AND ("physical therapy" OR "physiotherapy" OR "physical activity" OR "rehabilitation"))) AND ((Rest OR Inactivity))

Databases and Sites Searched	Number of results	Limits applied, revised number of results (if applicable)
PubMed	67	
CINAHL	33	
EMBASE	58	

INCLUSION and EXCLUSION CRITERIA

Inclusion Criteria
• Majority of participants are pediatric patients (birth to 18 years) with a diagnosis of concussion/mild traumatic brain injury. • Primary outcome of interest is resolution of post-concussion symptoms (some combination of dizziness, nausea, cervical pain, headache, and/or balance dysfunction). • Primary intervention is either physical therapy, physical activity, or "usual practice" (e.g. rest).
Exclusion Criteria
• Not published in English • Majority of participants are adults (>18 years of age) • Focus is concussion screening vs symptom management

RESULTS OF SEARCH

Summary of articles retrieved that met inclusion and exclusion criteria

Author (Year)	Risk of bias (quality score)*	Level of Evidence**	Relevance	Study design
Schneider (2013)[3]	AMSTAR score: 5/11	3a	high	Systematic review mainly of non-randomized studies with one RCT. (Downgraded to level 3a evidence due to inclusion of case studies/case series.)
Winkler (2015)[4]	AMSTAR score: 7/11	3a	high	Systematic review of five non-randomized studies and one RCT. (Downgraded to level 3a evidence due to inclusion of case studies/case series.)
Chrisman (2016)[5]	n/a	5	high	Invited Commentary
Wells (2016)[6]	n/a	5	moderate	Narrative Review
Makdissi (2013)[7]	n/a	5	moderate	Qualitative review of literature
Grool (2016)[8]	Modified Downs and Black checklist score: 12/29	2b	high	Prospective cohort study
Alsalaheen (2010)[9]	Modified Downs and Black checklist score: 13/29	2b	moderate	Retrospective cohort study
Moser (2015)[10]	Modified Downs and Black checklist score: 9/29	2b	high	Prospective cohort study

*Indicate tool name and score

**Use Portney & Watkins Table 16.1 (2009); 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:

- **Schneider KJ, Iverson GL, Emery CA, McCrory P, Herring SA, Meeuwisse WH. (2013)[3]** was selected due to its relatively high level of evidence as a systematic review, and topical relevance to the clinical question. This review addresses rehabilitative treatment in addition to more general physical activity and rest interventions. The majority of participants in the studies evaluated for this review are children or adolescents, meaning they meet the inclusion criteria for the original clinical question.
- **Winkler R, Taylor NF. (2015)[4]** was also selected due to its relatively high level of evidence as a systematic review, AMSTAR score, and topical relevance to the clinical question. This review specifically looks at the population of interest for the original clinical question and addresses the benefits of rest versus physical activity, including prescribed exercise.

SUMMARY OF BEST EVIDENCE

(1) Description and appraisal of "The effects of rest and treatment following sport-related concussion: a systematic review of the literature" by Schneider et al, 2013.[3]

Aim/Objective of the Study/Systematic Review:
This systematic review seeks to compare prescribed rest to several different medical and rehabilitative interventions for patients with sport-related concussions. Using evidence from studies that examine the effects of prescribed rest, various medical treatments, and rehabilitation methods, the reviewers explore when rest or treatment might be most appropriate for a patient exhibiting post-concussion syndrome (PCS) symptoms, such as dizziness, headache, and cervical pain.
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 paper is a systematic review. <u>Methods</u> All six reviewers took part in creating the search strategies for this review. Actual searches were carried out by one reviewer. Two others reviewed abstracts that were deemed questionable for inclusion. Two others reviewed studies which met inclusion criteria. Data extraction was performed by four reviewers. All six authors contributed to writing the final systematic review. <u>Search Strategy</u> • Literature was identified through a search of nine databases (PubMed, CINAHL, PsychInfo, Cochrane Controlled Trials Registers, Health STAR, Sport Discus, EMBASE, Web of Science, and ProQuest.) • The citations of search results collected from the original Web of Science search were reviewed for further sources. • Two additional articles were include for review with no information provided as to search strategy. • Searches for literature related to rest outcomes included combinations of the following terms: variations on concussion or post-concussion syndrome, rest, physical exertion, therapy or rehabilitation, and sport. • Searches for literature related to treatment outcomes included combinations of the following terms: variations on concussion or post-concussion syndrome, variations on exercise/treatment/therapy/rehabilitation, brain training, and various PCS symptoms (headache, dizziness, etc.)

Selection Criteria

- This review considered randomised controlled trials, cohort studies, quasi-experimental designs, case series, case crossovers, case studies, peer-reviewed published articles, and abstracts.

Data Extraction and Quality Assessment

Reviewers extracted data regarding study design, study sample size, participant age, participant gender, treatment type, treatment intensity, treatment duration, and what researchers deemed key findings. When studies included relevant data, effect size and means were extracted or calculated by reviewers with 95% CIs. This extracted data was collected in a summary reference table.

The Oxford Centre for Evidence Based Medicine Levels of Evidence and the Downs and Black criteria were used to determine study quality and level of evidence.

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

The reviewers do not explicitly note the setting for interventions for each individual study but it is presumed that, for the outcomes of interest to this CAT, interventions were performed either at outpatient clinics or through supervised return to activity in community/school settings.

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.

Number of Studies and Study Designs

- Of six sources exploring "rest" the reviewers identified two which met their inclusion criteria.[3] Both studies in this category were retrospective case series design studies.
- Of fifteen sources exploring "treatment/activity" the reviewers identified twelve which met their inclusion criteria. The studies in this category included two retrospective case series, two case series, four case studies, two case-crossover studies, one retrospective quasi-experimental study, and one randomized control trial.

Characteristics of Studies

- All sources involved participants with a diagnosis of sports-related concussion.
- Participants, in studies which reviewers included data on age for (n=11), ranged in age from 8-38 years old with the majority of studies involving adolescent participants between 12 and 17 years old.
- Study size ranged from n=1 to n=184.

Quality of Studies

- Utilizing the Oxford Centre for Evidence Based Medicine Levels of Evidence the reviewers ranked nine studies as Level 4, four studies as Level 5, and one study as Level 2.
- The reviewers do not provide their calculated Downs and Black scores.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

Since this was a systematic review, there was no single treatment or control. The systematic review itself only contained one randomized controlled trial.

- The single RCT included in this review involved a control group who followed a program of prescribed rest followed by gradual return to activity and an intervention group which receive individualized physical therapy treatment (including manual, vestibular, and other PT interventions as applicable.)

The remainder of the reviewed studies involved no control groups due to the nature of their design (i.e. case study, case series, etc.) Interventions for these studies include:

- Non-RCT reviewed studies involving "rest" examined outcomes of a period of cognitive rest or a period of cognitive and physical rest.

- Non-RCT reviewed studies involving "treatment" utilized: a retrospective measure of activity intensity (n=1), pharmacologic therapy (n=5), aerobic exercise (n=2), individualized PT including manual,
- neuromotor control, and vestibular rehabilitation components (n=1), hyperbaric oxygen therapy (n=1), gradual return to activity with use of ibuprofen and neck collar (n=1).

Experimental

See above.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

This systematic review cites multiple outcome measures of various interventions following sports-related concussion. All the included studies which evaluate rest or interventions of interest for this clinical question utilized some measure of PCS symptom severity and/or duration. The majority of included studies utilized patient-report of symptom severity as an outcome measure, either through direct report or use of a subjective patient-report outcome measures.

Examples of these measures include the Post-Concussion Symptom Scale (PCSS) and Graded Symptoms Checklist (GSC)- both of which evaluate post-concussion symptom severity. Three studies utilized the Immediate Post-Concussion Assessment and Cognitive Testing (ImPACT) measure which combines patient report data with patient demographic data and cognitive functional test data.

Additionally, medical clearance for return to sport, vestibular testing outcomes, postural stability testing outcomes were utilized discussed in this review as means of quantifying PCS symptom response to treatment or rest.

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.]

Rest

This review found mixed evidence for the efficacy of rest as an intervention for PCS. Of the two studies that evaluated the benefits of rest, one found that participants who underwent a prescribed period of cognitive rest reported PCS symptoms for a longer period of time than those who did not (57 days vs. 28 days, p=0.002). Conversely, the other study found that scores on both the ImPACT and PCSS measures improved for individuals who underwent a one week prescribed period of physical and cognitive rest (ImPACT effect size: 5.4, p=.001; PCSS means: 3.8-11.4 for those with rest vs. 22.0-28.1 for those without, no measure of significance included).

Treatment/Activity

In contrast to the mixed findings for rest, the review finds that sub-maximal aerobic exercise and individualized physical therapy interventions were associated with positive outcomes such as reduced symptom severity and duration for individuals with PCS (given the use of different outcome measures across studies, the review does not calculate an average effect size). This review indicates that the intensity of activities after concussion may determine whether or not activity is beneficial, with moderate activity being more beneficial than high intensity activity.

Individualized physical therapy interventions (involving some combination of vestibular therapy, manual therapy, and sensorimotor/neuromuscular retraining) may hold promise for patients with PCS. This review identified reductions in symptom severity and increased rates of medical clearance for return to sport in patients who participated in these intervention programs. This conclusion was mainly based on an RCT, which found that 73.3% of patients who received the PT intervention were medically cleared to return to sport after eight weeks, compared to 7.1% in the control group (p<0.001).

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

"The current evidence evaluating the effect of rest and treatment following SRC (sports-related concussion) is sparse. An initial period of rest may be of benefit. Low-level exercise and multimodal physiotherapy may be of benefit for those who are slow to recover" (Schneider,1.)[3]

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 review represents an initial attempt to create recommendations for management of persistent symptoms following sports-acquired concussion based wholly on evidence. This differs from earlier recommendations, which were based on expert consensus statements. As a result, even though the review struggles in some areas, it is an important step towards creating an evidence-based post-concussion symptom management framework. The reviewers provide clear inclusion criteria and a thorough review of the characteristics of included studies; and within the parameters of the inclusion criteria, which necessitated participants in included studies be involved in sport, there was wide variation in gender and sport. This means that outcomes of this review should be generalizable to many patients.

In general, the weaknesses of this systematic review have to do with the nature of the non-randomized studies it explores. While the reviewers do acknowledge the lack of comparison groups in the majority of the included studies and their overall low level of evidence quality, they do not provide their calculated Downs and Black criteria scoring to provide a reference for the level of evidence provided by these non-randomized studies. An additional concern with the evidence in the included studies is that many of the outcomes rely on patient-report measures, which are subjective in nature.

This review is also limited by lack of clarity surrounding the reviewers' methods when searching for, selecting, and reviewing evidence. For instance, while multiple reviewers participated in data extraction, only one reviewer performed study selection, which could lead to selection bias, especially as that reviewer (K. Schneider) is the author of two of the studies which were selected for review. Furthermore, the reviewers provide details about the databases that were searched and their search strategies, but they do not say when the searches were performed. This matters because additional evidence could have become available since the time of search. Also, the reviewers do not address if "grey" (unpublished) literature or literature not published in English was included in their search, which could indicate they have overlooked evidence which might help answer their clinical question. The reviewers also failed to provide a list of studies that were excluded from review, which makes it difficult to check whether they adhered to their selection criteria.

Other concerns include: the reviewers note the likelihood of publication bias due to the sparsity of research addressing their clinical question, but fail to provide an actual assessment of publication bias; the reviewers provide disclosures for their own conflicts of interest, but do not mention potential conflicts of interest for the studies themselves; and the table summarizing studies was difficult to access and sloppily done, with many key aspects of the studies not adequately summarized, including missing measures of statistical significance for some of the studies. Generally it is hard to get a sense of how thoroughly the reviewers captured current evidence.

The validity of this systematic review was assessed using the AMSTAR measurement tool and it scored 5/11.

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 authors of this review identify a number of potentially beneficial interventions in the management of PCS in patients with sports-related concussion. Based on the specific PCS symptoms presented by an individual, there may be benefit to evaluation and treatment by a physical therapist.

The only negative outcomes noted in this review involved either prolonged rest or high intensity activity. For this reason, the use of multi-modal physical therapy approaches and supervised low-moderate intensity exercise are likely a safer treatment option in this population. Clinicians who choose to use prolonged rest, which has traditionally been the standard treatment, should be sure to monitor patients closely given the potential for negative consequences.

That said, the lack of available clinical evidence regarding this topic means that this review's findings are not robust enough to act as clinical guidelines. Instead, the review should be considered as a framework for further research. For instance, the clinically significant positive effects for exercise (particularly moderate exercise) and physical therapy interventions suggest that both are fruitful areas for future research. To take one example, the physical therapy interventions considered in the article (individualized interventions, including manual and vestibular techniques) led to a very large increase (73.3% versus 7.1%, $p<0.001$) in the percentage of patients medically cleared to return to sport after eight weeks.

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 review is relevant for the clinical question under consideration here. At the time it was written, it was the most rigorous attempt to systematically review existing knowledge about exercise and physical therapy interventions for adolescents who have had concussions. Specific aspects of the study that make it relevant include: most of the patients included in the reviewed studies were adolescents, which is the patient group of interest for the clinical question; the reviewers' positive findings for physical therapy and aerobic exercise interventions provide a promising avenue for further exploration; and the broader categories of physical therapy intervention covered in the review (e.g. - manual therapy, vestibular therapy, neuromuscular/sensorimotor retraining) are all practical and feasible approaches to many of the symptoms associated with PCS (e.g. - cervical pain, head ache, and balance deficits).

However, the evidential basis of this systematic review is not strong enough to determine clinical decisions, and there are other aspects of the review that limit its usefulness. Beyond the issues raised above, the review does not provide specific detail as to what physical therapy interventions were utilized in any given study, which makes it difficult to judge the applicability of these techniques to the patient of interest for this clinical question. It is also worth noting that the review is nearly five years old, so new evidence, at least in the form of additional case studies, has likely emerged that would make it possible to augment these findings with the patient of interest in mind.

(2) Description and appraisal of "Do Children and Adolescents with Mild Traumatic Brain Injury and Persistent Symptoms Benefit From Treatment? A Systematic Review" by Winkler et al, 2015.[4]

Aim/Objective of the Study/Systematic Review:

The objective of this systematic review is to synthesize the findings of studies that examine treatment effects in pediatric patients presenting with long-lasting symptoms after mild traumatic brain injury (mTBI) – or post-concussion symptoms/syndrome (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.

This paper is a systematic review conducted following PRISMA guidelines.

Search Strategy

- Literature was identified through a search of the following databases: MEDLINE, CINAHL, and PsycINFO
- Searches were conducted with combinations of variations of the terms "mild head injury" and "children"
- Citation lists of literature identified in search were used to identify further pertinent literature.

Selection Criteria

Inclusion Criteria

- Studies
- Published in English
- Published in a peer-reviewed source
- Study population includes participants aged birth to 18 years old
- In studies which include participants over the age of 18, the average age is less than 21 years old and outcomes of participants 18 and younger must be reported separately.
- Participants had experienced a documented mTBI secondary to head trauma. In addition to a report of "mTBI," a report of TBI with Glasgow Coma Scale score, occurrence and length of loss of consciousness, and/or presence and length of post-traumatic amnesia were accepted as ways of quantifying severity of TBI.
- Addresses treatment
- Addresses functional patient outcome/s

Exclusion Criteria

- Opinion pieces, single case studies, and commentary
- TBI which was documented as moderate to severe or met that criteria based on Glasgow Coma Scale score, occurrence and length of loss of consciousness, and/or presence and length of post-traumatic amnesia which would indicate moderate-severe TBI.
- Participants had not experienced head trauma
- Addresses assessment (ex. MRI findings) but not treatment
- Does not directly address a functional patient outcome

Methods

Two reviewers independently examined titles and abstracts from the search to determine if they met search criteria. If this could not be determined through review of title and abstract a review of the full article was performed by both reviewers. If the reviewers did not agree on the inclusion of a given study they came to a consensus decision which was then checked with a Kappa statistic to quantify level of agreement (ranging from "poor" to "almost perfect"). This Kappa statistic was use to determine inclusion or exclusion of these studies which initially were not agreed upon.

Quality assessment, Data Extraction, and Data Analysis

The Downs and Black criteria was used to assess the quality of studies included in this review.

Reviewers extracted data relevant to study results, design, and characteristics. In regards to participant data, reviewers extracted data addressing age, gender, and number of participants. This data is organized in a table for comparison.

Studies were grouped by treatment type (medical or non-medical), their results and characteristics were compared, and, when possible, effect sizes of treatments were calculated by the reviewers.

Setting

[e.g., locations such as hospital, community; rural; metropolitan; country]

The reviewers do not explicitly note the setting for interventions for each individual study but it is presumed that – for the outcomes of interest to this CAT – interventions were performed either at outpatient clinics or through supervised return to activity in community/school settings.

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.

Number of Studies and Study Design

- After screening 37 articles the reviewers identified six which met the criteria for inclusion in the systematic review.
- Study designs include: retrospective case audits (n=4), a controlled trial (n=1), and a prospective review (n=1).

Characteristics of Studies

- A total of 421 subjects were studied in the six studies cumulatively.
- A little over half were male (64%) and the majority were older than 10.
- Studies showed variance in how participants were determined to have a mTBI (ER report, Glasgow Coma Scale score, etc. – see "Inclusion Criteria for full list of potentially qualifying diagnostic criteria).
- The time frame between mTBI and treatment ranged from one day to over two years across studies.

Quality of Studies

- Based on the reviewers' scores using the Downs and Black criteria the studies are low-medium in quality. The mean score was 14.3 out of 31.

Intervention Investigated

[Provide details of methods, who provided treatment, when and where, how many hours of treatment provided]

Control

Since the study was a systematic review, there was no single treatment or control. Furthermore, the systematic review only contained one controlled trial. In it, the treatment group received a one-time intervention (patient education brochure.)

Other interventions (and lengths of interventions) include:

- Prescribed physical and cognitive rest for 1 week following mTBI (n=1)
- Prescribed activity: a program of gradually increase periods of aerobic exercise combined with visualization and coordination exercises for 3 months following mTBI (n=1)
- Nurse-led patient/parent education session (n=1)

Experimental

See above.

Outcome Measures

[Give details of each measure, maximum possible score and range for each measure, administered by whom, where]

Duration and severity of PCS symptoms were the outcomes of interest to this systematic review. All included studies measured some variation of PCS symptom (dizziness, headache, balance impairment, etc.) severity and/or duration. The six studies utilized a variety of outcome measures, but mainly relied on direct patient or patient and parent report of symptom severity and/or duration. The majority of formal outcome measures utilized by these six studies were patient-report measures such as the Post-Concussion Syndrome Checklist, Rivermead Post-Concussion Questionnaire, the Post-Concussion Scale, or the Post-Concussive Symptom Inventory. One study utilized the ImPACT measure which combines patient report data with patient demographic data and cognitive functional test data.

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.]

All nonmedical interventions discussed in the review had positive effects on PCS symptom severity and/or duration. For instance, cognitive and physical rest for a week following mTBI was found to be correlated with decreased symptom severity and increased cognitive performance, as measured by ImPACT (neither effect size nor measures of statistical significant were provided). Participation in an active rehabilitation program (a combination of supervised aerobic exercise, coordination exercises, visualization exercises, and patient education) was associated with decreased PCS symptom severity and return to normal activity (post-concussion scale mean score went from 30, SD = 20.8; to 6.7, SD = 5.7). Patient education interventions were linked to decreased duration, severity, and number of PCS symptoms in individuals who received either written or in-person education on PCS (no quantitative measures of effect size were provided for these).

Original Authors' Conclusions

[Paraphrase as required. If providing a direct quote, add page number]

Though all six intervention studies reported positive outcomes in regards to PCS symptoms, the reviewers note that, "It is difficult to determine whether the positive findings resulted from intervention or reflected natural resolution of the symptoms with time. There is a need for more, higher-quality studies of interventions designed to reduce the duration and severity of persistent post-concussion symptoms" (Winkler et al., 324).

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 validity of this systematic review was assessed using the AMSTAR measurement tool and scored: 7/11. Weak points included the exclusion of grey literature from the researchers' search (because one of their inclusion criteria was whether a study was peer-reviewed). This is a problem because the reviewers might have missed relevant studies. An additional concern is that the reviewers did not include a list of excluded studies, which makes it difficult to assess whether they followed their stated criteria for inclusion. The reviewers also did not include graphical aids (ex. funnel plots) or statistical tests to evaluate the likelihood of publication bias, and did not address conflicts of interest for the studies included in review.

Strengths

In terms of strengths, the reviewers provided clear inclusion and exclusion criteria which were sensical and relevant to the aim of the review. Two reviewers independently reviewed studies for inclusion, which reduced the risk of bias. The review's results are presented in a clear narrative fashion, which is appropriate for the small number of included studies and the variety of interventions they utilize. Additionally, the reviewers acknowledge issues of validity and risk of bias raised by the small number of included studies and the low level of evidence inherent in their non-comparison group designs.

Weaknesses

Beyond the issues raised above, the main concerns are that a small number of studies (n=6) were included in the final analysis for this systematic review and they were generally low quality. First, the non-comparison nature of five of the six studies presents a potential sources of bias, and the one controlled study did not have randomized treatments. An additional concern is that most included studies relied (at least partially) on subjective patient-report outcome measures, which makes it difficult for reviewers to draw objective clinical conclusions from them. And a final concern is that the studies included in the review focus primarily on children over the age of ten, which raises questions about their applicability to younger children. The included studies also oversample males, which – while representative of who gets concussions – makes it difficult to test whether females respond to the treatments in different ways.

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.]

In this well-conducted review, the authors reach the tentative conclusion that non-medical interventions such as prescribed rest, prescribed activity, and patient education may hold promise in the management of PCS in children. However, as the authors rightly note, these results are only suggestive because there is limited research on each of these treatments, and the existing studies have weak internal validity because they do not have control groups and/or treatments.

That said, it is possible that the authors are too negative in their assessment of existing work. For instance, at one point they indicate that findings related to rest and activity are "contradictory" (331) because the included studies found positive outcomes for each. But, this isn't the case: the two interventions are targeted towards different time frames in the recovery period (rest immediately after and exercise later), which means that the findings could be complementary.

While it is necessary to be cautious given the limitations of the studies included in the review, some of the studies identified large effects, which indicates promising avenues for future research.

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 systematic review is relevant for the clinical question under consideration here. The patient of interest for this clinical question falls squarely in line with the patient population of this review, both in age and diagnosis. The general principles of this review- that treatment interventions (including physical therapy) may be beneficial to this patient population- are certainly applicable to the case of interest for this clinical question and the reviewers provide a solid background on the topic and suggest avenues for further research.

But, the studies included in the review are not strong enough to serve as the basis for clinical decision making. The variance in interventions and intervention timeframes, combined with a lack of specificity in regards to what exact physical therapy interventions were utilized, means that it is difficult to directly apply outcomes of this study to the patient of interest here.

As noted in regards to Schneider et al's review, screening a patient for cervical or vestibular complaints which may contribute to PCS symptoms such as headache, neck pain, and balance deficits is both practical and feasible.

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.]

Evidence Synthesis

The reviewed evidence suggests that pediatric patients experiencing persistent post-concussion symptoms may benefit from a variety of interventions which fall under the umbrella of "physical therapy." Multimodal physical therapy approaches which integrate vestibular, manual, and neuromuscular/sensorimotor approaches have been linked to decreased symptom severity via patient-report measures, as has supervised sub-maximal aerobic exercise.[3,4] While the reviewed evidence supports the use of sub-maximal aerobic exercise in this population it is important to note that exercise should be supervised, of a low-to-moderate intensity, and limited by the participant's symptoms.[10,5]

Whether or not these interventions offer better outcomes than prolonged prescribed rest in pediatric patients is difficult to establish based on current evidence. While an extended period of rest may lead to deconditioning and prolonged or increased PCS symptoms there is some evidence which supports a period of rest beyond the initial days following a concussion (up to a week).[3] The reviewed evidence indicates there may be a complimentary relationship between prescribed rest and intervention, but further research is required to explore this concept.[5,4,3]

These findings are applicable to this clinical question because they make important early steps in the creation of an evidence-based framework for pediatric post-concussion management and support further research into the use of physical therapy to manage PCS symptoms in these patients.

While encouraging, the conclusions of the two systematic reviews should be viewed as preliminary. Research on physical therapy approaches to treating concussions in pediatric populations is still in its infancy and existing research suffers from several different issues. The studies included in these two reviews exhibited issues such as a lack of control groups, no randomization, small sample sizes, and reliance on self-report measures – all of which pose a threat to their internal validity. This becomes especially important when considering if a study results are outcomes of a given intervention or simply the result of the body's natural healing process.[5]

Clinical Implications

The reviewed evidence supports a physical therapy evaluation for adolescents who are experiencing PCS symptoms such as headache, cervical pain, balance deficits, or dizziness. These findings may indicate that it is appropriate for therapists to reference the more widely established body of research regarding the use of physical therapy interventions in adult populations with PCS when making clinical decisions concerning a pediatric patient.[11,12,13,14,15]

The physical therapy interventions included in these reviews were individualized and multimodal in nature. Without more information regarding how patients were screened for these evaluations, it is difficult to determine which aspects of the interventions were driving the positive results. This issue is compounded by the lack of detail in the description of the physical therapy interventions provided in the reviews. Furthermore, differences in the time frames for interventions makes it difficult to compare across the different interventions. Until the evidence base for research on physical therapy approaches to pediatric PCS is more established, practitioners should draw on the cognate literature on adults, stay abreast of new research as it emerges, and use their best clinical judgement.

Implication for Future Research

Moving forward, there are several paths for future research: The most immediate concern is establishing safe parameters for intervention. Some treatments touched on in these reviews – such as high intensity aerobic exercise – showed negative effects on patient outcomes.[3] Future work should determine when exercise does more harm than good for pediatric patients recovering from concussion. As part of this effort, the overall quality of research needs to be improved.[3,4] Randomized controlled trials with large, representative samples and less subjective outcome measures would be an important step in the right direction. As part of these studies, researchers should pay more attention to the timing of different types of interventions because the studies discussed in both reviews suggest that different interventions will be effective at different times.[3,4]

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