Return to Work Following Mild Traumatic Brain Injury

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• Independent practice in forensic neuropsychology, including athletes
Traumatic brain injuries occur on a broad continuum of severity, from very mild injuries to catastrophic injuries resulting in death or severe disability.
Continuum of TBI Severity

Very mild/transient    Uncomplicated mild    Complicated mild    Moderate    Severe    Catastrophic

Approximately 90% of all injuries
Moderate-Severe TBI

• Can result in:
  – widespread damage to the structure and function of the brain
  – permanent changes in physical functioning, cognition, emotional functioning, behavior, and personality
  – permanent disability from work

• Outcome is variable, however, ranging from very good to very poor.
Numbers for

Mild Traumatic Brain Injury (MTBI)

- Vast majority of injuries in civilians (and military)
- Common comorbidities (in civilians)
  - Neurological – up to 25%
  - Psychiatric (incl. alcohol and substance abuse) – up to 30%
- Intracranial lesion on conventional neuroimaging – 0-40%
- Neurosurgical intervention – 1%
- Mortality – 0.1%
- Majority (70-80%) recover within days or weeks
Vulnerability of the Vascular System
(multi echo SWI venogram)
Why is White Matter Vulnerable?

1. Anatomy
2. Physics & Forces
Mild Traumatic Brain Injuries are Not Created Equally
Spectrum of MTBI

Extremely Mild (Transient)

Structural Damage (Permanent)
Continuum of Pathophysiology

- Minor Neurometabolic
- Major Neurometabolic & Pathoanatomical (e.g., Contusion)
Rate of Day-of-Injury CT Abnormalities

- Incidence of intracranial abnormalities in MTBI in Emergency Department studies
  - 5% to 40% across studies
  - It increases with lowering of GCS: 15, 14, 13

- MRI reveals a greater rate
Tampere University Hospital
Emergency Department

• 2,766 patients undergoing head CT for a suspected or confirmed MTBI
• Percentage with trauma-related abnormality: 11.6%
• Stratified by GCS scores:
  – 15 = 10.1%
  – 14 = 36.1%
  – 13 = 48.1%
  – GCS was not available = 11.5%

Isokuortti et al., in preparation
Day-of-Injury CT Abnormalities

- Acute intracranial lesion
- Pre-existing intracranial abnormality

Isokuortti et al., in preparation
Continuum of Biological & Psychological Vulnerability

Extremely Hardy  Extremely Vulnerable
There is no *simple*, reasonably explanatory model for good or poor outcome
PTSD and Mild Traumatic Brain Injury

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CHAPTER 3
A Biopsychosocial Conceptualization of Poor Outcome from Mild Traumatic Brain Injury

Grant L. Iverson
A Few Examples of Risk Factors for Long-Term Symptoms and Problems

**Biological**
- Genetics
- Injury severity
- Prior brain injury

**Psychological**
- Past mental health problems
- Resiliency
- Current traumatic stress

**Social/Environmental**
- Life stress and problems with employment
- Litigation
Biopsychosocial Model for Poor Outcome

**Pre-Injury Factors**
- Personality Characteristics or Disorders
- Biopsychosocial Resilience/Hardiness
- ADHD
- Learning Disability
- Genetics Relating to Injury Vulnerability

**Biopsychosocial Vulnerability**
- Depression
- Anxiety
- Genetic Vulnerability

**Post-Concussion-Like Symptoms**
- Cognitive Diminishment
- Mental Health Problems
- Social Psychological Factors
- Insomnia
- Chronic Headaches or Bodily Pain
- Depression
- Anxiety/Stress/Worry
- PTSD

**Traumatic Axonal Injury**
- Altered Neurotransmitter Systems
  - Expectations
  - Diagnosis Threat
  - Nocebo Effect
  - Lifestyle & Family Dynamics Changes
  - Anger/Bitterness
  - Justification/Entitlement
  - Litigation Stress

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Recovery from Concussion in Sports
By definition, a sport-related concussion is a mild traumatic brain injury.
Is sport-related concussion a benign injury?

Results from meta-analyses
Adverse Effects of Sport Concussion on Cognition

- Concussion Hours < 24: -0.97
- Concussion Days > 7 Mod: -0.22
- Severe > 2 Years: -0.84
- TBI: -1.03
- MCI-Early Dementia
Acute Concussion-Cognition: -0.81
Acute Concussion-Balance: -2.56
Acute Concussion-Symptoms: -3.31
MTBI 1-3 Months-Cognition: -0.12
Mod-Severe TBI > 2 Years-Cognition: -0.84
Pathophysiology

- Complex interwoven cellular and vascular changes

- **Multilayered Neurometabolic Cascade**

- Under certain circumstances, cells degenerate and die
Primary Mechanisms

• Ionic shifts
• Abnormal energy metabolism
• Diminished cerebral blood flow
• Impaired neurotransmission
Fortunately, the brain undergoes dynamic restoration
Assessment Timeline

- Sideline
- Post-Game
- 24 Hours
- First Week
- Second Week
- Third Week
- At Risk!
Rest Following Injury

How much and for how long?
What is the rationale for rest?

• The injured brain might be in a state of neurometabolic crisis.

• Assuming that neurometabolic crisis involves an “energy crisis,” then vigorous activity might compound or magnify the energy crisis.

• Passing another mechanical force through the injured brain, while it is in a state of neurometabolic crisis, might result in magnified pathophysiology.
Critical Questions

• How do we define “rest”? 
• How long should an athlete rest? 
• How do we define gradual resumption of activities? 
• How much rest is too much rest? 
• When should we begin active rehabilitation?
Is Rest After Concussion “The Best Medicine?”: Recommendations for Activity Resumption Following Concussion in Athletes, Civilians, and Military Service Members

Noah D. Silverberg, PhD; Grant L. Iverson, PhD
Silverberg and Iverson (2012) concluded that bed rest exceeding three days is not recommended and gradual resumption of pre-injury activities should begin as soon as tolerated.
Is rest in the initial days following concussion a good idea?

In my opinion, yes.
What does the Sport Concussion Group 2012 Zurich Consensus Statement say?

• “In the absence of evidence-based recommendations, a sensible approach involves the gradual return to school and social activities (prior to contact sports) in a manner that does not result in a significant exacerbation of symptoms”

(McCrory et al., 2013)
Gradual Return to Sports Following Injury
Consensus statement on concussion in sport: the 4th International Conference on Concussion in Sport held in Zurich, November 2012

Paul McCrory,1 Willem H Meeuwisse,2,3 Mark Aubry,4,5,6 Bob Cantu,7,8 Jiří Dvořák,9,10,11 Ruben J Echemendia,12,13 Lars Engebretsen,14,15,16 Karen Johnston,17,18 Jeffrey S Kutcher,19 Martin Raftery,20 Allen Sills,21 Brian W Benson,22,23,24 Gavin A Davis,25 Richard G Ellenbogen,26,27 Kevin Guskiewicz,28 Stanley A Herring,29,30 Grant L Iverson,31 Barry D Jordan,32,33,34 James Kissick,6,35,36,37 Michael McCrea,38 Andrew S McIntosh,39,40,41 David Maddocks,42 Michael Makdissi,43,44 Laura Purcell,45,46 Margot Putukian,47,48 Kathryn Schneider,49 Charles H Tator,50,51,52,53 Michael Turner54

Consensus Statement on Concussion in Sport: the 3rd International Conference on Concussion in Sport held in Zurich, November 2008

P McCrory, W Meeuwisse, K Johnston, J Dvorak, M Aubry, M Molloy and R Cantu

doi:10.1136/bjsm.2009.058248
Management Protocol: Stepwise

• No activity / Rest
• Light aerobic exercise
• Sport-specific exercise
• Non-contact training drills
• Full contact practice
• Return to play
Progressive Return to Activity
Guidelines for Military Service Members

Defense and Veterans Brain Injury Center
Handouts, Guidelines, Slides can be downloaded
Progressive Activity Process

- Six stage approach from ‘Rest’ to ‘Unrestricted Activity’
- Progression is measured across physical, cognitive, and vestibular domains
- Utilizes the Neurobehavioral Symptom Inventory (NSI) for symptom tracking
- Resting heart rate (HR) and blood pressure (BP) are used as physiological measures to evaluate activity tolerance

DoD photo by Sgt. Justin Naylor (left), MWR West Point photo (center), US MilitaryCycling.com photo (right)
<table>
<thead>
<tr>
<th>Rehabilitation Stages</th>
<th>Description</th>
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<tbody>
<tr>
<td>Stage 1</td>
<td>Rest</td>
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<tr>
<td>Stage 2</td>
<td>Light Routine Activity</td>
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<tr>
<td>Stage 3</td>
<td>Light Occupation-oriented Activity</td>
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<tr>
<td>Stage 4</td>
<td>Moderate Activity</td>
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<td>Stage 5</td>
<td>Intensive Activity</td>
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<tr>
<td>Stage 6</td>
<td>Unrestricted Activity</td>
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Recovery Time in Athletes
NCAA Football Cohort

- 1,631 players
- 94 concussions
- Balance problems resolved in 3-5 days
- Symptoms gradually resolved by 7 days
- Cognition resolved by 5-7 days
- 91% appeared recovered by 7 days

McCrea et al. (2003)
Pennsylvania High School Football Cohort

- 2,141 players
- 3-year prospective cohort study
- 134 concussions
- Players followed until recovered

Recovery Curve (N = 134)

Days Post Injury

- 91% recovery at day 40
- 46% recovery at day 10

(Numbers and points on graph represent percentages and days post injury, respectively.)
Recovery Curves (N = 134)

Days Post Injury

- No Previous Concussions
- 1 or More Previous Concussions

94%
84%
Multiple Concussions
Multiple Concussions

• Literature is mixed.

• Overall, group studies suggest possible lowered threshold, worse initial presentation, and slower recovery in some athletes with multiple injuries.

• Tremendous individual differences, however.
Recovery from Mild Traumatic Brain Injury in Civilians
Most people recover functionally within 3 months following injury.
Most people return to work within 3 months.

Return to work rates are highly variable across studies and are likely influenced by many factors separate from the injury to the brain.
Return to Work Rates

• There is tremendous variability in how quickly people return to work following an MTBI, but most do so within the first month.

• Some, but not all, studies suggest that injury severity within the MTBI classification range is associated with time to RTW.

• The risk factors for delayed return to work are diverse, complex, and not fully understood.

• A biopsychosocial perspective is helpful.
Return to Work Rates

• Across counties and studies, return to work rates range from:
  – 22% to 84% in the first week,
  – 25% to 99% within the first month,
  – 48% to 100% 3 to 6 months post injury,
  – 46% to 100% 1 year post injury.

Iverson et al. (2012)
Methodological Differences in RTW Studies

- Definitions of return to work (e.g., return to pre-injury employment vs. return to meaningful activity)

- Variations in the definition of MTBI (e.g., inclusion of GCS = 15 only vs. GCS = 13–15)

- Variations in the inclusion and exclusion of individuals who were unemployed or performing domestic duties prior to injury

- The failure of some studies to take into account pre-injury employment status (e.g., return to full-time vs. part-time vs. unemployed).

Iverson et al. (2012)
Education and Reassurance as a Medical Management Strategy
There is some evidence that early education and reassurance can help patients manage symptoms better and can facilitate positive expectations for recovery.
Civilians who sustain an MTBI are at substantially increased risk for experiencing depression in the first year following injury.

The etiology of depression is likely individualized and multifactorial.
Post-concussion-like symptoms can be mimicked or magnified by traumatic stress, anxiety, pain, depression, sleep disturbance, and social psychological factors at any point in the recovery trajectory.
Individuals who are symptomatic at 3-6 months are at considerable risk for being symptomatic at 1-2 years post injury.
Factors Affecting Recovery Time

- General health
- Previous concussions / neurological problems
- Pre-injury mental health problems
- Mechanism of Injury: MVA vs. Sports
- *Acute Psychological Distress* in the first few days
- *Severity of concussion symptoms in the first week*
- Post-Acute co-occurring conditions (depression, PTSD, chronic pain)
- Personality Characteristics
- Motivation
- Litigation
Introduction to the Post-Concussion Syndrome

• What is it?
• How long does it last?
• Can it be misdiagnosed?
ICD-10 Criteria for Postconcussional Syndrome

- Must endorse symptoms in at least 3 domains
  - Physical
  - Emotional
  - Cognitive
  - Insomnia
  - Excessive worry over symptoms
  - Intolerance for alcohol
• Physical Symptoms (headache, dizziness, balance problem, noise sensitive, light sensitive, and/or fatigue)

• Emotional Symptoms (irritability, sadness, nervousness, and/or feeling more emotional),

• Cognitive Symptoms (poor concentration, poor memory); and

• Insomnia (trouble falling asleep and/or sleeping less than usual).
Post-Concussion Syndrome

• More common in women than men.
• Pre-injury mental health problems are a major risk factor.
• It is associated with or influenced by traumatic stress in service members, veterans, and civilians.
• Persistent symptoms at 1 or 3 months are a risk factor for persistent symptoms at 1 year.
• Easy to misdiagnose in people with depression, anxiety, PTSD, and chronic pain.
The symptoms of mild TBI can be mimicked or magnified by traumatic stress, anxiety, pain, depression, sleep disturbance, and social psychological factors at any point during recovery.
The Nonspecificity Conundrum

Symptoms of the post-concussion syndrome are common in people with other health problems
“Postconcussion-Like” Symptoms are Common in:

- University students
- Mental health outpatients
- General medical patients
- Chronic pain patients
- Personal injury litigants
Misdiagnosis of the persistent postconcussion syndrome in patients with depression

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Accepted 14 December 2005
Misdiagnosis of PCS in Depression

• 64 patients with depression

• Diagnosed and referred by family physician or psychiatrist

• Independently confirmed diagnosis with SCID-I

Iverson (2006)
PCS-Like Symptoms in Patients with Depression (Blue = Mild; Red = Mod-Severe)
ICD 10 Diagnostic Criteria

Mild PCS = 89.1%

Moderate – Severe Symptom Endorsement

57.8%
Treatment & Rehabilitation
Basic Principles: Initial Months Following Injury

• Focused, Evidence-Based Treatment for Specific Symptoms and Problems
  – Medications
  – Physical Therapy
  – Vestibular Rehabilitation
  – Exercise
  – Psychological Treatment
Exercise as Treatment

- Exercise facilitates molecular markers of neuroplasticity and promotes neurogenesis in the healthy rodent brain and the injured brain.

- Associated with changes in neurotransmitter systems (Chaouloff, 1989; Molteni, Ying, & Gomez-Pinilla, 2002).
Exercise

• Improved mood and lower stress (Callaghan, 2004; Conn, 2010)

• Improved sleep quality (Youngstedt, 2005)

• Positive effects on self-esteem (Ekeland, Heian, Hagen, Abbott, & Nordheim, 2004)
Exercise

• Effective treatment, or adjunctive treatment, for mild forms of anxiety and depression (Daley, 2008; Mead et al., 2009; Rethorst, Wipfli, & Landers, 2009)

• Associated with reduced pain and disability in patients with chronic low back pain (Bell & Burnett, 2009; Henchoz & Kai-Lik So, 2008)

• Regular long-term aerobic exercise reduces migraine frequency, severity, and duration (Koseoglu, Akboyraz, Soyuer, & Ersoy, 2003; Lockett & Campbell, 1992)
Research on Exercise for MTBI

• Several small studies suggest exercise training is helpful for persistent symptoms in adolescents and adults
Psychological Treatment for People with Chronic Problems
Psychological Treatment

- Cognitive Behavior Therapy
- Self-Management
- Behavioral Activation
- Stress Management
- Acceptance & Commitment Therapy
Conclusions

• Mild TBIs are heterogeneous.

• An initial period of rest is helpful but too much rest can be harmful for some people.

• Most athletes appear to recover within one month and most civilians appear to recover within three months.
• Patients with depression or chronic pain, in the absence of head trauma, report very high levels of concussion-like symptoms

• A substantial minority of healthy control subjects also endorse high levels of symptoms

• Poor outcome cannot be explained by purely neurological, psychological, contextual, or motivational factors

• The only reasonable approach to understanding poor outcome following Mild TBI is a biopsychosocial perspective
Careful and Comprehensive Assessment
= Targets for Treatment and Rehabilitation
Reduce Symptoms; Improve Function

- Sleep Disturbance
  - Stress & Anxiety
  - Depression
  - Deconditioning
- Headaches
  - Bodily Pain
Treat what you can treat.

Success begets success.

Reduce symptoms.

Improve functioning.