

# Appendix 3.3

## Buffalo Concussion Treadmill Test (BCTT)

### BUFFALO CONCUSSION TREADMILL TEST (BCTT) – INSTRUCTION MANUAL

#### Purpose

- To investigate exercise tolerance in patients with post-concussive symptoms (PCS) lasting more than 3 weeks.
- To help establish appropriate levels of exercise to aid in Return to Play for concussed athletes and assist in treatment protocols.
- To aid in differentiating between possible diagnoses for concussive symptoms (Cervicogenic injury, PCS, etc.) and etiology of the concussion.
- To identify physiological variables associated with exacerbation of symptoms, and the patient's level of recovery.

#### Eligibility

- Before beginning the BCTT, participants should be evaluated for medical and physical ability to exercise. Considerations may include (but are not limited to): cardiovascular illness, respiratory dysfunction, serious vestibular/balance problems, motor dysfunction, and certain orthopedic injuries.
- Do not follow the BCTT if the patient is experiencing such cervical dysfunction that the test could cause considerable pain or harm, is experiencing severe vestibular/balance issues that would impair walking on a treadmill, has a history of unstable cardiac or respiratory disease, or has a lower extremity or spinal orthopedic pathology that compromises safe walking
- The BCTT is not recommended for patients scoring higher than 7/10 for symptom severity.

<b>Table 1. Contraindications to Exercise Testing</b>
<b>Absolute</b>
<ul style="list-style-type: none"><li>• Acute myocardial infarction (within 2 d)</li><li>• High-risk unstable angina*</li><li>• Uncontrolled cardiac arrhythmias causing symptoms or hemodynamic compromise</li><li>• Symptomatic severe aortic stenosis</li><li>• Uncontrolled symptomatic heart failure</li><li>• Acute pulmonary embolus or pulmonary infarction</li><li>• Acute myocarditis or pericarditis</li><li>• Acute aortic dissection</li></ul>
<b>Relative†</b>
<ul style="list-style-type: none"><li>• Left main coronary stenosis</li><li>• Moderate stenotic valvular heart disease</li><li>• Electrolyte abnormalities</li><li>• Severe arterial hypertension‡</li><li>• Tachyarrhythmias or bradyarrhythmias</li><li>• Hypertrophic cardiomyopathy and other forms of outflow tract obstruction</li><li>• Mental or physical impairment leading to inability to exercise adequately</li><li>• High-degree atrioventricular block</li></ul>
<small>*ACC/AHA Guidelines for the Management of Patients With Unstable Angina/Non-ST-Segment Elevation Myocardial Infarction (350) (see Table 17).</small>
<small>†Relative contraindications can be superseded if the benefits of exercise outweigh the risks.</small>
<small>‡In the absence of definitive evidence, the committee suggests systolic blood pressure of &gt;200 mm Hg and/or diastolic blood pressure of &gt;110 mm Hg. Modified from Fletcher et al.<sup>7</sup></small>

#### Safety Considerations

- On testing, participants must be dressed for exercise (comfortable clothing, running shoes), wearing any vision or hearing aids (glasses, etc.), and should be hydrated and well rested.
- It is suggested that two persons assist in conducting the BCTT, in order to assure safety of the participant, with one individual positioned behind the participant (at back of the treadmill) at all times

while test is in progress. It is also recommended that one or more persons with CPR training are present during testing.

- It is important to engage in casual conversation with the patient during the exercise test to assess his/her confidence level as well as any changes in cognitive and communicative functioning. As exercise intensifies, note if patient seems to have difficulty communicating, looks suddenly pale or withdrawn, or otherwise appears to be masking serious discomfort.
- Be aware of postural and structural changes (slouching, rounding the back, leaning head) - noting the patient's thoracic and cervical posture can offer clues on the etiology of the injury.

## **Preparation**

### **Equipment Requirements**

- Treadmill with capacity to reach 15 degrees of elevation  
*Note:* Test can be adapted for treadmills which can reach a minimum of 12 degrees elevation
- Heart rate monitor (Polar brand recommended)
- Borg RPE Scale (Rating of Perceived Exertion) and Concussion Symptom Severity Scale (Likert scale) – *See form attached*
- Test Results form for monitoring heart rate, changes in RPE and symptoms, and relevant observations – *See form attached*
- Chair, water and towel for participant recovery after exercise

### **Setup**

- Attach heart rate monitoring device according to manufacturer's instructions
- Post RPE and Symptom scales within comfortable viewing distance of participant while on treadmill (it is suggested that participant should **not** have to turn head to view scales)

## **Test Protocol**

### **Starting the Test**

1. Inform participant about test procedures and what to expect during the BCTT.
2. Explain and demonstrate the RPE and Likert scales and obtain resting scores. Remind participant that he/she will be asked to rate exertion and symptom severity at each minute during exercise. The RPE scale is a measure of perceived physical activity, and can be explained to participants as a measure of "how hard you feel like your body is working". The scale's numbers (6-20) and descriptors should be pointed out. The Likert symptom scale is a measure of symptom severity ("how good/bad your symptoms are making you feel right now"), and should be distinguished as being distinct from RPE. The scale's numbers (1-10) and pictures (expressions of physical pain) should be pointed out.
3. Patient should begin by standing on the ends of the treadmill while the treadmill is turned on. The experimenter should set treadmill at a speed of **3.6mph** for patients over 5'5", and **3.2mph** for those 5'5" and under. Starting incline is **0 degrees**. Speed can be adjusted depending on athletic status or overall comfort of treadmill speed – patients should be moving at a brisk walking pace.
4. After one minute at this pace, treadmill incline is increased to 1 degree. Participant is asked to rate RPE and symptom severity. Subjective scores and heart rate (bpm) are recorded. This procedure is repeated each minute, with ratings and heart rate being recorded, and treadmill increasing in incline at a rate of 1 degree/minute. Changes to Likert rating should be specifically clarified/noted (for example, if the rating moves from 2 to 3, it should be clarified if this reflects the addition of a new symptom, increased severity of an existing symptom, etc.). Experimenter should also record general observations as the test progresses.
5. Once treadmill reaches maximum incline (15 degrees or 12 degrees in modified test), speed is increased by **0.4mph** each minute in lieu of increased incline.

6. Once test is terminated (see below), speed is reduced to 2.5mph and incline reduced safety back to 0 for a 2 minute cool-down (if participant is safe to continue). During this time, Likert ratings should continue to be reported each minute.

### Terminating the Test

Test continues until:

- Maximum exertion (RPE score of 19.5) is reported **or**
- Test is terminated by experimenter due to a symptom exacerbation that causes significant increase in pain or symptom severity (an increase of more than 3 points on the Likert scale from resting score, addition of several new symptoms, or marked increase in severity of symptoms resulting in difficulty continuing test) **or**
- Experimenter notes a rapid progression of complaints (ex. headache to searing focal pain) between symptom reports, patient appears faint or unsteady, or determines that continuing the test constitutes significant health risk for the participant, **or**
- Patient reports an inability to continue the test safely

### Outcomes

#### Diagnosis

- The BCTT can be used in conjunction with balanced error scoring, cervical proprioceptive screening, manual assessment and soft tissue palpation to determine the presence/absence of post-concussion syndrome or cervical/thoracic injuries.

Patients who have symptoms, but do not have a physiologic threshold (can exercise to max) should be evaluated for dysfunction of the cervical spine, vestibular system or temporomandibular region.

#### Treatment/Return to Play

- On completion of the BCTT, concussion patients may be given an exercise prescription based on 80% of the maximum heart rate reached **without** symptom exacerbation. Patients are instructed to exercise at this level for 20 minutes daily without exceeding the time, or heart rate constraints.

Patients may increase heart rate by swimming, walking or stationary cycling - the athlete should not attempt resistance training.

If any post-concussion symptoms return along the progression, the athlete must return to the previous asymptomatic stage/maximum heart rate.

- If the patient can exercise to voluntary exhaustion on the BCTT without eliciting symptoms, you may begin the process of returning him/her to play by following the fivestep return to play program of the Zurich Consensus Statement.
- Other prescriptions and recommendations will be based on the patient's particular complaints. A patient may be recommended for cervical physical therapy, vestibular physical therapy, infusion therapy or treatment for temporomandibular joint disorders