

Return to Work Following Mild Traumatic Brain Injury

Grant L. Iverson, Ph.D.

Professor, Department of Physical Medicine and Rehabilitation,
Harvard Medical School;

Director, MassGeneral Hospital for Children Sport Concussion Program; &
Associate Director, Traumatic Brain Injury Program,
Home Base, A Red Sox Foundation and Massachusetts General Hospital Program

Occupational and Environmental Medical Association of Canada
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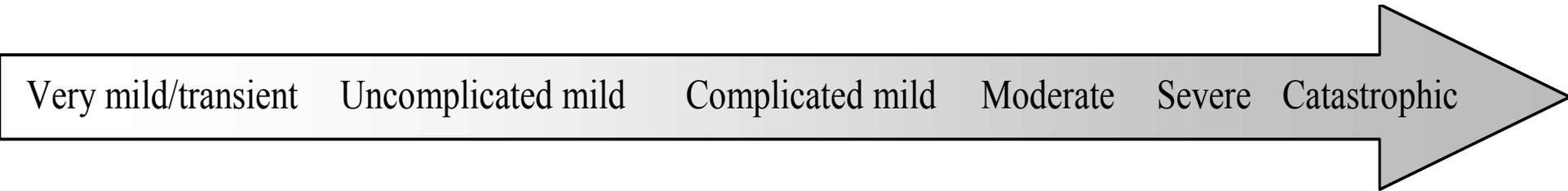
- Canadian Institutes of Health Research
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- Royalties for books and one neuropsychological test (WCST-64)
- Independent practice in forensic neuropsychology, including athletes

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



————— Approximately 90% of all injuries —————

Moderate-Severe TBI

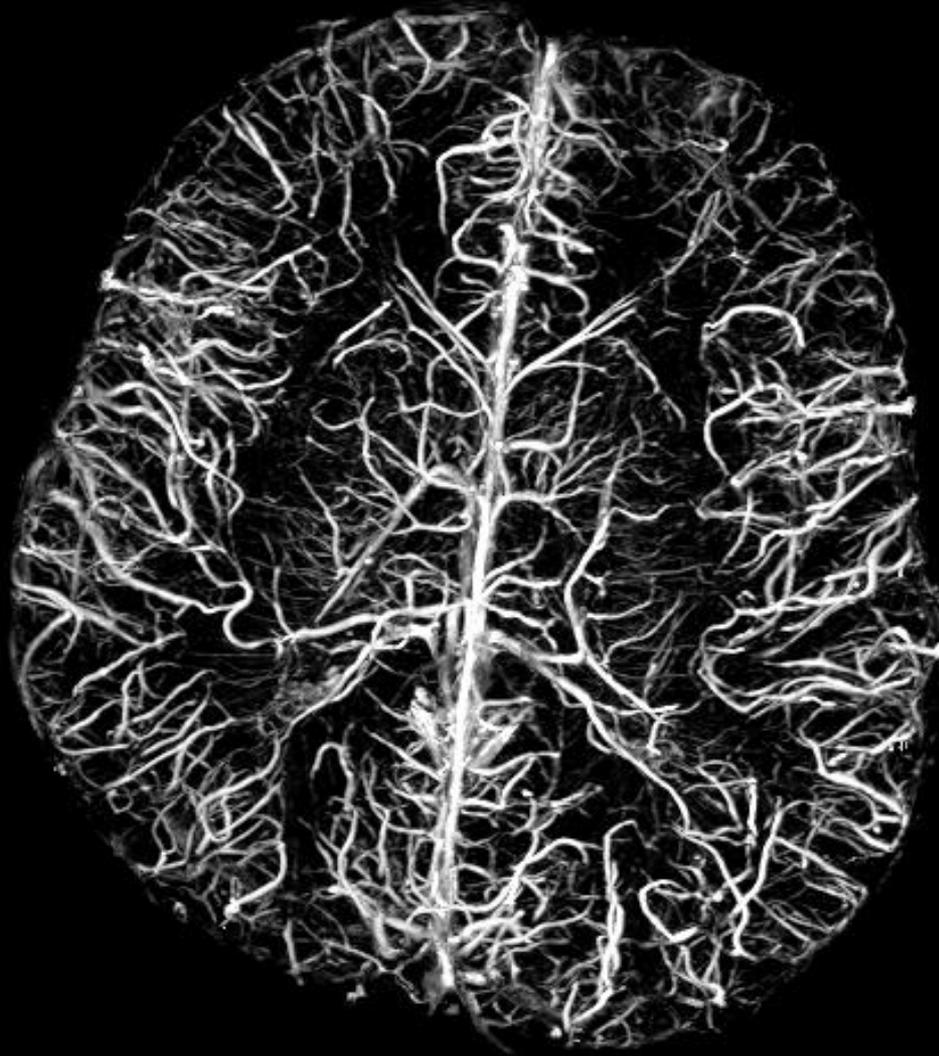
- Can result in:
 - widespread damage to the structure and function of the brain
 - permanent changes in physical functioning, cognition, emotional functioning, behavior, and personality
 - permanent disability from work
- Outcome is variable, however, ranging from very good to very poor.

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

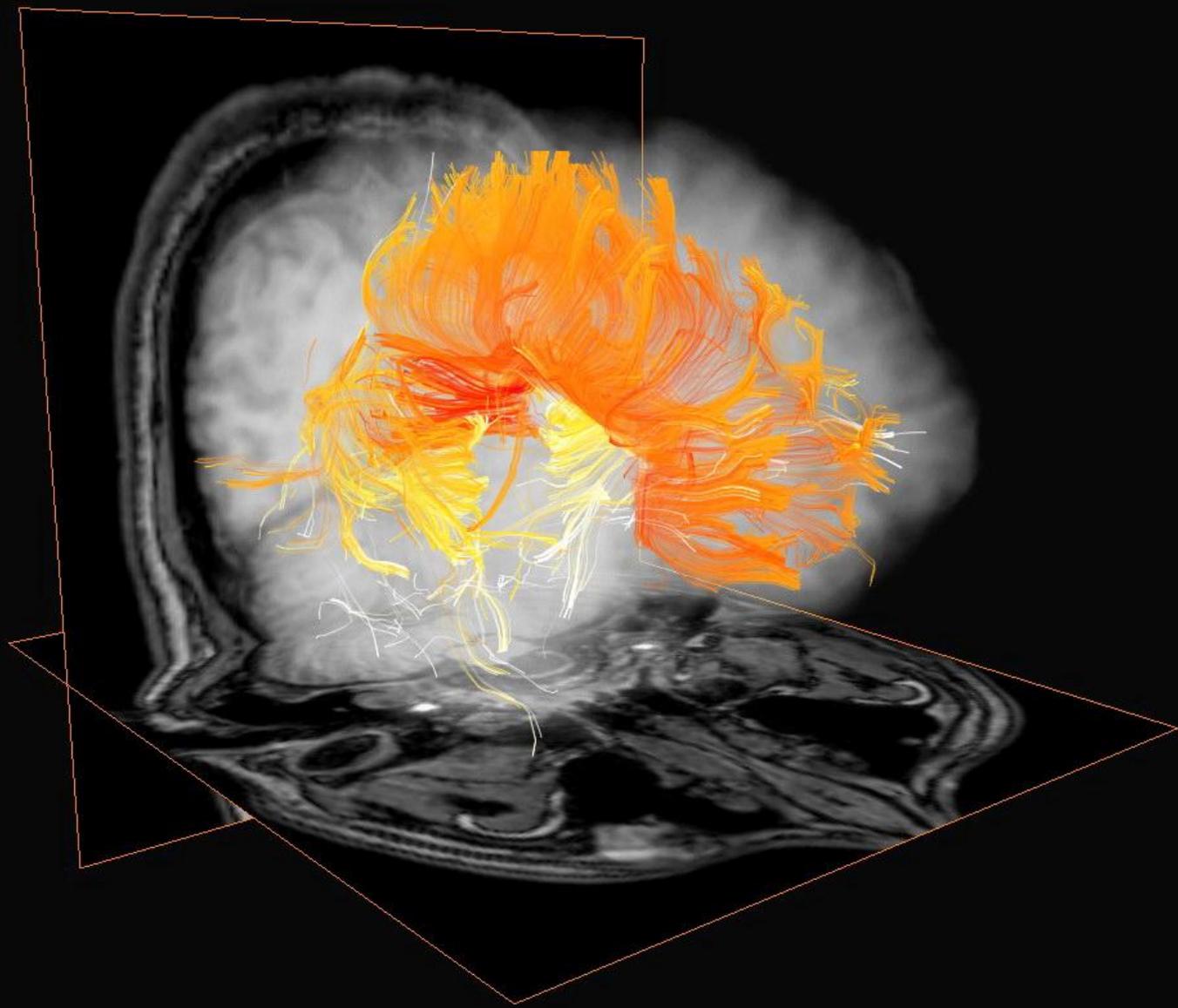
Vulnerability of the Vascular System

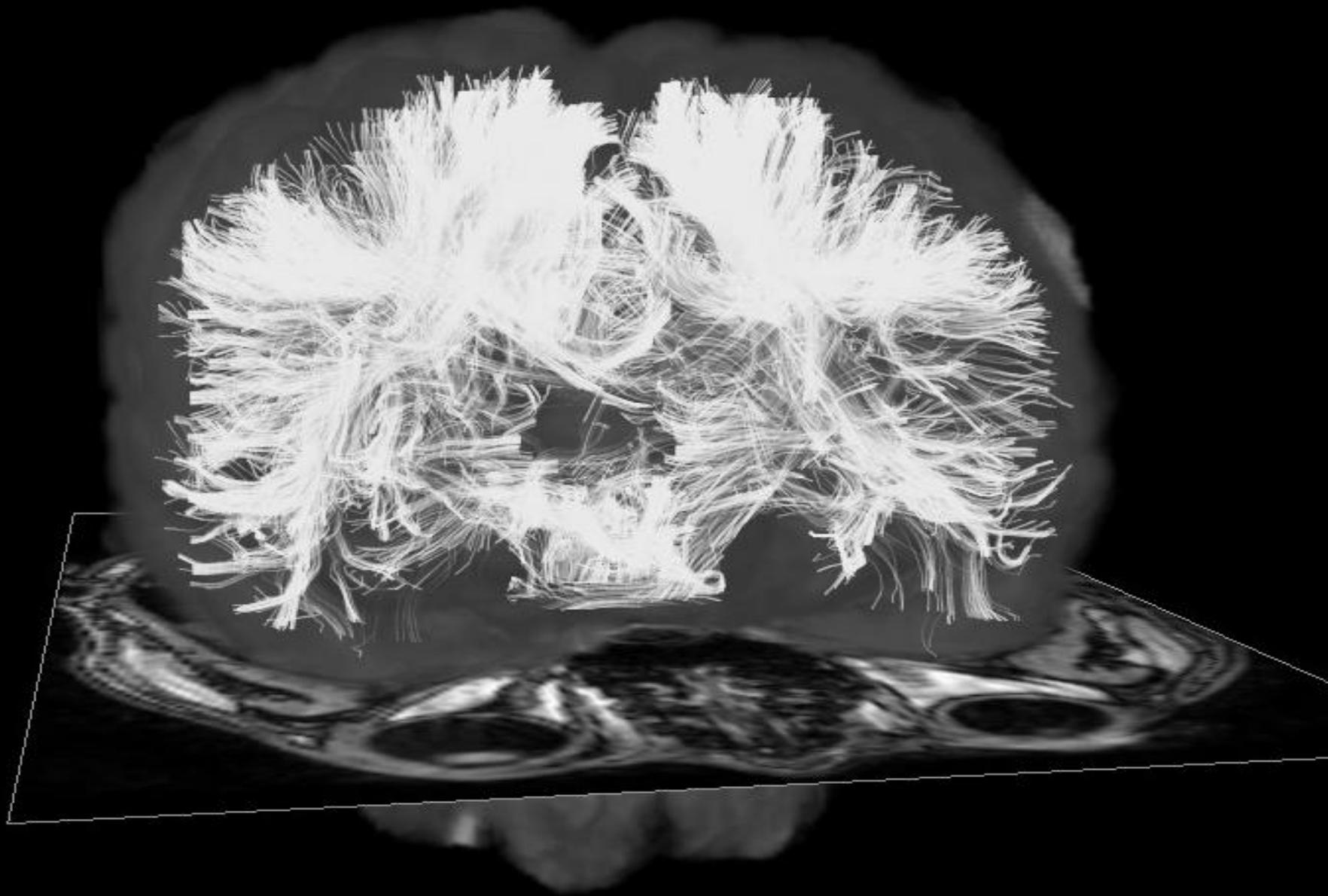
(multi echo SWI venogram)



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

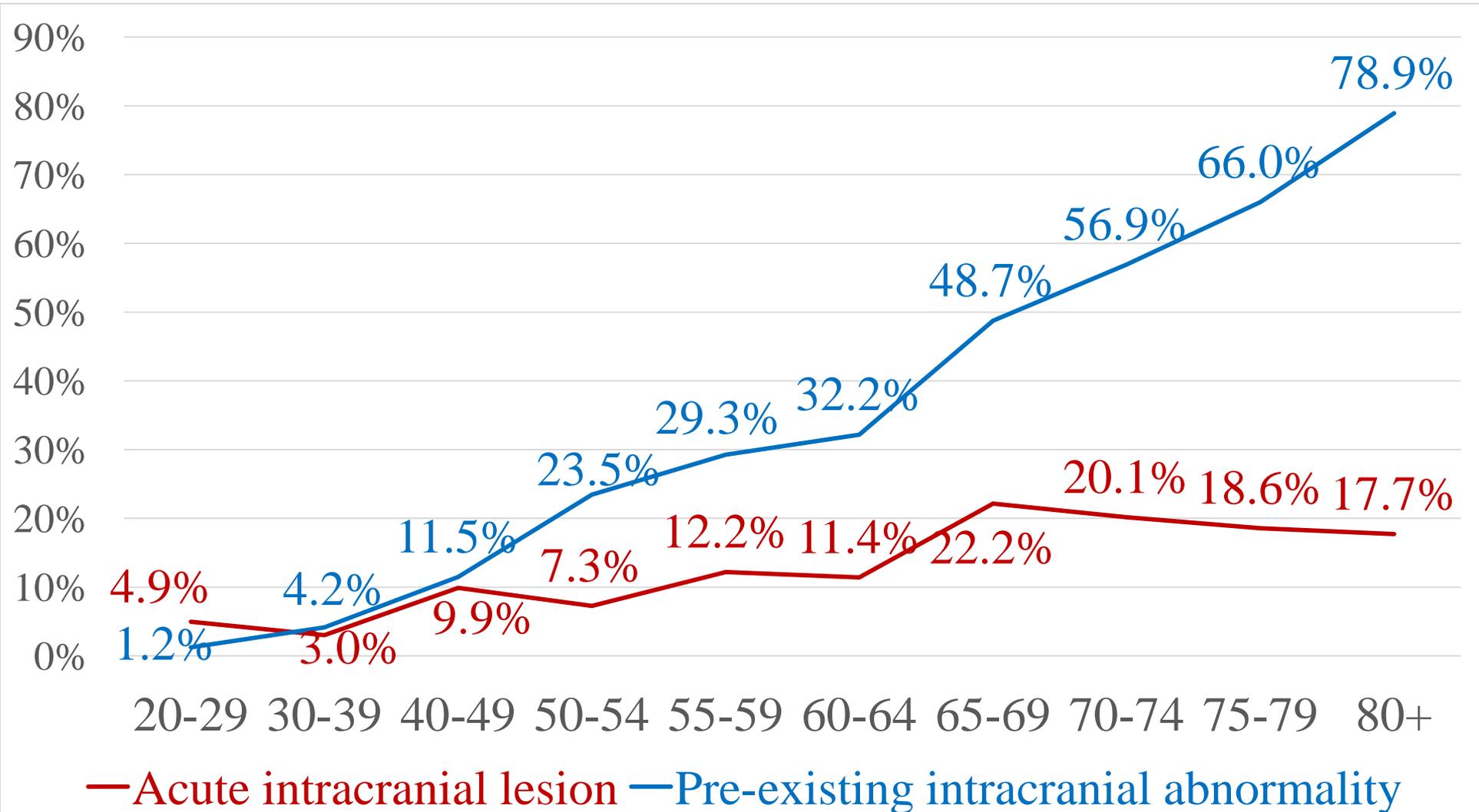
- Incidence of intracranial abnormalities in MTBI in Emergency Department studies
 - 5% to 40% across studies
 - It increases with lowering of GCS: 15, 14, 13
- MRI reveals a greater rate

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



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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Jennifer J. Vasterling
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Terence M. Keane

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

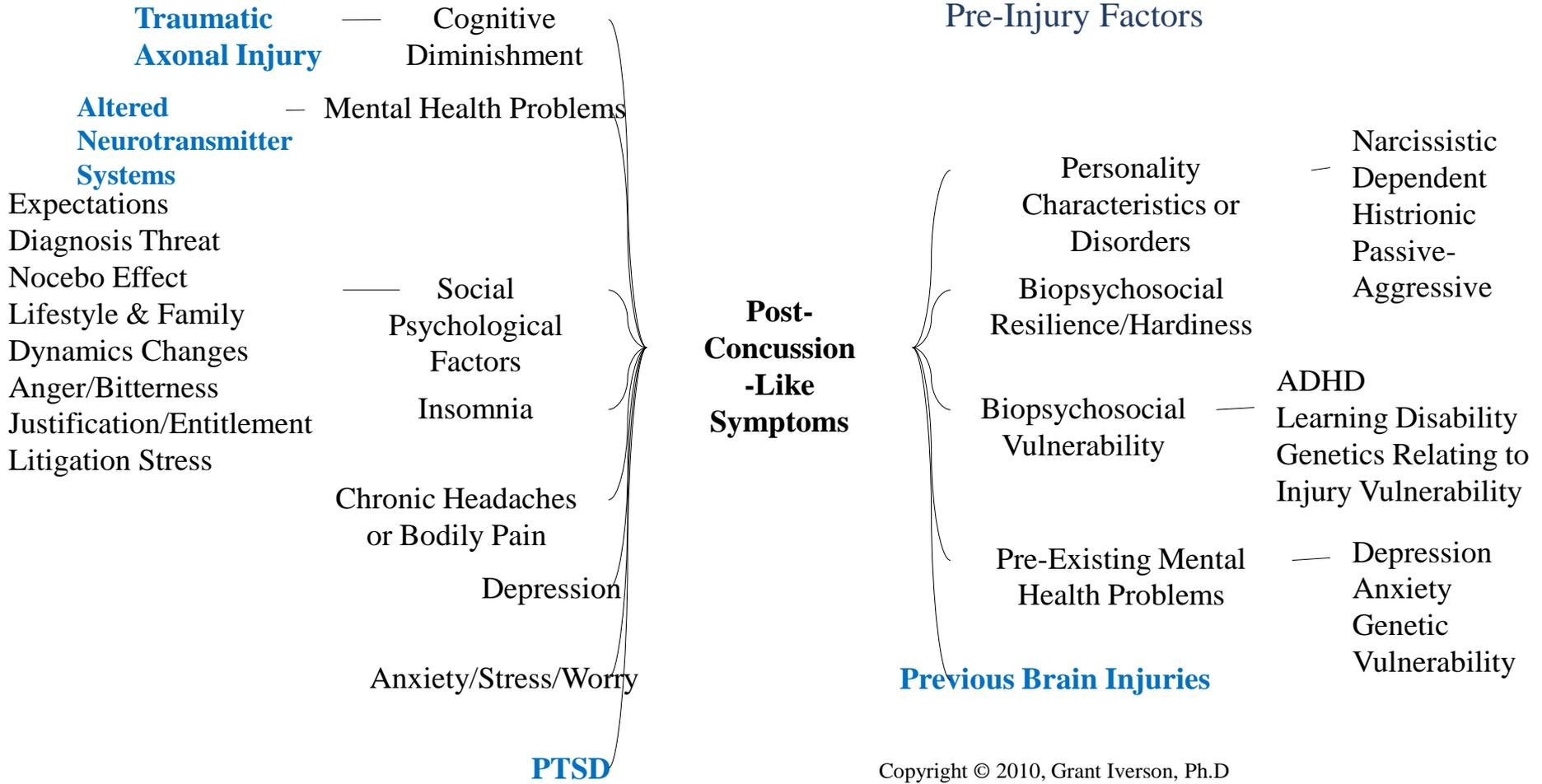
Psychological

- Past mental health problems
- Resiliency
- Current traumatic stress

Social/ Environmental

- Life stress and problems with employment
- Litigation

Biopsychosocial Model for Poor Outcome



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Recovery from Concussion in Sports

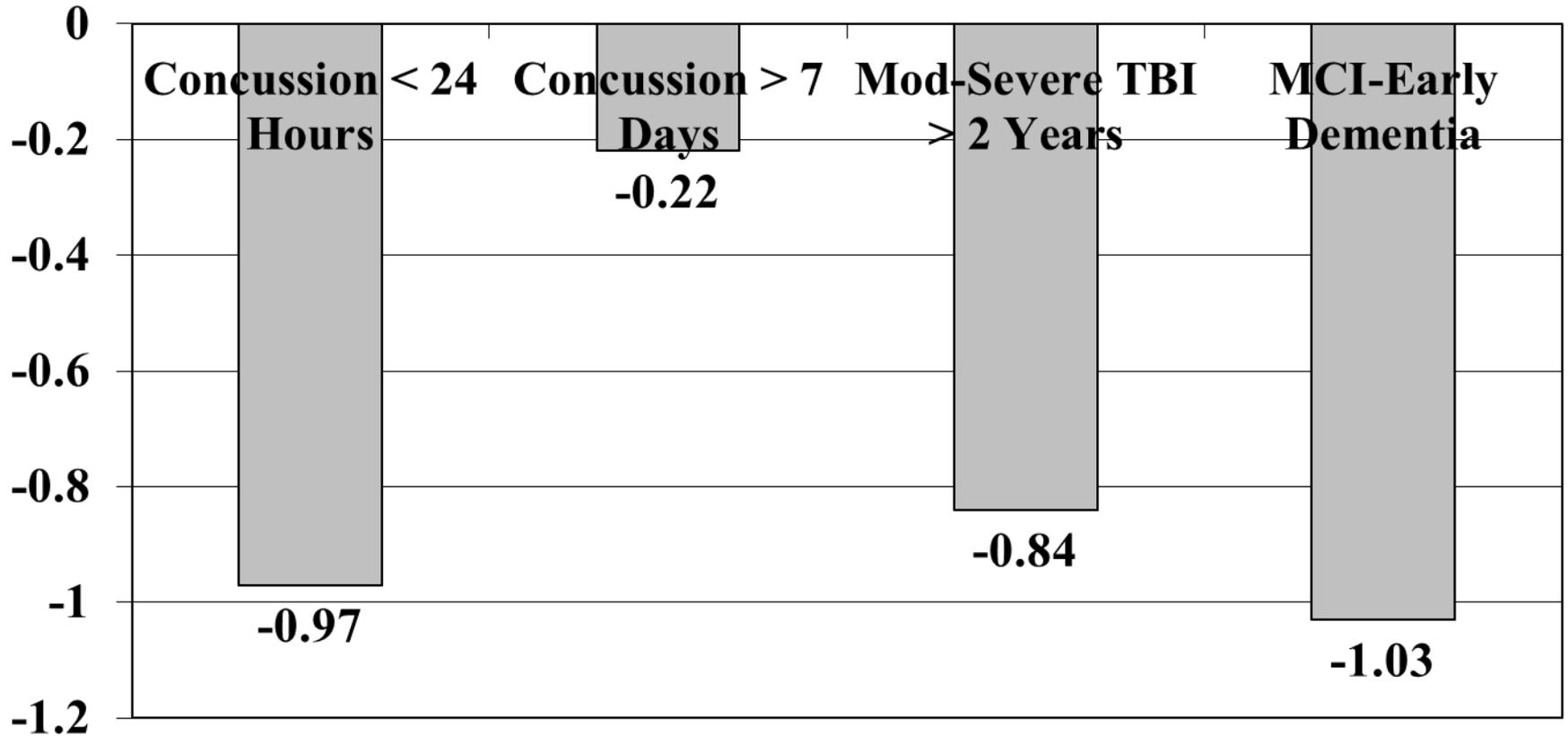


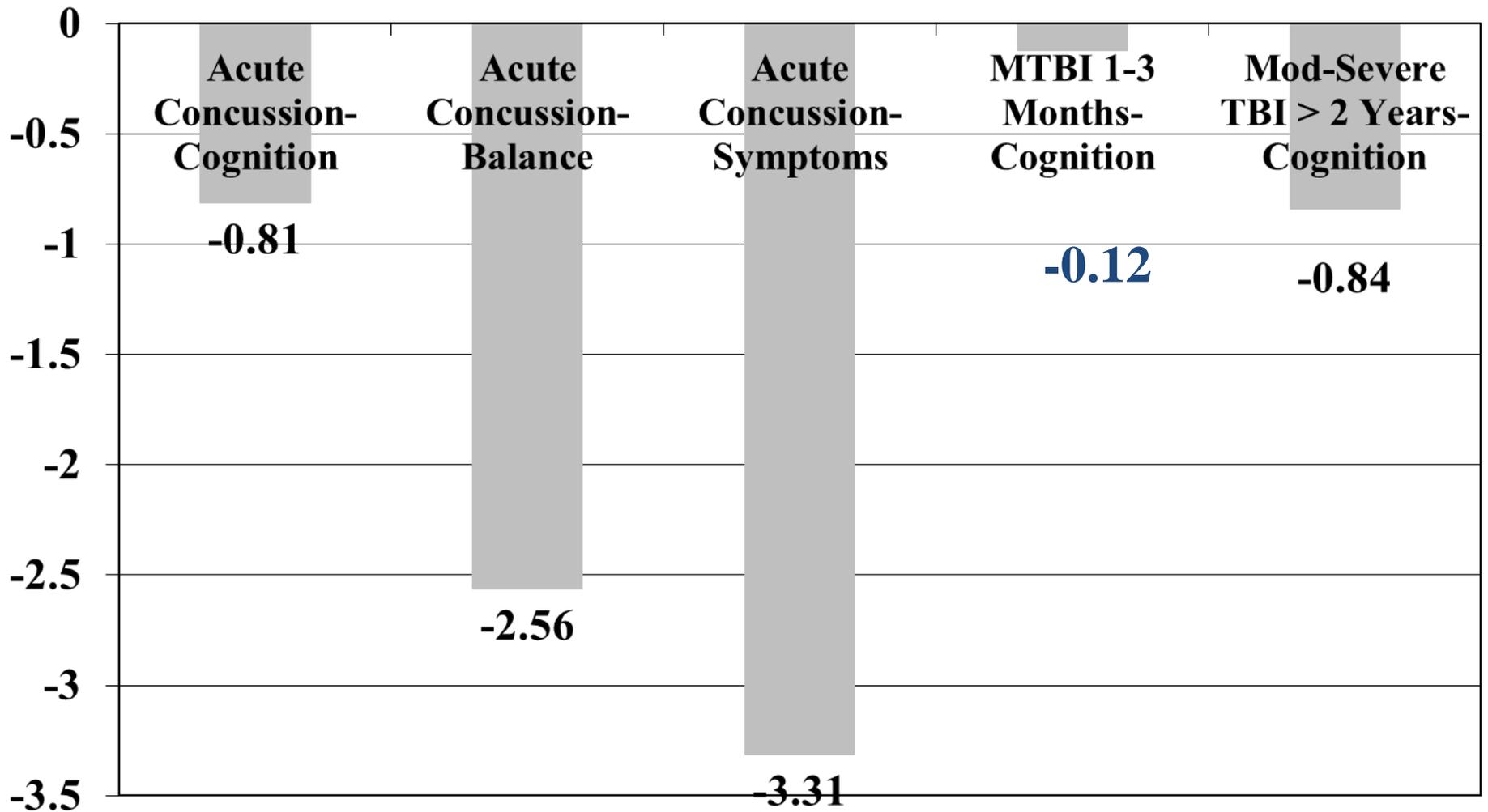
By definition, a sport-related concussion is a mild traumatic brain injury.

Is sport-related concussion a benign injury?

Results from meta-analyses

Adverse Effects of Sport Concussion on Cognition





Pathophysiology

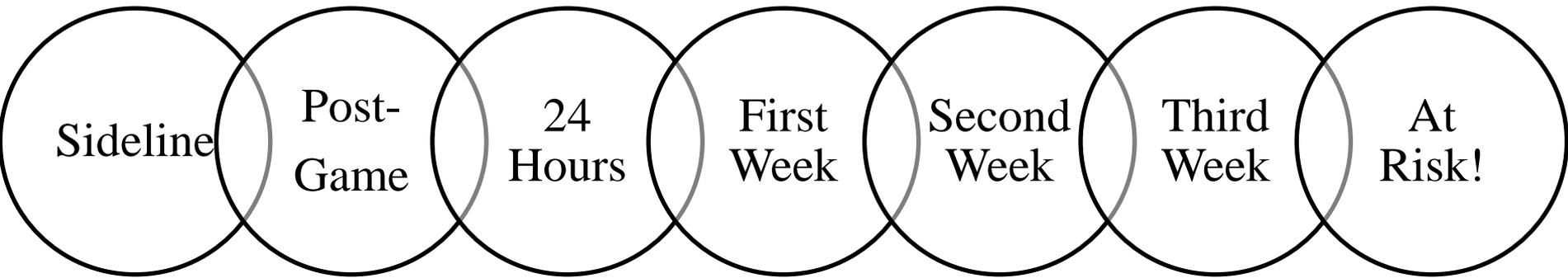
- Complex interwoven cellular and vascular changes
- **Multilayered Neurometabolic Cascade**
- Under certain circumstances, cells degenerate and die

Primary Mechanisms

- Ionic shifts
- Abnormal energy metabolism
- Diminished cerebral blood flow
- Impaired neurotransmission

Fortunately, the brain undergoes
dynamic restoration

Assessment Timeline



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”

(McCrorry 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

Br. J. Sports Med. 2009;43:i76-i84
doi:10.1136/bjism.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)



Stages of Progressive Activity



Rehabilitation Stages	Description
Stage 1	Rest
Stage 2	Light Routine Activity
Stage 3	Light Occupation-oriented Activity
Stage 4	Moderate Activity
Stage 5	Intensive Activity
Stage 6	Unrestricted Activity

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

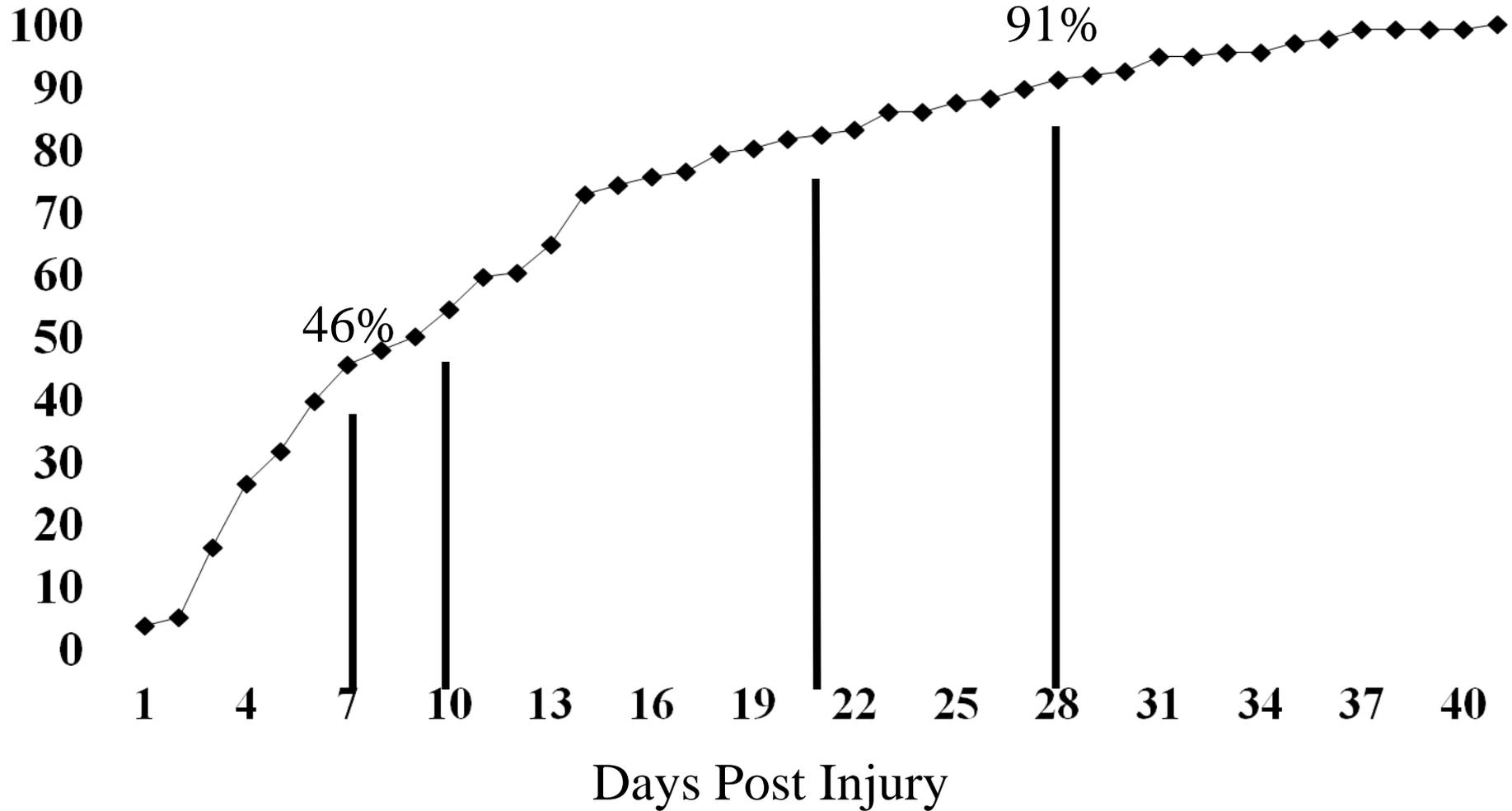
McCrea et al. (2003)

Pennsylvania High School Football Cohort

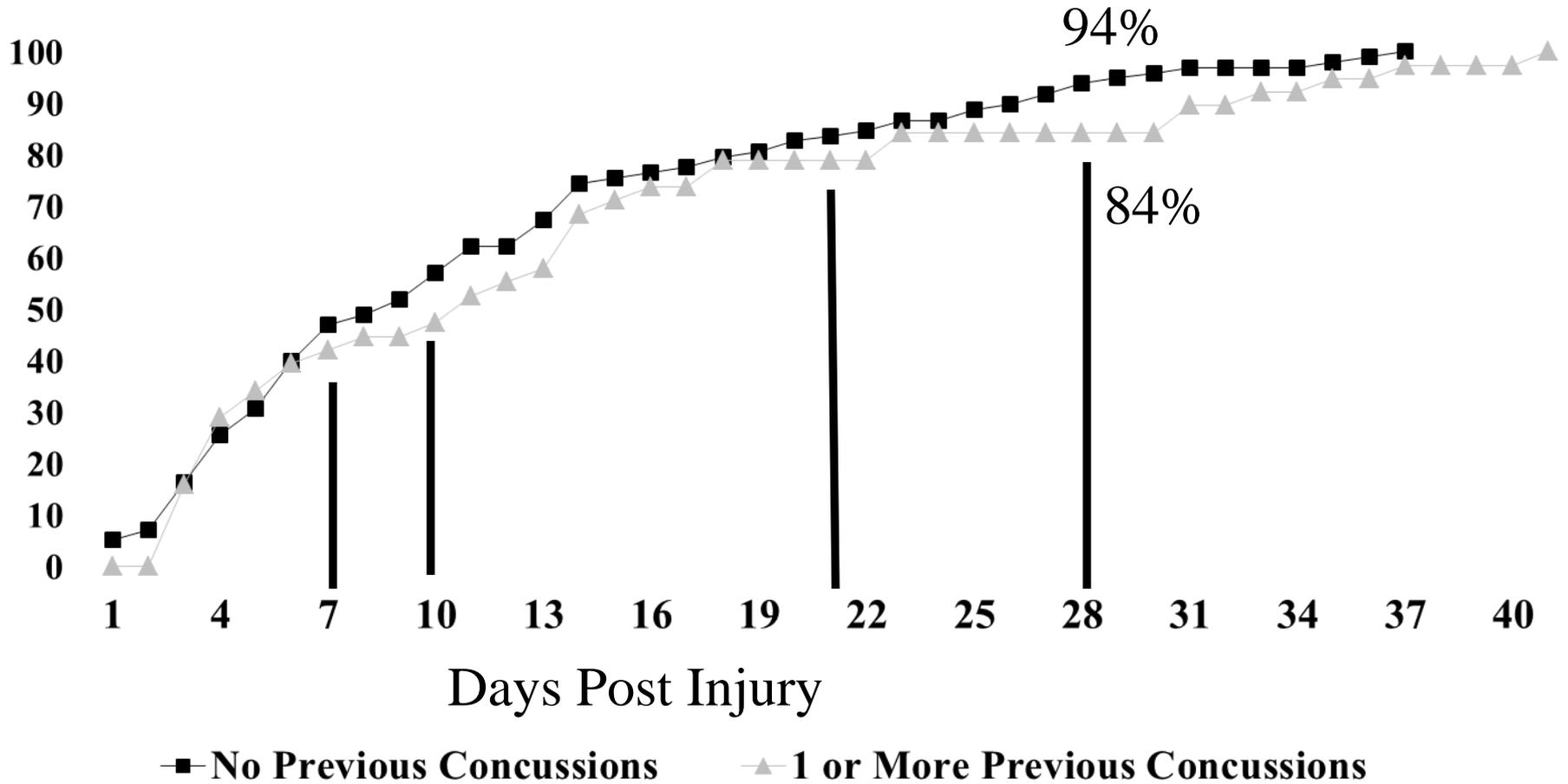
- 2,141 players
- 3-year prospective cohort study
- 134 concussions
- Players followed until recovered

Collins, Lovell, Iverson, Ide, Maroon (2006)

Recovery Curve (N = 134)



Recovery Curves (N = 134)



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.



Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95(3 Suppl 2):S201-9



REVIEW ARTICLE

Systematic Review of Return to Work After Mild Traumatic Brain Injury: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis



Carol Cancelliere, DC, MPH,^{a,b} Vicki L. Kristman, PhD,^{c,d,e,f} J. David Cassidy, PhD, DrMedSc,^{a,b,f,g} Cesar A. Hincapié, DC, MHSc,^{a,f} Pierre Côté, DC, PhD,^{b,f,h,i} Eleanor Boyle, PhD,^{f,g} Linda J. Carroll, PhD,^j Britt-Marie Stålnacke, MD, PhD,^k Catharina Nygren-de Boussard, MD, PhD,^l Jörgen Borg, MD, PhD^l

J Head Trauma Rehabil
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Return to Work Following Mild Traumatic Brain Injury

Minna Wäljas, PsyLic; Grant L. Iverson, PhD; Rael T. Lange, PhD;
Sivi Liimatainen, MD, PhD; Kaisa M. Hartikainen, MD, PhD; Prasun Dastidar, MD, PhD;
Seppo Soimakallio, MD, PhD; Juha Öhman, MD, PhD

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).

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



Archives of Physical Medicine and Rehabilitation

journal homepage: www.archives-pmr.org

Archives of Physical Medicine and Rehabilitation 2014;95(3 Suppl 2):S257-64



REVIEW ARTICLE

Nonsurgical Interventions After Mild Traumatic Brain Injury: A Systematic Review. Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis



Catharina Nygren-de Boussard, MD, PhD,^a Lena W. Holm, DrMedSc,^b
Carol Cancelliere, DC, MPH,^{c,d} Alison K. Godbolt, MBChB, MD,^a Eleanor Boyle, PhD,^{e,f}
Britt-Marie Stålnacke, MD, PhD,^g Cesar A. Hincapié, DC, MHSc,^{c,f}
J. David Cassidy, PhD, DrMedSc,^{c,d,e,f} Jörgen Borg, MD, PhD^a

J Rehabil Med 2004; Suppl. 43: 76–83

Taylor & Francis
healthsciences

NON-SURGICAL INTERVENTION AND COST FOR MILD TRAUMATIC BRAIN INJURY: RESULTS OF THE WHO COLLABORATING CENTRE TASK FORCE ON MILD TRAUMATIC BRAIN INJURY

Jörgen Borg,¹ Lena Holm,² Paul M. Peloso,³ J. David Cassidy,^{2,4,5} Linda J. Carroll,⁴ Hans von Holst,⁶ Chris Paniak⁷ and David Yates⁸

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.



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REVIEW ARTICLE

Systematic Review of Self-Reported Prognosis in Adults After Mild Traumatic Brain Injury: Results of the International Collaboration on Mild Traumatic Brain Injury Prognosis

J. David Cassidy, PhD, DrMedSc,^{a,b,c,d} Carol Cancelliere, DC, MPH,^{b,d} Linda J. Carroll, PhD,^e Pierre Côté, DC, PhD,^{c,d,f,g} Cesar A. Hincapié, DC, MHSc,^{b,c} Lena W. Holm, DrMedSc,^h Jan Hartvigsen, PhD,^{a,i} James Donovan, BSc, DC,^b Catharina Nygren-de Boussard, MD, PhD,^j Vicki L. Kristman, PhD,^{c,k,l,m} Jörgen Borg, MD, PhD^j



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

Grant L. Iverson

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Behav. Sci. Law 31: 686–701 (2013)
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(wileyonlinelibrary.com) DOI: 10.1002/bsl.2087

Neuropsychological Differential Diagnosis of Mild Traumatic Brain Injury

Glenn J. Larrabee, Ph.D.* and Martin L. Rohling, Ph.D.†

30

Conceptualizing Outcome From Mild Traumatic Brain Injury

Grant L. Iverson, Noah Silverberg, Rael T. Lange, and Nathan D. Zasler

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

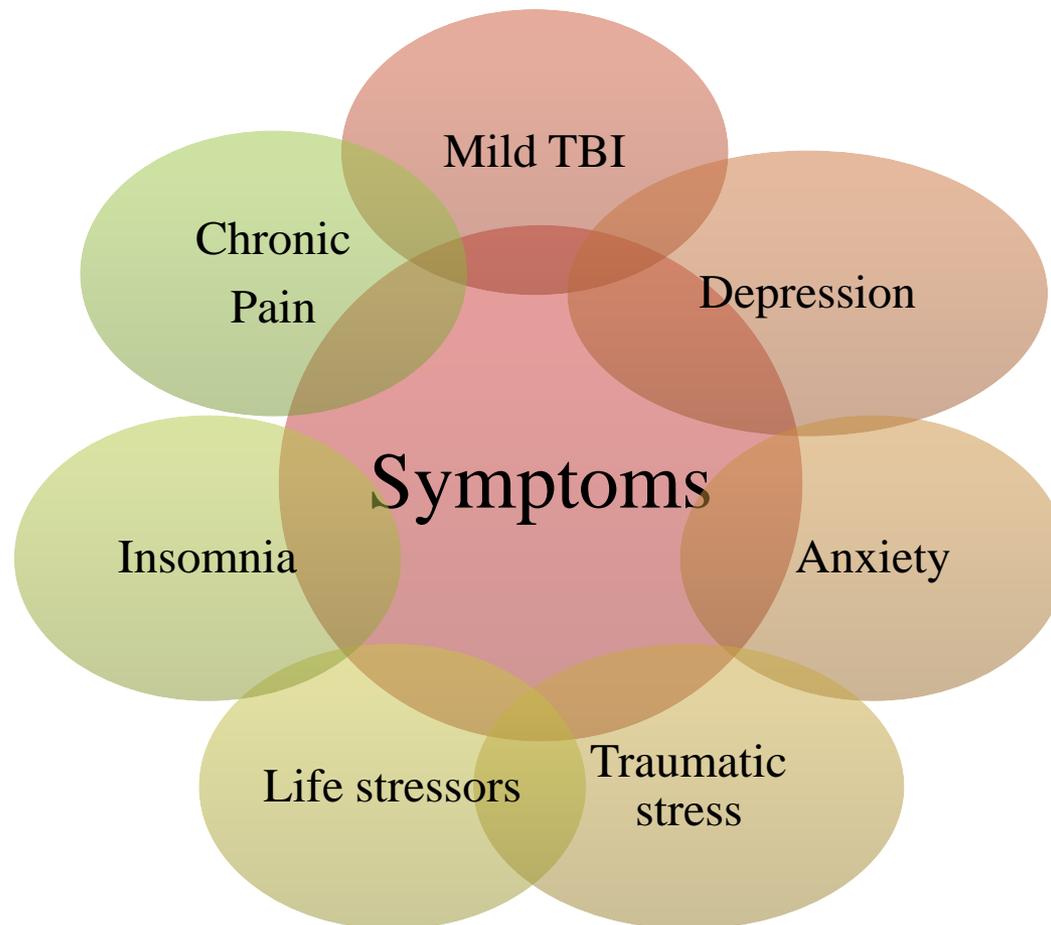
- Must endorse symptoms in at least 3 domains
 - Physical
 - Emotional
 - Cognitive
 - Insomnia
 - Excessive worry over symptoms
 - Intolerance for alcohol

- 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



Archives of Clinical Neuropsychology 21 (2006) 303–310

Archives
of
CLINICAL
NEUROPSYCHOLOGY

Misdiagnosis of the persistent postconcussion syndrome in patients with depression

Grant L. Iverson*

Department of Psychiatry, University of British Columbia & Riverview Hospital, 2255 Wesbrook Mall, Vancouver, BC V6T 2A1, Canada

Accepted 14 December 2005



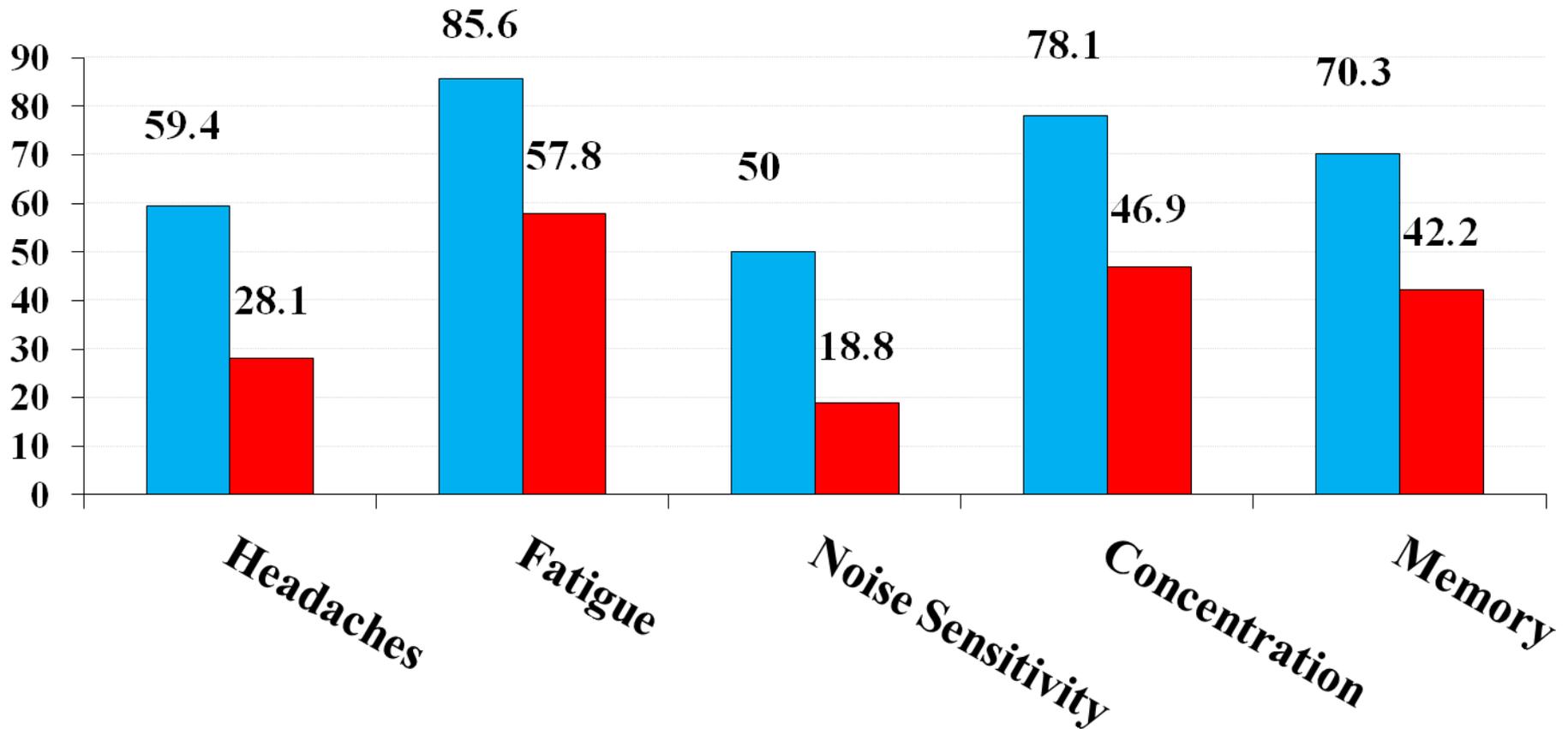
Misdiagnosis of PCS in Depression

- 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

Guidelines for Concussion / Mild Traumatic Brain Injury & Persistent Symptoms

Second Edition

For adults (18+ years of age)



Complete Version



Ontario Neurotrauma Foundation
Fondation ontarienne de neurotraumatologie

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**

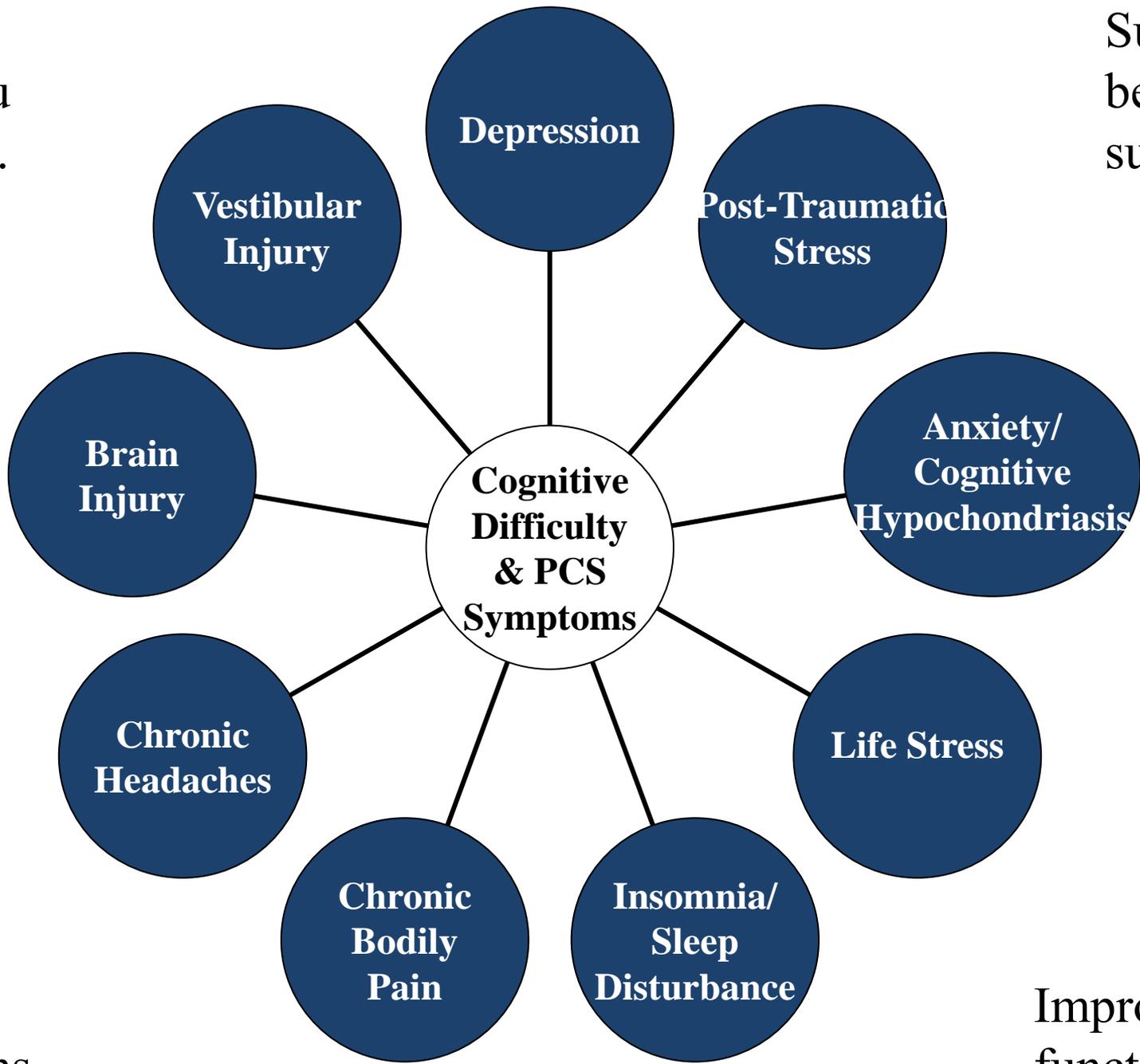
Careful and Comprehensive Assessment
= Targets for Treatment and
Rehabilitation

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.