Behavioral & Clinical Strategies in Concussion Management: Active Strategies to Improve Outcomes

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Disclosures

- Research grant funding past 3 years
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  - Centers for Disease Control
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- Other Disclosures
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Agenda

• Review the current evidence concerning exercise and rehabilitation post-concussion – 30 minutes

• Discuss concussion rehabilitation strategies - 45 minutes

• Describe the role behavior change and policy may play in implementing current evidence concerning exercise and rehabilitation post-concussion – 30 minutes

• Questions/Discussion- 15 minutes

Objectives

• Evaluate the current state of evidence concerning exercise and rehabilitation acutely and sub-acutey following concussion and its benefits over strict rest.

• Describe effective concussion rehabilitation strategies.

• Describe the role behavior change and policy may play in implementing current evidence concerning exercise and rehabilitation post-concussion.

Concussion: A Multifaceted Condition
...especially true for student-athletes
For Many Years ....Consensus Driving Best Practice...

Previous Gold Standard: 
*Rest Followed by Graded Exertion*

Is Rest After Concussion “The Best Medicine?”: Recommendations for Activity Resumption Following Concussion in Athletes, Civilians, and Military Service Members

Yuval H. Steinberg, PhD; Grant L. Inrott, PhD

Changing Landscape

Adolescent and young adult settings

• Increased awareness
• Societal interest
• Policy changes
• Organizational investment
• Passive to active
  • Educational strategies
  • Management and treatment strategies
• Surge in scientific evidence
Symptom Limited Activity

Light Aerobic Activity

Sport Specific Exercise

Non-Contact Training

Full Contact Training

Return to Sport / Full Contact Return to Play

Current Return to Sport Strategy

Short Term Issues

- Worsening of post-concussive signs and symptoms
- Repeat concussion with post concussion syndrome
- School-related issues in student athletes
- Second Impact Syndrome (younger athletes)

Long Term Issues

- Prolonged concussion symptoms (daily basis)
- Depression, cognitive impairment, dementia
- Long-term academic issues in student athletes
- Decreased Quality of Life
Supporting Need for Intervention: Prolonged/Persistent Symptoms

Supporting Need for Intervention: Prior Concussion & HRQL Effects

Adjusted mean difference estimates (colored bars) and associated 95% confidence intervals (error bars) for HRQL outcomes standardized scores comparing prior concussion groups to the no prior concussions group. An asterisk indicates significant difference compared to the no prior concussions group.

Register-Mihalik et al., ACSM 2019

2.2x greater risk in previously concussed players
Nordstrom et al. 2014

60% higher injury risk for previously concussed players
Cross et al. 2015
Concussion associated with injury in retired NFL players
3+ concussions = 73-165% higher odds of sustaining lower extremity injury
Pietrosimone et al. 2015

Odds of injury 2.5x within 90 days after concussion
Brooks et al. 2016

Comprehensive Intervention

Biopsychosocial Consideration in Evaluation and Treatment of concussion (Register-Mihalik, 2020)

<table>
<thead>
<tr>
<th>Biopsychosocial Consideration</th>
<th>Biopsychosocial Consideration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biological</td>
<td>Psychological</td>
</tr>
<tr>
<td>Physiologic Considerations</td>
<td>Anxiety and depression</td>
</tr>
<tr>
<td>Neuroendocrine cascade post-concussion</td>
<td>should be considered in evaluation and treatment</td>
</tr>
<tr>
<td>Autonomic nervous system function</td>
<td>for evaluation</td>
</tr>
<tr>
<td>Early exercise may provide physiologic adaptations to improve outcomes</td>
<td>Clinical manifestations and considerations for evaluation</td>
</tr>
<tr>
<td>Symptomatology</td>
<td>General mood considerations</td>
</tr>
<tr>
<td>Cognitive function</td>
<td>Integration back into social activities that do not exacerbate symptoms may improve outcome perceptions</td>
</tr>
<tr>
<td>Motor/Balance</td>
<td>Exercise and rehabilitation effects on psychosocial outcomes (e.g., quality of life)</td>
</tr>
<tr>
<td>Medication/pharmacologic considerations</td>
<td>Comprehensive approach (inpatient may improve outcomes)</td>
</tr>
<tr>
<td>Sex and age may influence outcomes and treatment considerations</td>
<td>Peer support and Cognitive Behavioral Therapy, especially in those with persistent symptoms (e.g., headache)</td>
</tr>
<tr>
<td>Social</td>
<td>Health</td>
</tr>
<tr>
<td>Peer/teammate interaction</td>
<td>Family</td>
</tr>
<tr>
<td>Engagement in daily social activities without symptom exacerbation early in the process</td>
<td>School</td>
</tr>
<tr>
<td>Rehabilitation as a means for social interaction</td>
<td>Consider the Full Picture</td>
</tr>
<tr>
<td>Social support systems consideration</td>
<td>Consider the Full Picture</td>
</tr>
<tr>
<td>Work and school interactions</td>
<td>Consider the Full Picture</td>
</tr>
</tbody>
</table>
Treatment Assumptions

- Too much symptom exacerbation following physical or cognitive activity is a sign that the brain's dysfunctional neurometabolism is being pushed beyond tolerable limits.

- In guiding recovery, management of neurometabolic demands on the brain is central.

Activity

(When Done Right)

Outdoes Rest

Benefits of Strict Rest After Acute Concussion: A Randomized Controlled Trial

Thomas, 2015
Growing Body of Research

Modes of Intervention

Brief (24-48h) rest is appropriate for most patients

Following brief rest, patients should gradually increase activity

Cervical and vestibular rehabilitation

Multifaceted care

Submaximal, monitored, sub-symptom threshold exercise may also benefit

Schneider et al, 2017
### Evidence Supporting Exercise & Rehabilitation: Aerobic Exercise

Leddy, 2019

- 103 concussed participants (46% female)
- Randomly signed aerobic exercise vs. stretching treatment
  - Supervised aerobic exercise ~20 min sessions daily at a prescribed heart rate on a treadmill or bike
  - No tx administered prior to 48 hours post-injury
  - Mean time to visit 4.8/4.9 days from injury
  - Aerobic exercise recovered in median 13 (IQR 10-18.5) days
  - Stretching recovered in median 17 (IQR 13-23) days

### Study Overview of Key Recent Exertion, Exercise, and Rehabilitation Studies

<table>
<thead>
<tr>
<th>Study Authors</th>
<th>Design</th>
<th>Participants</th>
<th>Key Findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Remigio et al. 2019</td>
<td>Randomized Controlled Trial</td>
<td>32 youth, 30 with concussion</td>
<td>Patients who received CSPR were more likely to report improvements in concussion vs. those with VRT, but the effect was not significant; differences in dizziness handicap (95% CI: 0.6-1.4) were not significant.</td>
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</tbody>
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Graded Exercise Testing...

Use of Graded Exercise Testing in Concussion and Return-to-Activity Management

John J. Lexell, M.D., FACSM FACQ* and Barry Miller, Ph.D.1

Cervicogenic Dysfunction

Common concussion symptoms that could have a cervicogenic basis include neck pain or stiffness, and headache.

"Cervicogenic post-concussion disorder" posture/neck strain with symptoms such as dizziness and postural instability.

Cervical spine has complex proprioceptive inputs.

Impairments in sensorimotor features such as eye-movement control, cervical joint position sense and postural stability affecting balance have been found in association with persistent neck pain of both insidious and traumatic origins. (Treleaven, Clamaron Cheers, & Jull, 2011, p. 636).

Armstrong, 2008
Sports Med

Head and Neck Position Sense

Armstrong, Pfau-Ackles and Diane Taylor
Health and Exercise Science Centre, Auckland University of Technology, Auckland, New Zealand

Fig. 1: Schematic diagram of the neural connections described in the head and neck joint sense. Note: the clear box and dotted line indicate a secondary role.

[Diagram of head and neck position sense]
Cervicogenic Options

- Cervical manipulation has been shown to be more effective as compared to mobilization. (Dunning, 2016)
- Therapeutic exercise and manipulation/mobilization were equally effective and that both were more effective than no treatment in the management of chronic cervicogenic headaches. (Jull, 2002)

Examples: neck ROM, strengthening, proprioceptive targeting

Visual Therapy

- Strobe training even in healthy people improves cognitive outcome and performance (Applebaum 2011 & 2012, Smith 2012)
- Studies in acquired and TBI patients show improvements in oculomotor function following training (Kapoor, 2018)
- Oculomotor training improves reading and visual attention in mild TBI patients (Thiagarajan, 2014)

• Retrospective analysis of patients with mild TBI who underwent vision therapy for oculomotor signs and symptoms found that 90% had complete or marked improvement in their primary symptoms. (Cuffaro, 2008)

Oculomotor dysfunction
Vergence dysfunction
Accommodative dysfunction
Visual-spatial & visual-vestibular dysfunction

Vestibulo-ocular

Maintains visual stability during head movements

Vestibulospinal

Responsible for postural control

The primary role of the vestibular system is to maintain head and eye coordination, upright posture and balance, and conscious realization of spatial orientation and motion.
Vestibular Therapy

Feasibility of early physical therapy for dizziness after a sports-related concussion: A randomized clinical trial

J. C. Bower 1, 2, A. House 1, 2, R. S. Philipp 1, 2, M. C. Moughlan 2, M. Henderson 2

Outcomes Following a Vestibular Rehabilitation and Aerobic Training Program to Address Persistent Post-Concussion Symptoms
An Exploratory Study
Brian M. Moore, PT, DPT 1, 2
Joseph F. Adams, PT, DPT 1, 2
Edward Bacenti, PT, DPT 1, 2

Examples Visual-Vestibular

• Smooth pursuits, saccades, gaze stability, and convergence, habituation, VOR, Convergence

Video Examples in the Real World
VOR and Convergence
Cervicovestibular Therapy
Schneider et al, 2014 - BJSM

- 31 concussion patients ages 12-30 with symptoms > 10 days and with dizziness, neck pain, and/or headaches
- Vestibular or cervical spine involvement
- 15 Intervention Group
- Both groups weekly sessions and GRTP; treatment also received cervical spine and vestibular rehabilitation
- Of those who completed the intervention, patients in the treatment group >10x more likely to be cleared to return to sport by 8 weeks post-injury

Exercises
Schneider et al, 2014 - BJSM

- Cervical Spine
- Manual therapy (joint mobs.)
- Cervical neuromuscular retraining
- Sensorimotor retraining

- Vestibular
- Habituation
- Gaze stabilization / Adaptation
- Standing and dynamic balance
- Canalith repositioning maneuvers

Evidence Supporting Exercise & Rehabilitation: Dual-Task

- Motor and cognitive tasks
- Low-level to more intense progressions
- Fun, engaging, move to sport-specific

Pilot work
- Improvements in balance and coordination after 4 weeks
Ingreselli et al, 2014
Current Active Rehabilitation Study
Role of Active Rehabilitation in Concussion Management: A Randomized, Controlled Trial

Specific Aim 1
Compare the effects of a multidimensional rehabilitation protocol versus enhanced graded exertion on clinical recovery, return to play, and patient outcomes after SRC.

Specific Aim 2
Demonstrate the safety and feasibility of active intervention protocols when introduced during the sub-acute recovery period after SRC, as part of a multidimensional rehabilitation protocol.

Register-Mihalik, McCrea, & Guskiewicz
Funding: NFL
Current Active Rehabilitation Study
Role of Active Rehabilitation in Concussion Management: A Randomized, Controlled Trial

MDR General Progression Overview

- Guided by symptom presentation and activities of concern for return to sport
- Symptom severity primary marker for progression
- Easy/hands-on activity progressed to divided attention and sport-specific activities
- Integrated with return to sport progression once asymptomatic

Other treatments for consideration....
## Biopsychosocial Considerations in Evaluation and Treatment of Concussion

*Register-Mihalik, 2020*

### Biopsychosocial Model

**Biological**
- Physiologic Considerations
- Neurometabolic cascade post-concussion
- Autonomic nervous system function
- Early exercise may provide physiologic adaptations to improve outcomes

**Psychological**
- Anxiety and depression should be considered in evaluation and treatment
- Exercise and rehabilitation effects on psychological outcomes (e.g., quality of life)

**Social**
- Peer/teammate interaction
- Engagement in daily social activities without symptom exacerbation early in the process

### Considerations from Current Evidence

- Assessment of deficits & current state of patient
- Clinical supervision & direction
- Tracking & monitoring of progress
- Appropriate skills to conduct activity / refer when needed
- Dose, timing, intensity...

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### Behavior & Implementation Matters

*Bekker, 2017; Donakson, 2017*

- Are there policies/procedures that support or hinder implementation of new practices?
- Do clinicians buy in and want to integrate this program into their practice?
- Where/how is the program disseminated?
- Do the coaches buy in to the program? Do the athletes buy in? Do they comply?
Behavior Change at Multiple Levels of the Sport Environment is Necessary to:

- Improve Primary, Secondary, and Tertiary Prevention
- Improve Clinical Management
- Improve Clinical & Patient Outcomes

Clinical Experiences Tie into Disclosure

Previous experience with concussion is associated with lower attitudes and worse reporting outcomes (Baugh, 2019, Register-Mihalik, 2017)

Student-athletes and cadets weigh Cost vs. Benefit (Weber, 2019 In Press)

What does this mean in the context of current “rules” and guidelines?

- It’s rehabilitation, make sure it’s in your standing orders and protocols
- You are not entering the “RTP” process (Stage 2) when starting activities like this, you are conducting rehabilitation activities as you would with any other injury
- Best practice is not to begin Stage 2 of the return-to-play strategy until asymptomatic
- Complete continuing education to be trained in any new skills/activities
- Clinician directed and supervised activity appears safe, even in close proximity post-concussion
Changes in Clinical Practice
Pragmatic Considerations

**General awareness of new evidence**
- Current return to sport strategy
- New evidence around rest/activity post-concussion

**Alignment of policies with current evidence**
- State laws
- Athletic association policies
- Current concussion protocols

**Clinician change practice towards the new evidence**
- Buy-in
- Resources
- Local strategies for their current practice and model of care

**Participants engage in intervention**
- Buy-in to new strategies
- Coach/team buy-in to changes in practice
- Time to complete intervention

While we are concerned with patient-level interventions, there are other “interventions” to consider.

**Policy**
- Policies that encompass current evidence and best practice
- Societal perceptions of concussion care

**Community/Organization**
- Administrative support and buy-in
- Infrastructure and materials to support exercise and rehabilitation strategies
- Clinical protocols inclusive of exercise and rehabilitation strategies

**Interpersonal (Relationship)**
- Medical provider continued education
- Medical provider implementation of exercise and rehabilitation strategies
- Coach and other key stakeholder support of concussion management strategies

**Intrapersonal (Athlete)**
- Patient buy-in to exercise and rehabilitation strategies
- Patient experiences with care
- Patient personal and medical history

Kerr, 2014; Register-Mihalik, 2017; Lininger, 2019

Register-Mihalik, 2020
Clinically directed sub-threshold exercise and rehabilitation acutely and sub-acutely post-concussion appears to be effective and safe. Key behaviors of many involved in the concussion management process as well as policies should be considered in order to effectively implement current best practices in a timely manner across various clinical settings.