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## 1. Project Title and Purpose

### **Project Title:**

Implementation of a Precision Exercise and Activity Calculator for Concussion (PEAC Concussion): A Buffalo Treadmill testing informed process for Prescribing Sub-system Threshold Exercise (STE) in a standardized manner in Early Concussion

### **Project Purpose (clearly indicate the Recommendation number and wording from the Clinical Practice Guideline):**

The overall purpose of this project is to implement a standardized tool (Precision Exercise and Activity Calculator for Concussion - PEAC Concussion) for physicians to prescribe aerobic exercise in a heterogeneous, non-athletic adult concussion population after 48 hours post injury.

More specifically:

- 1) To implement the use of the Buffalo Treadmill test to guide the prescription of subsystem-threshold exercise for those who consent to complete.
- 2) To create an intervention toolkit for return to activity with or without an exercise test, that could be used by other concussion clinics across Ontario.
- 3) To standardize the Ontario Neurotrauma Foundation guideline recommendations for patient advice for Rest and Return to Activity

## 2. Project Description:

### A. Methods:

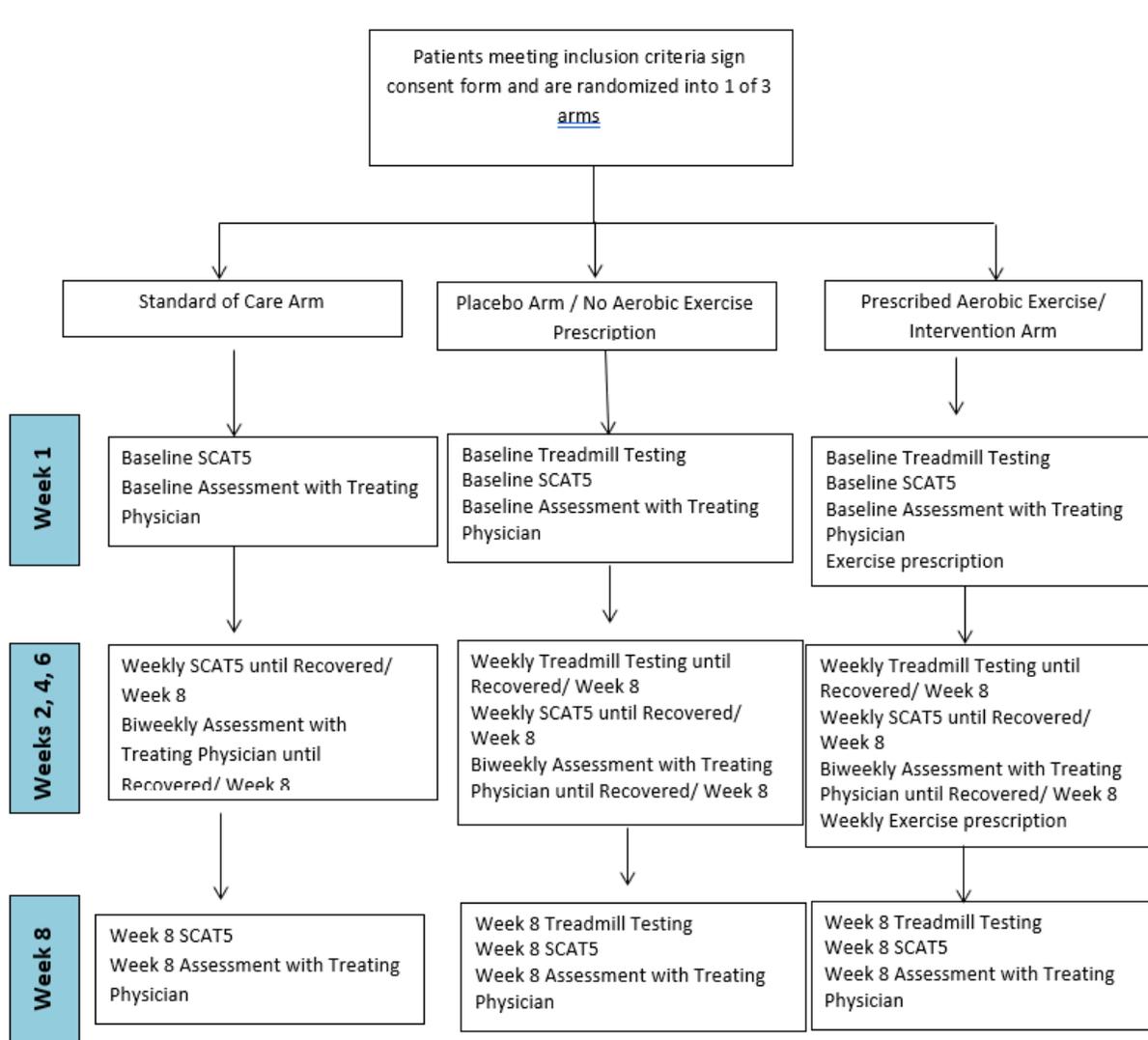
Along with the grant recipient and the Project Lead (knowledge broker), five clinicians were identified to participate in this implementation project. Clinicians were given a standardized approach to using patient's performance on treadmill testing, in order to standardize prescription for return to activity, more specifically subsystem-threshold exercise. Clinicians were also given on patient assessment for recovery. Accommodations and precautions were taken to ensure the utmost safety of participants and staff during the pandemic.

At week 1, demographic variables such as age, sex, gender and past medical and psychological history were collected. They were also given the self reported symptom inventory from the Sports and Concussion Assessment Tool-5 (SCAT). In order to mitigate risks from exercise such as cardiovascular or respiratory events, all eligible participants were assessed by clinic physicians for exercise fitness and elevated risk for exercise-related sudden cardiac events using the American College of Sports Medicine's (ACSM) Exercise Preparation Health Screen (**Appendix A**). Potential falls risks was mitigated by screening for prior or concurrent orthopedic injuries by the treating clinic physician.

Participants were recruited using the following inclusion Criteria; able to provide informed consent prior to entry; referred from the emergency department with recent (<1 week) history of trauma to the head; GCS score of 13-15 on presentation to the ED; SCAT score > 9 at week 1; physician cleared for exercise i.e. low risk for cardiac disease (defined as no cardiopulmonary symptoms and meet no more than one

risk factor for heart disease); willing to exercise. Our exclusion criteria include evidence of intracranial hemorrhage, contusion or injury on brain imaging (CT Scan), on beta-blocker medication; on high dose (>50mg/day) tricyclic antidepressant medication; pre-existing or current orthopedic injuries preventing exercise, pre-existing vestibular disease preventing exercise, heartrate increase <30 bpm from rest on treadmill test, deemed asymptomatic from concussion by clinic physician, unable/unwilling to follow commands.

Participants were randomly assigned to 1 of 3 arms (as in figure below): an intervention arm consisting of 30 minutes of prescribed, sub-symptom, structured high-moderate intensity aerobic exercise (based on peak symptom-exacerbated heart rate), 5 times with weekly treadmill testing; a comparable attention arm of weekly treadmill testing but no exercise prescription; or usual standard of care arm (which includes standard exercise recommendations without specifying type, amount, or intensity and no weekly treadmill testing). Patients were followed for 8 weeks following concussion diagnosis. Primary Outcomes was assessed at Week 8.



The Placebo Arm and Intervention Arm patients then underwent the Buffalo Concussion Treadmill Test (BCTT), which is a symptom-limited test of up to 20 minutes on the first visit to determine threshold for exercise induced symptom exacerbation. Participants randomized to either of the Intervention or Placebo Arm underwent the following treadmill protocol:

- Walk on a treadmill at a brisk pace, each minute the incline of the treadmill increases.
- Blood pressure is measured before and after treadmill testing.
- Heart rate, rating of perceived exertion and symptoms are measured every minute, prior to the next incline increase.
- The test was stopped when a participant's number, or intensity, of symptoms increases beyond 3 points, or if they are deemed to be exercise tolerant i.e., reaching the 20 minute treadmill test without worsening of concussion symptoms and/ or able to exercise to 80% of age predicted maximal heart rate (calculated as  $207 - (0.7 * \text{age})$ ). Participants who did not achieve a minimum 30 BPM difference between resting heart rate and treadmill test heart rate at stop criterion at baseline assessment were excluded from participating in the exercise study.

All participants were assigned a commercially available heart rate monitor (Fitbit™) bracelet to wear for 12 hours each day throughout the duration of the trial in order to determine compliance with the exercise prescription (for those assigned to the prescription arm) and to measure regular activity levels (for those assigned to the standard of care arms). Patients in the exercise prescription arm were required to log their physical exercise, duration, exertion, heart rate, and any symptoms in an activity log and receive automated daily text message reminders to exercise. All participants also completed SCAT symptom questionnaires and a physician exam every other week (beginning at week 1), until they are recovered or Week 8 (whichever comes first).

#### Arm 1: BCTT exercise test and exercise prescription (Exercise test and Intervention Arm)

Patients in the exercise prescription arm underwent a treadmill test each week. They were prescribed exercise based on a symptom-limited threshold. If the treadmill test is stopped due to symptom exacerbation, heart rate was recorded and used for the exercise prescription. The heart rate target for exercise was calculated as follows:  $[(\text{Symptom-Exacerbated Heart Rate} - \text{Resting Heart Rate}) \times 0.90] + \text{Resting Heart Rate}$

Exercise prescriptions example (**Appendix B**) Stationary bicycle: After an easy warmup spinning of 1 to 2 minutes. Increase resistance and cadence to achieve a target heart rate of X. Monitor your symptoms and exercise for Y minutes. Gentle stretching and warm down after getting off bicycle.

#### Arm 2: BCTT protocol with standard of care and no exercise Rx (Placebo Arm) exercise prescription

Patients assigned to the Placebo Arm underwent weekly treadmill testing but did not receive an exercise prescription. Instead, they were provided with standard of care exercise scripted instructions by the clinic physician. This included the benefits of exercise post-concussion, but to be mindful of symptom-exacerbation and not push/work through symptoms.

Script example:

- Mild symptoms are OK to exercise with; if you notice your symptoms increasing to a point where they are hindering your ability to exercise, lower the intensity
- If symptoms dissipate, begin to increase intensity again to a point where symptoms are manageable
- Low intensity exercise is better than no exercise at all
- Avoid stopping exercise suddenly as it may lead to an exacerbation of symptoms such as dizziness. Always cool-down, even if it is at a very low intensity.

Arm 3: No BCTT protocol and standard of care exercise prescription

Patients in the standard of care arm were not given an explicit exercise prescription. They were provided with standard of care exercise scripted instructions by the clinic physician. This included the benefits of exercise post-concussion, but to be mindful of symptom-exacerbation and not push/work through symptoms.

Script example:

- Mild symptoms are OK to exercise with; if you notice your symptoms increasing to a point where they are hindering your ability to exercise, lower the intensity
- If symptoms dissipate, begin to increase intensity again to a point where symptoms are manageable
- Low intensity exercise is better than no exercise at all
- Avoid stopping exercise immediately as it may lead to an exacerbation of symptoms such as dizziness. Always cool-down, even if it is at a very low intensity.

To measure Clinical process and Assess Barriers to Knowledge and Monitor Knowledge Use, a checklist was used for physicians to indicate use of the information provided (i.e., pre-injury activity level, age, pre-existing/current cardiovascular factors, activity level on previous week as indicated by patient and a wearable device, treadmill testing data etc.) (In progress)

Clinical Outcome was measured using a 3-step approach (Assessed at weeks 1, 2, 4, 6, 8 post-concussion); Have a Sport Concussion Assessment Tool (SCAT) symptom inventory score  $\leq 9$ , AND are deemed sufficient for discharge by the clinic physician, AND are exercise-tolerant as per the Buffalo Concussion Treadmill Test. This meant that they are able to exercise for 20 minutes OR achieve 80% of their age-predicted maximum heart rate, OR a rating of perceived exertion of 18/20 (signifying very hard) without symptom exacerbation.

The implementation process was measured using the Physicians Feasibility Survey to get input on use of instructions, patient information and other data listed above. Patient interviews were also conducted at interval to assess usefulness, the clarity and consistency of instructions provided. Patients were asked about the consistency between physicians in the prescription, advice and guidance regarding exercise.

Implementation outcome was measured by looking at proportion of patients who receive standardized prescription for exercise in our clinic.

## B. Data collection Tools:

### i. Tools to measure Clinical process

- a. Physician checklist (Not developed yet)

### ii. Tools to measure Clinical outcome

- a. Sport Concussion Assessment Tool [SCAT] Symptom Inventory (already existed; **Appendix C**)
- b. Physician's Recovery Indicator (Locally-developed **Appendix D**)
- c. Exercise Tolerance using the Buffalo Concussion Treadmill Test (already existed, but modified for our use- **Appendix E**)

### iii. Tools to measure Implementation process

- Physicians Feasibility Survey (Locally-developed **Appendix F**)
- Patient interview (Not yet developed)

## C. Findings (process and outcome):

Using the feedback given by physicians and patients during the implementation process will enable us to incorporate changes into the process in order to perfect the use of this tool. These changes will make the process of prescribing exercise by clinicians and the process of patient completing their required exercising an easy and usable process, and a process that can be implemented at other clinics.

We would expect speedy recovery, as a result of this exercise intervention, will lead to less people with persisting concussion symptoms. As a result, there will be less health care usage and spending in Ontario. We also will expect to change the misconception within the patient population that resuming activities after 48 hours of a concussion is somehow detrimental. This study and findings will show that regulated and monitored exercise, is in fact, safe and beneficial to patients. In turn, it will show that faster recovery will also enable faster return to work/school/play and return to pre-injury quality of life for patients. The efficacy of this intervention will give patients who are worried about their symptoms the confidence that they can return to activities safely. Monitored, graduated and physician prescribed exercise will reassure patients that it is safe to exercise at the intensity that is prescribed, at the time post injury. Practical and easy to do exercise prescriptions at home will enable patients to carry out the exercises without a treadmill or a bicycle. They can be done by walking, running, cycling or stair climbing, as long as the goal heart rate and intensity are reached.

This study will also show that a systematic method of prescribing individualized exercise prescription can become part of the standard of care following concussion and will put exercise at the forefront of clinicians mind as a safe intervention for concussion symptoms. Furthermore, it will provide instructions and guidance on how to calculate and prescribe exercise in a graduated and monitored manner

#### D. Summary:

- Implementation of a systematic method of prescribing individualized exercise prescription can become part of the standard of care and is feasible in an acute concussion care setting
- Sustainability of use of tools and resources is possible with regular feedback from clinicians, which indicate that most clinicians continued to use the fatigues scale scores from the beginning, but the fatigue resources were utilized only after 4-6 weeks post injury

#### E. Lessons Learned:

- There are several variables that impact the implementation of a practice or change in practice in a team environment. More specifically, clinicians' various beliefs in symptom trajectory in a given population. Finding a standardized process for monitoring symptoms and providing intervention can be challenging. It is important to take a collaborative approach and be receptive to feedback from all team members. This will ensure a mutually agreed upon standard process that can be implemented, which fulfils the overall goal of providing the best possible evidence-based care to our patients
- Equally, it is crucial to ensure that clinicians are satisfied and are willing to adapt to the new process
- Even though the goal of our project was to implement a systematic method of prescribing individualized exercise prescription, we learned that it is important to be receptive to the feedback both from patients and clinicians as to the timing of the use of both the assessment tools and prescribing exercise so that the benefits of both are maximized
- Patient feedback is crucial in determining what is beneficial to them and when it is most beneficial

### 3. Recommendations for next steps to support full sustainable

**implementation:** (for your organization, for future implementation projects, for policy, for system organization)

- Regular one-on-one touch base with clinicians (in addition to group input) would serve as an opportunity to reinforce and ensure sustained use of this tool; it improved ownership and accountability of clinicians and motivated them to actively participate in implementing and sustaining the practice
- A more appropriate and customized approach or process may be required for each population group i.e. acute concussion versus post concussive stage.
- In order to draw any reliable conclusions about the clinical outcome of the implementation of this project, quantitative data will need to be collected over a lengthier period of time with a larger number of participants

#### 4. What has been done to ensure Sustainability:

- We have seamlessly incorporated the process of screening for factors affecting exercise in our patients
- Developed a standardized training toolkit including a video for Buffalo Concussion Treadmill Testing, formula for calculating exercise intensity and duration, and standardized scripts for clinicians when providing prescriptions for exercise. This will be a critical part of our standard patient care protocol. This tool kit is available electronically in our clinic and ONF.
- Regularly scheduled meetings with clinicians, to evaluate and tweak the efficacy of process

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