POST-CONCUSSION SYNDROME MANAGEMENT GUIDELINES

INTRODUCTION

The most recent Consensus Statement on Concussion in Sport has defined a concussion as a "complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces". Concussions can be caused by a blow to the head, face, neck or body. This trauma will result in a set of clinical symptoms that may or may not include loss of consciousness. A concussion will typically result in short lived, spontaneously resolving neurologic impairments and largely reflect a functional rather than structural injury. (1)

Current guidelines recommend that any athlete who has suffered a concussion be removed from play and not allowed to return until evaluated by a physician, even if they report being symptom free. (2) Current treatment following concussion includes physical and cognitive rest until asymptomatic, at which time a stepwise return to sport can be initiated. (1) The majority of sport-related concussions recover within a 7-10 day period from onset (80-90%), (1) but a minority of these subjects may experience persistent symptoms, cognitive and physical deficits beyond this point. (3)

When symptoms persist beyond the natural recovery period, the term post-concussion syndrome (PCS) can be applied. (4) There is confusion currently surrounding the definition of post-concussion syndrome with the World Health Organization suggestion that persistent symptoms lasting greater than 1 mo while the DSM-IV classficiation requires greater than 3 mo. (5,6)

The primary forms of treatment for PCS have traditionally included, rest, education, neurocognitive rehabilitation and antidepressants. These forms of treatment have shown little effectiveness in the treatment of PCS. (7) More recently, studies have begun looking at varying treatment options including vestibular rehabilitation (8,9), visual training (8-11), cardiovascular training (7,8,12-17) and treatment of cervical spine dysfunction (8) with some promising results.

This document is intended to provide the user with instruction and direction in the rehabilitation of PCS. The physiotherapist must exercise their best professional judgment to determine how to integrate this protocol into an appropriate treatment plan. As an individual's symptoms and progress is variable, this protocol must be individualized. It is essential to ensure that any treatment should be performed with the goal of avoiding symptom exacerbation.

POST-CONCUSSION SYNDROME AND TREATMENT GUIDELINES

1) CERVICOGENIC

Background

Cervical spine injury is well documented following a trauma; however, it is often overlooked following a concussion. Anatomically, the cervical spine is closely linked to structures that can cause many of the same symptoms as concussion. Cervicogenic headache frequently co-exists with complaints of dizziness, tinnitus, nausea, imbalance, hearing complaints and ear/eye pain. Baron (18) identified the greater occipital nerve (GON) as the source of these symptoms in a group of 147 patients whose chief complaints were dizziness (93%), tinnitus (4%), headache (3%) and ear discomfort (0.7 %).

Literature has reported the referral patterns of the three occipital nerve roots (C1-3) and their convergence on the nucleus caudalis of the trigeminal tract. These nerve roots along with the joint complexes (z-joint, ligaments, nerves, discs and muscles) have been identified as possible sources of head pain. Muscle trigger points have also been implicated in head pain, dizziness and nausea. (19)

The receptors in the cervical spine have many connections to the vestibular and visual apparatus. Dysfunction of the cervical receptors due to a cervicogenic headache can alter afferent input, subsequently changing integration of timing and sensorimotor control. Changes in cervical joint position sense, eye movement control and postural stability have been measured in patients with neck pain (20, 21)

Assessment

1) Subjective Reports
    - Common subjective reports of cervicogenic headache include (22):
        - Moderate to severe, non-throbbing pain, usually starting in the neck
        - Episodes of varying duration or fluctuating, continuous pain
        - Headaches commonly unilateral and provoked by neck movements, prolonged postures or pressure on tender points
        - Can present as pain on the opposite side when severe, but does not appear isolated to opposite side
        - Ipsilateral, non-radicular arm pain can occur frequently
        - Frequently co-exists with complaints of dizziness, tinnitus, nausea, imbalance, hearing complaints, ear/eye pain

2) Flexion- Rotation Test (FRT) (23,24)
    - Cervical spine is fully flexed and then rotated. Positive flexion-rotation test is thought to be related to dysfunction of C1/2
    - Positive test = 15 degree difference in rotation on one side compared to the other. 45 degrees on range considered normal
    - Can be reliably used with subjective complaints of a headache (24)
    - 90% sensitivity, 88% specificity (23)

3) Cranio-Cervical Flexion Test (CCFT) (25)
   - Assesses the ability to isolate the deep neck flexors, accurately target specific pressure and to measure endurance
   - Patient lying in supine with pressure biofeedback (PBU) under cervical lordosis
   - Inflate PBU to 20mmHg and instruct patient in head nod using deep neck flexors
   - Palpate for superficial muscle recruitment (ie. SCM, scalene) and look for improper form, difficulty targeting or fatigue
   - Hold 10 sec, 10 times before progressing
   - Continue with sequential testing from 22-30mmHg
   - Scoring is out of 100

4) PAIVM
   - Performed in prone
   - Most painful segment and hypomobile segment on PAIVM has a kappa value of .45-.76 (moderate to good) (24)

5) Length Tension Testing (LTT)
   - Uneven loading of the upper cervical spine can be associated with degenerative changes in the spine or abnormal length tension of muscles that attach to the occiput and upper cervical spine
   - Length-tension testing of the following muscles should be considered (26):
     - Sub-occipital muscles
     - Upper fibres of traps
     - Anterior/posterior scalene
     - Levator Scap
     - Splenius capitus
     - Masseter/temporalis

6) Cervical joint position sense

Treatment

The treatment program implemented will depend on patient-specific assessment findings and patient tolerance. Treatment options for patients with cervicogenic pain and dysfunction include:

1) Range of Motion – unidirectional and/or combined movements
2) Mobilizations – as per assessment findings
3) Deep Neck Flexor (DNF) training
   - Can be performed in multiple positions:
     1) sitting (with/without head support)
     2) supine
     3) 4-point kneeling
   - Can progress to DNF recruitment with extremity movement, addition of resistance or change in position
4) Deep Neck Extensor (DNE) training
   - Can also be performed in multiple position and in combination with DNF recruitment

5) Muscle Extensibility Exercises
    - Stretching
    - Muscle energy techniques
6) Postural correction
7) Cervical Proprioception
    - Ex. head repositioning exercises, vestibular exercises
8) Acupuncture

2) AUTONOMIC

Background

Following a concussion, a metabolic cascade of brain neurochemical changes produces an initial hypermetabolic state as the brain attempts to restore homeostasis. This is quickly followed by metabolic depression as cerebral blood flow (CBF) declines and the demands of brain energy begin to exceed their supply (27).

Concussion is also associated with other metabolic and physiologic changes such as:

- Greater HR at rest (28)
- Greater HR with physical (29) and cognitive stresses (30)
- Greater sympathetic and lower parasympathetic nervous system activity (29)
- Altered Heart Rate Variability (HRV) which reflects the brain-heart physiological connection between the sympathetic and parasympathetic N.S. balance (31)
- Decreased CBF and disturbed cerebral autoregulation (ability to maintain CBF at relatively constant levels)(32)

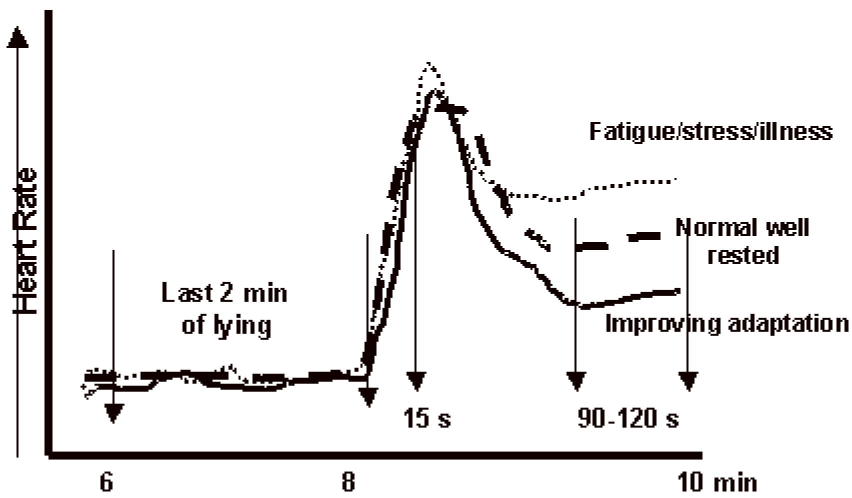
Initial treatment of concussion consists of a period of physical and cognitive rest because symptoms can be exacerbated with these tasks in the acute post-injury phase (2). Exercise in this acute period may increase brain metabolic demand (increased ATP) at a time when the brain energy is compromised (33). Exercise too soon afterwards can also affect the production of brain-derived neurotrophic factor (BDNF) which promotes neuronal recovery (34).

Beyond the acute stages, PCS treatment has traditionally consisted of rest, education, neurocognitive rehabilitation and anti-depressants with limited effectiveness (35,36). In this post-acute phase, exercise may provide some benefit to the patient with PCS such as:

- Increased parasympathetic activity and improved autonomic regulation (37)
- Increased global, regional and cerebral blood flow (38)
- Increased BDNF production with improved cognitive performance (12)
- Improved mood, sleep and depression (39, 40, 41)
- Reduction in systemic markers of inflammation (42)

Assessment

1) Rusko Heart Rate Test (43)
   - Measures the autonomic response to positional changes
   - Pt lying for 8 minutes while wearing a heart rate monitor
   - The average heart rate for the last two minutes of lying is recorded
   - Pt then stands up. Heart rate is recorded after 15 seconds of standing and the average heart rate between 60-90 seconds is also recorded
   - An elevated heart rate between 60-90 seconds post standing may be indicative of poor recovery hard training, illness or stress



2) Bike Testing
   - Patient's baseline SCAT2 scores are taken at rest, and resting heart rate is recorded
   - Patient begins riding at 50% of their maximum heart rate and symptoms are re-recorded every 5 min
   - After 5 minutes, if there is an increase in any one symptom, the patient is to stop riding. If no change or decrease in all symptoms, the patient may continue up to a time of 20 minutes
   - The patient is also advised to stop at any point in time if they note an exacerbation of symptoms
   - Treatment should start at an intensity of 80% of the maximum heart rate achieved before symptom exacerbation (sub-symptom threshold) (17)

Treatment

Leddy et al found that the use of a graded exercise program resulted in an increased in the patient's max HR and BP threshold as well as their maximum exercise time.(15) Baker et. al also reported a 71% return to full activity following a graded exercise program. (13)

Based on their research, Leddy et al. recommend that the exercise program be an individualized, progressive, sub-symptom threshold aerobic exercise program. (15) Exercise options may include:

- Stationary bike
- Treadmill walking/running
- Elliptical

As mentioned above, aerobic exercise begins at an intensity of 80% of the maximum heart rate achieved before symptom exacerbation (sub-symptom threshold).

The patient's baselines symptoms are collected using the SCAT2 and are re-checked every 5 minutes to ensure no exacerbation has occurred. Patients are instructed to STOP aerobic exercise if any worsening of symptoms. Once the patient can reach a 20-30 minutes of cardio with no increase in their symptoms, then the intensity can increased by approximately 10%. This increase in intensity may require an associated reduction in duration. It is recommended to increase duration first, then intensity. The end goal will be to reach 80-90% intensity for 20-30 minutes with no exacerbation of symptoms

Any exercise program should be performed on a regular schedule (ie. daily) and for sufficient duration to allow the regulatory and auto-regulatory systems to adapt. Patient should STOP aerobic activity if any exacerbation of symptoms.

3) VESTIBULAR

Background

Balance deficits and postural instability are commonly reported post-concussion (44, 45, 46). A study by Lovell et al (47) found that 43% of patients will report balance problems. Furthermore, symptoms that may negatively affect ones balance, such as dizziness (55%) and visual blurring or double vision (49%) are also frequently reported. Balance issues have been reported to last for years post-concussion (46).

As a result, the assessment and treatment of the vestibular system as well as postural stability are an important component of the physiotherapy plan post-concussion. The 3rd Annual Consensus Statement on Concussion has found that "postural stability testing provides a useful tool for objectively assessing the motor domain of neurologic function". Postural control can be made up of different components including static stability, dynamic stability, anticipatory reactions and reactions to external forces (48). For this reason it may be advisable to implement a battery of tests to include all components of stability.

Vestibular rehabilitation has been used as a method of treatment in patients with persistent dizziness and balance deficits that have not resolved with rest. (9) Alsalaheen et al. implemented an individualized program consisting of gaze stabilization exercises, standing balance, walking with balance challenges and in a few cases canalith repositioning. Significant improvements were reported in self-report and performance measures post vestibular rehabilitation. (9)

Assessment

Evaluation of balance should consist of tests that include both static and dynamic components.

- BESS
    - Test consists of 6 conditions with eyes closed in 3 different stances: narrow based, single leg and tandem stance performed on level ground and a compliant surface (ie. Airex)
    - Positions are held for 20 seconds and the examiner records the number of errors
    - Errors include: removing hands from iliac crest, opening eyes, taking a step, stumbling, abducting or flexing the hip > 30 degrees and lifting the forefoot/heel off the ground
    - The maximum number of errors per position is 10
    - Clinical acceptable reliability (0.80) was attained when BESS was administered 3 times in a single day or 2 times on separate days (49)

- Dynamic Gait Index
    - 8-item test with a 4-point ordinal scale with 0 representing severe impairment and 3 representing normal function
    - Research has shown that the subtests of 1) "gait with vertical head turn", 2) "gait with horizontal head turn" and 3) "gait and pivot turn" correlated significantly with self-reported balance problems (46)

- MiniBEST (48)
    - 14-item test with 4 "subscales" being tested:

  - Anticipatory postural adjustments
  - Postural responses
  - Sensory orientation while on compliant or inclined surface
  - Dynamic stability in gait, with or without a cognitive task
- Each item scored on a 3-point scale from 0 (severe) to 2 (normal)
- Patient performs all balance tasks in flat heeled shoes or bare feet

- BPPV testing
  a. Dix-Hallpike Test
     - Patient seated with head rotated 45 degrees towards test side
     - Patient rapidly taken supine with head extended 30 degrees
     - Ensure patient keeps eyes open and observe for nystagmus
     - Patient may also reports symptoms of vertigo

  b. Head Roll Test
     - Patient lying supine with head elevated approximately 20 degrees
     - Roll head quickly to left
     - Observe eyes for nystagmus
     - Bring head back to neutral position and roll head quickly to right and observe
     - Affected side is the one that provokes the most vertigo and nystagmus

- VOR Assessment
  a. VOR cancellation
     - Grasp patient's head with both hands and tilt head forward to 30 degrees
     - Instruct patient to focus on your nose
     - Slowly move the patient's head side to side while you move in same direction with your face
     - Note patient's ability to maintain fixation and any saccadic eye movements or reports of symptoms

  b. VOR slow
     - Same setup as per the VOR cancellation test
     - Slowly move the patient's head side to side while you remain stationary
     - Note patient's ability to maintain fixation on your nose or any reports of symptoms

  c. Head Thrust Test
     - Same setup as per above
     - Slowly move the patient's head side to side, then quickly rotate the patient's head in one direction and stop
     - Movement should be a small amplitude with position held at the end
     - Note patient's ability to maintain fixation, saccadic eye movements or reports of symptoms
     - Forgo this test if significant pain or restriction in cervical spine mobility. Instruct patient regarding quick movement prior to initiating the test.

Treatment

1) Canalith Repositioning – as findings on Dix-Hallpike or Head Roll Test dictate
2) Balance exercises
    - Can progress from:
        - 2-1 foot
        - Firm to soft surface
        - Level ground to incline or uneven surface
        - Add upper/lower extremity movements, first without resistance and then with
        - Decreased to increased # of tasks (ie. add cognitive task to balance)
        - Incorporate visual training exercises (as discussed below)
        - Sport/activity specific balance
3) VOR Exercises
    - Substitution exercises – move eyes to a target and then head
    - VOR exercise – keep focused on target while shaking head back and forth
    - Can work side to side, up and down
    - Can work in increasing speed, change base of support (ie. sitting to standing to single leg stance) or incorporate functional activities (ie. walking while looking)
4) Core stability exercises
5) Gait exercises

4) VISION/VISUAL PROCESSING

Background

Studies have shown that 50-90% of individuals with an acquired brain injury demonstrate visual dysfunction. These visual deficits may be the result of trauma to primary or secondary visual pathways as well as the primary and visual associated visual cortices. (10, 11)

Signs and symptoms of visual dysfunction may include blurred vision, light sensitivity, slowed or loss of place while reading, peripheral vision restrictions, poor spatial judgement/depth perception and vestibular symptoms in crowded environments. (10, 11)

Vision plays an important role in balance, gait, driving and other activities of daily living, and therefore, disturbances can have a profound effect on one's physical abilities. Visual field deficits may also present a safety hazard as poor spatial awareness and depth perception can increase the risk of tripping, bumping into objects and falling. (10, 11)

Visual deficits, although separate from cognitive deficits can exacerbate cognitive difficulties such as memory, attention and concentration. (10)

It is therefore important to screen for visual dysfunction early in the rehabilitation process. Early intervention may also be advantageous because the first year post traumatic brain injury has been identified as an important period during which natural recovery occurs. (10)

Assessment

1) Cover Test
    - Have the patient look at a close target (ie. your nose)
    - Cover one eye with your hand and remove it to the side of their face. Repeat 2-3x
    - Assessing eye movement as the eye is uncovered. Exotropia is the eye moving inwards, esotropia is the eye moving outwards and vertical is the eye moving up or down.
        - No movement of either eye = no strabismus
        - If one eye moves = strabismus on that side
        - If both eyes moves = incorrect or alternating strabismus

2) Fixations (11)
    - Evaluates the ability of the patient to locate and fixate on a target within their visual field
    - Present a target at midline (approx. 16-20 inches from face). Patient should be able to located the target and fixate for several seconds (ie. 10 seconds)
    - Repeat to left/right of midline
    - Steady fixation is the ability to maintain fixation for several seconds. Unsteady fixation is the ability to fixate but the inability to maintain the fixation. Finally, no fixation is the inability to find the target

3) Smooth Pursuits (11)
    - Have the patient look at a target with their head straight (approx. 20 inches from face)

- The patient follows the moving target using only their eyes
- Move the target to the left about 45 degrees from the center, then move upwards and downwards. Repeat the same pattern on the right
- Inability to direct their gaze in one or more directions is a sign of impairment
- Also observe the effort required to complete the task

4) Saccades (11)
    - Use 2 small targets at 20 inches away from the patient's face and about 12 inches apart
    - With their head facing forward and looking between the two targets, have the patient look back and forth at the two targets using only their eyes
    - Abnormal finding is the eyes missing or over/undershooting the targets. Must also observe the effort required to complete the task

5) Convergence (11)
    - Use a small target starting about 16 inches from the patient's nose
    - Slowly move the target towards the patient's nose
    - The Near Point of Convergence (NPC) is recorded when the patient reports diplopia (double vision) or loss of ocular alignment. Normal is 2-3 inches from nose
    - The Near Point of Discomfort for Convergence (NPDC) is recorded at the point where the patient reports discomfort from fixation
    - Slowly move the target away from the patient's nose. Recovery is the point where the patient reports single vision again. Normal is 3-4 inches from the nose
    - Scoring is as follows:
        - Absent = no convergence
        - Impaired = inability to converge on target within 12 cm
        - Intact = convergence less than 12 cm

6) Visual Midline Shift (50)
    - Stand at side of patient and ensure no objects in front of patient to orient them to midline
    - Eyes (but not head) follow a wand as you move it across their visual field at a constat speed
    - Patient tells you to stop when the wand is directly in front of their nose
    - Can assess from either side, up and down
    - Using a face diagram, draw a line indicating where the patient reported their midline

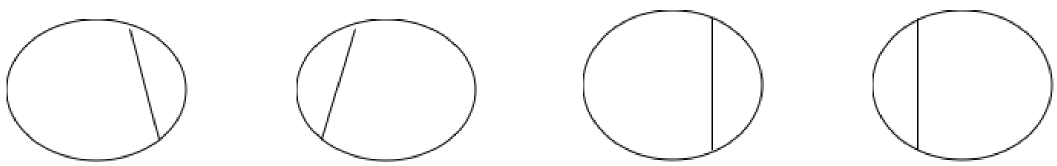
Treatment

All visual exercises can be performed in isolation or can be progressed by increasing speed, increasing duration, changing base of support or incorporating vestibular integration. All exercises should be performed within symptom tolerance.

1) Fixations
    - Keep head still and move eyes to different target, hold vision on each target for a few seconds
    - Gradually increase duration of fixation, or number/location of target
2) Pursuits
    - Use eyes to track objects moving within the patient's visual field (ie. ball on a string, pen)
    - Gradually progress duration of movement, location and speed of object
3) Saccades
    - Eyes will jump back and forth between two targets without moving the head
    - Repeat as fast as possible
    - Gradually progress speed or location of targets
4) Near/Far
    - Hold onto a paper with a photo/word and have a second page on a wall in the distance
    - Using only their eyes, patient will look down at the image until it is in focus, then look up until image on wall is in focus
    - Repeat as fast as possible
5) Vergence
    - Brock String
        - 3 beads on a string and hold string up to nose
        - Patient looks at closest bead which should look like a single bead. The other two will appear as two beads (like the string is making a "Y")
        - Move to the middle bead which should now look like a single bead, and the others should appear double (like an "X")
        - Move up and down the string and gradually progress speed
    - Pencil Push-ups
        - Patient holds pencil in front of their nose at a distance where they see only a single pencil
        - Patient slowly brings the pencil closer to their nose until the pencil appears double
        - Hold for a few seconds and slowly move away from their nose
        - May gradually increase duration, number of repetitions
6) Visual/Vestibular Integration
    - May progress balance tasks by adding head movements, ball for maintaining fixation or for tracking
    - Progress task from 2 to 1 leg stance, add Airex or BOSU, incorporate functional movements such as lunges/squats/walking/running
    - Incorporate visual field stimulation with objects such as Bodyblade, ball toss (up/down, bouncing on floor, against wall)

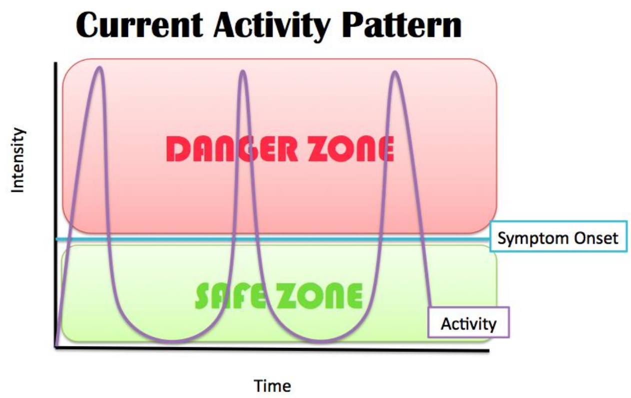
- Binasal Occlusion – Patient with visual dysfunction may benefit from the use of binasal occlusion, which involves placing translucent tape (cloudy scotch tape) on the medial portion of a pair of glasses (either the patient's current glasses or a pair of frames without lenses). The width of the tape will vary depending on patient's deficits and may decrease over time. Tape can be placed vertically or at an angle depending on which is more beneficial to the patient (see picture below).

The use of binasal occlusion in individuals with post-trauma vision syndrome has been found to increase the amplitude of visual evoked potentials. This shows that the ambient process becomes more organized and provides more appropriate spatial information (50). These changes can result in improved tolerance for visual activities and a decrease in symptoms.



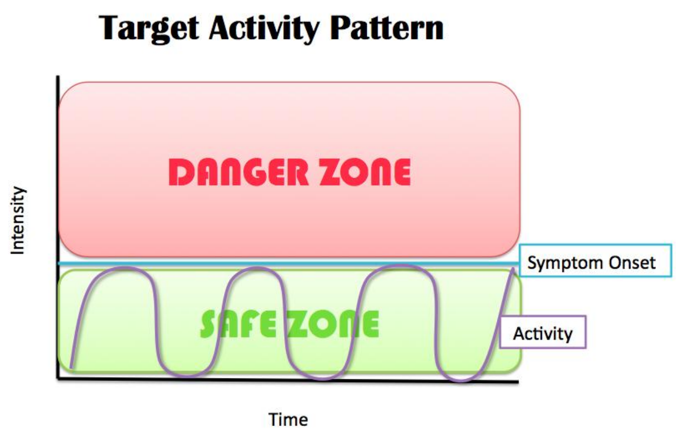
5) EDUCATION

It is important to educate the patient with post-concussion syndrome on the appropriate performance and structuring of return to activity. The goal is to gradually increase activity tolerance without crossing the symptom threshold. As a result, the planning and pacing of activities is of utmost importance both at home and within the clinic setting.



Intially patients often do too much activity and only stop when their symptoms limit them. Then they rest and once their symptoms subside they increase their activity level into the symptom or "danger zone". They often repeat this pattern over and over as represented in the ***Current Activity Pattern*** graph on the right.

Patients are advised that activities should remain below symptom threshold, as increases in symptoms can delay and be detrimental to recovery. Patients and therapists should set time restrictions for activities (based on sub-symptom threshold) and should use a timer to ensure that the patient works only within the prescribed time parameters. This will allow the therapist to monitor the patient's response to activity and will also teach the patient to self-pace and self-monitor while at home.



It may be appropriate to start with short reps of exercise with rest in between or varying between different types of activities (ie. switching from a visual to a cardio based task). This will also help the patient pace activities and structure their activity in an appropriate manner. Patients may also benefit from using a journal to plan their day ahead of time to ensure they are following guidelines and to assist the patient who is having difficulty with memory. A journal can also be useful to reflect back on to determine any cause and effect of setbacks which may occur while in treatment.

The goal is to return to full activities without any restrictions. However, patients with Post Concussion Syndrome whose symptoms are more severe and take longer to resolve may need to continue to plan and pace their activities on a longer term basis.

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