Active Recovery for Sport Related Concussion: The Buffalo Concussion Treadmill Test
Objectives:

- **Identify** possible uses for the Buffalo Concussion Treadmill Test (BCTT)
- **Identify** contraindications for the Buffalo Concussion Treadmill Test (BCTT)
- **Provide** overview of the step-by-step administration of the BCTT
- **Identify** stopping criteria
- **Describe** exercise prescription based on BCTT results
Concussion management: a paradigm shift

- “The cornerstone of concussion management is physical & cognitive rest until the acute symptoms resolve.” (McCrory et al., 2013)

- Interpretation

- “After a brief period of initial rest (24–48 hours), symptom-limited activity can be begun while staying below a cognitive and physical exacerbation threshold.” (McCrory et al., 2017)
What happened in between?
Is rest the best medicine?

• “The evidence evaluating the effect of rest and treatment following SRC is sparse.” (Schneider et al., 2014)

• “…too much activity can hinder recovery, but strict rest can do the same.” (McLeod et al., 2017)

• “…the best available evidence from clinical studies does not support the efficacy of prescribing complete rest for more than a few days following SRC.” (Schneider et al., 2017)

• “Physical exercise appears to improve PCSS scores & symptoms in patients with concussion.” (Lal et al., 2017)
Consistent conclusions & recommendations

- **Additional research is needed** to determine the effectiveness of rest, treatment, & return to activity.
- It’s **likely** that low level exercise may play a role in recovery.
- The exact timing, duration, intensity, & mode are **not yet known**.

http://research-methodology.net/research-methodology/research-design/conclusive-research/descriptive-research
Could (too much *) rest actually be bad?

- Mood dysregulation (Wells et al., 2015)
- Being sedentary following injury or illness is one of the most consistent risk factors for chronic disability (Silverberg & Iverson, 2013)
- Depression (DiFazio et al., 2015)
- Anxiety/Nocebo Effect (DiFazio et al., 2015)
- Physical deconditioning (Silverberg & Iverson, 2013; DiFazio et al., 2015)

http://vickislittleworld.blogspot.com/2012_03_01_archive.html
Standardized assessment:

The Buffalo Concussion Treadmill Test

- Needed a test to assess exercise intolerance in PCS individuals
- #1 criteria: Has to be safe
- Modified Balke Protocol (Leddy et al, 2010)
- Graduated exercise test
- Constant Speed
- Increasing incline
- Measure of physical exhaustion &/or exercise intolerance

http://concussion.ubmd.com/

http://www.smbs.buffalo.edu/ortho/unknown%209-10/answers.html
The Buffalo Concussion Treadmill Test (BCTT): Uses

• 1) Establish exercise intolerance—acute or PCS (Kozlowski et al., 2013)

• 2) Establish differential diagnosis of PCD (physiological, cervicogenic, vestibulo-ocular) (Baker et al, 2012; Leddy et al., 2013)

• 3) Individualized management protocols

• 4) Safe Return To Play (RTP) through re-established exercise tolerance (Leddy et al., 2011)
### Contraindications

#### Absolute Contraindications

<table>
<thead>
<tr>
<th>History</th>
<th>Unwilling to exercise</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Increased risk for cardiopulmonary disease as defined by the American College of Sports Medicine³</td>
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</table>

<table>
<thead>
<tr>
<th>Physical examination</th>
<th>Focal neurologic deficit</th>
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<tbody>
<tr>
<td></td>
<td>Significant balance deficit, visual deficit, or orthopedic injury that would represent a significant risk for walking/running on a treadmill</td>
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#### Relative contraindications

<table>
<thead>
<tr>
<th>History</th>
<th>ß-Blocker use</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Major depression (may not comply with directions or prescription)</td>
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<td></td>
<td>Does not understand English</td>
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</table>

| Physical examination | Minor balance deficit, visual deficit, or orthopedic injury that increases risk for walking/running on a treadmill |

Individuals with known cardiovascular, pulmonary, or metabolic disease; signs and symptoms suggestive of cardiovascular or pulmonary disease; or individuals ≥ age 45 who have more than one risk factor to include: (1) family history of myocardial infarction, coronary revascularization, or sudden death before 55 years of age; (2) cigarette smoking; (3) hypertension; (4) hypercholes-terolemia; (5) impaired fasting glucose; or (6) obesity (body mass index ≥ 30 kg/m²).

*(Leddy JJ, Willer B., 2013)*
Equipment & Preparation

- Treadmill w/ 15% incline
- Heart Rate Monitor
- Exercise clothes & shoes
- Water, towel, chair
Patient Education

- **Inform patient** about test procedures and what to expect during the BCTT.
- Explain and **demonstrate the RPE and Likert scales** and **obtain resting scores**. Remind patient that he/she will be asked to rate exertion and symptom severity at each minute during exercise.
- Explain that exercise is just like taking medicine: **if you take too much, it can make you sick/worse**. It’s important to be honest about how they are feeling.
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.

(Leddy & Willer, 2013)
Data collection

<table>
<thead>
<tr>
<th>Min</th>
<th>HR</th>
<th>RPE</th>
<th>Likert Scale</th>
<th>New Symptom?</th>
<th>Comments/Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</table>

Rate Your Overall Condition

- 0: Feel terrific, no symptoms
- 1-2: Feel some symptoms but quite tolerable
- 3-4: Symptoms a little worse
- 5-6: Symptoms much worse
- 7-8: Feeling quite symptomatic
- 9-10: Feel terrible, worst I ever felt
Safety

- 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.

Buffalo Concussion Test Instruction Manual
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.
BCTT Protocol

- Fit patient with HR monitor
- Patient should begin by standing on the ends of the treadmill while the treadmill is turned on.
- 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.

[Link to average speed for walking on a treadmill]

http://www.livestrong.com/article/512777-what-is-the-average-speed-for-walking-on-a-treadmill/
BCTT Protocol

- 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.).
- General observations also recorded
BCTT Protocol

- 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.
- Once test is terminated, *speed is reduced to 2.5mph* and incline reduced safety back to 0 for a 2 minute cool-down (if patient is safe to continue). During this time, Likert ratings should continue to be reported each minute.
- Allow patient to rest in a seated position until recovered.
BCTT-Walter
Stopping Criteria

- Maximum exertion (RPE score of ≥17-19) is reported
- Test is terminated by clinician due to a symptom exacerbation that causes significant increase in pain or symptom severity
  - ≥ 3 points over the pre-test overall symptom score on the 1-10 point VAS;
  - 1 point given for each increase in a symptom or appearance of a new symptom
- Clinician 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,
- Patient reports an inability to continue the test safely

### From testing to management...

<table>
<thead>
<tr>
<th>Clinical features</th>
<th>Physiological PCD</th>
<th>Vestibulo-ocular PCD</th>
<th>Cervicogenic PCD</th>
<th>Migraine</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mild to moderate, global, pounding headache at rest that is exacerbated by reproducible levels of physical (and sometimes) cognitive activity</td>
<td>Mild to moderate headache that is typically absent at rest but elicited or exacerbated by prolonged periods of reading, focusing, or time in complex visuospatial environments</td>
<td>Mild to moderate, dull, occipital headache that is elicited or exacerbated by activities that require prolonged neck stabilization or movement</td>
<td>Paroxysmal attacks of unilateral, severe, throbbing or pulsating headaches associated with photo- and phonophobia, nausea, and occasional vomiting</td>
</tr>
<tr>
<td></td>
<td>Early symptom-limited threshold</td>
<td>Patients typically do not experience an early symptom-limited threshold</td>
<td>Patients typically do not experience an early symptom-limited threshold</td>
<td>Provoked by stereotypical stimuli including bright lights, stress, dehydration, poor sleep, and certain foods.</td>
</tr>
<tr>
<td>Treatment</td>
<td>Sub-maximal aerobic exercise prescription</td>
<td>Targeted vestibular and vision therapy</td>
<td>Cervical spine manual therapy and proprioception re-training</td>
<td>Headaches last 4–72 h after which patients typically experience headache-free periods</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Headache medications or occipital nerve injections (occipital neuralgia)</td>
<td>Patients typically do not experience an early symptom-limited threshold</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Sub-maximal aerobic exercise prescription</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Prophylactic and abortive headache medications</td>
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</table>

*(Leddy et al., 2016)*
Exercise Prescription

- 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 **20-30 minutes daily** without exceeding the time, or heart rate constraints.
- Patients may increase heart rate (**walking or stationary cycling**) - the athlete should not attempt resistance training.
- Heart rate may be increased **5-10 bpm** weekly as tolerated.

https://dailyfit.ru/osnovy-bodibildinga/10-luchshix-xudshix-kardiotrenazherov/
Exercise Prescription

- 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, may begin the process of returning him/her to play by following the five step return to play program of the Zurich Consensus Statement.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Graduated return to play protocol</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rehabilitation stage</strong></td>
<td><strong>Functional exercise at each stage of rehabilitation</strong></td>
</tr>
<tr>
<td>1. No activity</td>
<td>Symptom limited physical and cognitive rest</td>
</tr>
<tr>
<td>2. Light aerobic exercise</td>
<td>Walking, swimming or stationary cycling keeping intensity &lt;70% maximum permitted heart rate No resistance training</td>
</tr>
<tr>
<td>3. Sport-specific exercise</td>
<td>Skating drills in ice hockey, running drills in soccer. No head impact activities</td>
</tr>
<tr>
<td>4. Non-contact training drills</td>
<td>Progression to more complex training drills, eg, passing drills in football and ice hockey May start progressive resistance training</td>
</tr>
<tr>
<td>5. Full-contact practice</td>
<td>Following medical clearance participate in normal training activities</td>
</tr>
<tr>
<td>6. Return to play</td>
<td>Normal game play</td>
</tr>
</tbody>
</table>

Note: BCTT: Baseline Cognitive Testing Tool.
Putting it all together

BCTT: Identify sy-limited HRt

20-30 min/day aerobic exercise at 80% of HRt

If tolerating increase HRt by 5-10 bpm weekly

Continue until 85-90% of APMHR for 20 min without sy

Repeat BCTT
Physician Clearance
Begin stepwise RTP
Clinical Bottom Line

- The **BCTT** has been demonstrated to be valid and reliable *(Leddy et al., 2011)*

- The **BCTT** has been shown to be **safe** for use both in PCS as well as acute concussion *(Cordingly et al., 2016; Leddy et al., 2017)*

- Daily **low intensity, sub-symptom threshold aerobic exercise** has been demonstrated to be **safe during concussion recovery** and may even **improve recovery time** *(Baker et al., 2012; Cordingly et al., 2016; Maerlender et al., 2016; Leddy et al., 2017; Mychasiuk et al., 2016; Gall et al., 2003; Kurowski et al., 2016)*

- Initial evidence suggests the **BCTT** may have **prognostic utility** when it comes to recovery time *(Leddy et al., in press)*

- **Recovery from concussion requires a multi-modal approach** *(Ellis et al., 2016)*
References

References

Thank You!