Concussion: Update on Pathophysiology and Mechanisms

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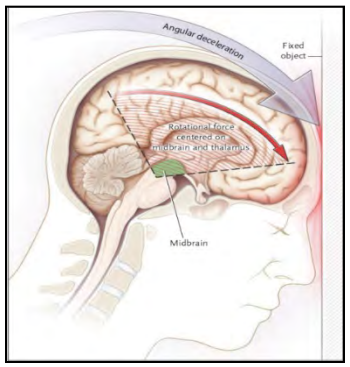
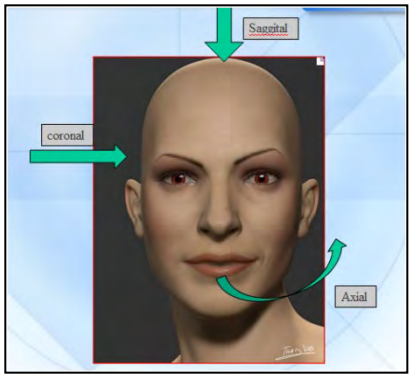
CNHS
George Washington University School of Medicine

- Concussion
  - Mechanisms
  - Population Health implications
  - Challenges in recovery

Concussion: Definition

- "Trauma-induced alteration in mental status that may or may not involve loss of consciousness…Confusion and amnesia are the hallmarks of concussion"
- "A bump or a blow that causes the brain to move rapidly within the skull"
- Impulsive force leading to rapid acceleration and deceleration to the brain, including linear, translational, rotational forces
- Trauma resulting in change in brain function
  - Not defined by scan, lab test. (yet) Remains…a *clinical diagnosis.*
  - Contact/Inertial - "This complex variety of responses makes each injury-causing situation nearly unique"





AAP 1997, CDC 2007, Meany 2011, Noble 2013, Choe 2018

Public Health Concern

- >1.1-1.9 mild/moderate sports related TBI/year in US
- 630,000 pediatric ED visits/year
- 128/100,000 people/year
- Football, Hockey most common sports
  - Most other sports
    - Cheerleading, soccer, wrestling, etc
    - Tennis
  - Falls, Sports, Bicycle
  - Slips, falls, vigorous movement

Skateboard

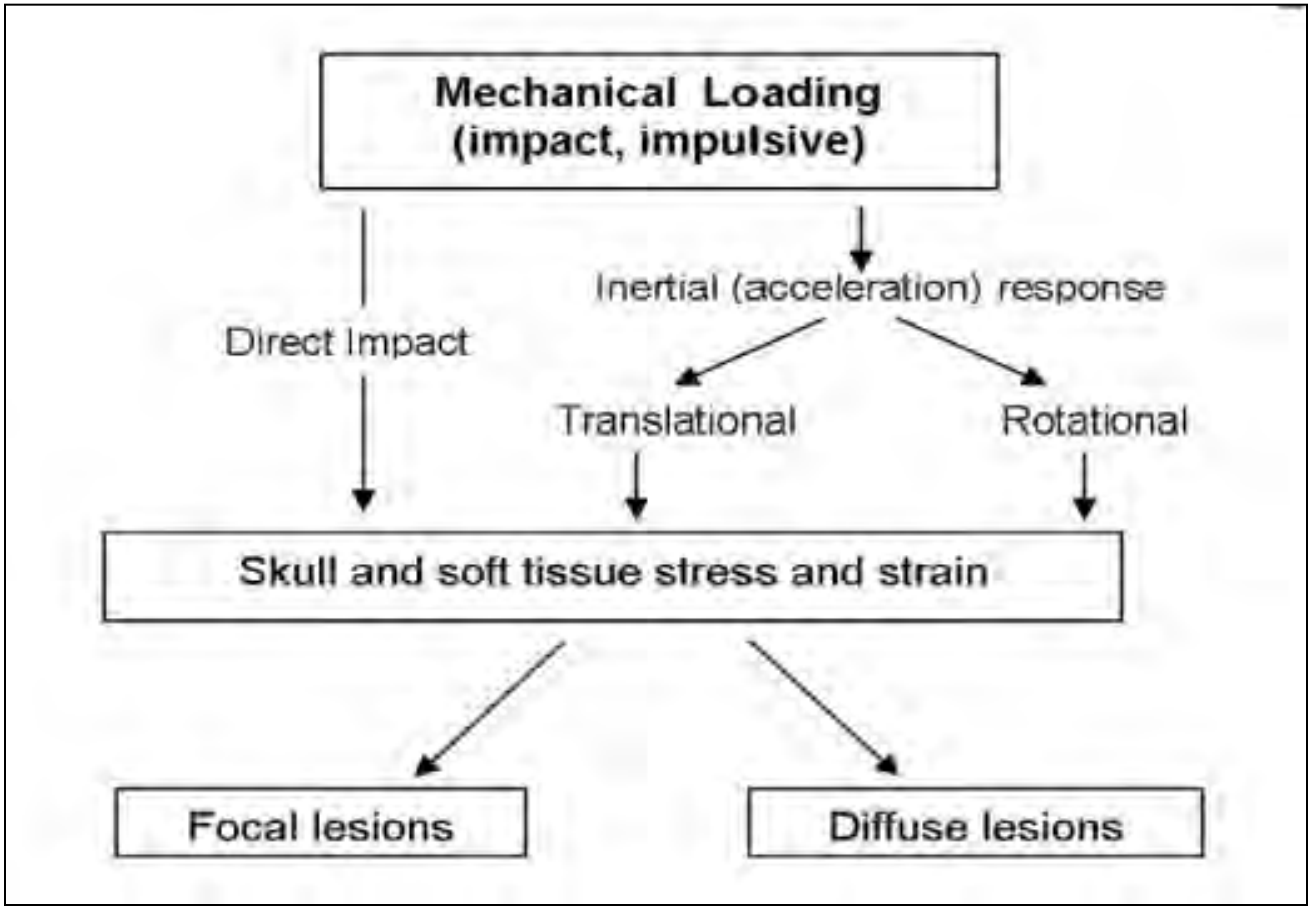
Thiessen 2006, Willer, 2006, Kirkwood 2006, Ropper 2007, Finch 2013, Choe 2018, Bergeron 2018

Continued Challenges: Pathophysiology

- Recollection of event
  - Military blast
  - PTSD
- Mechanisms
- Genetic propensity
- Diagnosis
- Treatment

One Size Fits All?

Mechanisms: Energy Transfers



O'connor 2011, Meaney 2011

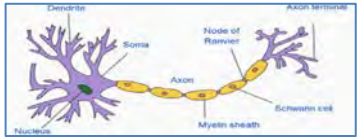
Mechanisms

Loading to the Head

Inertial Acceleration/Load Transmission

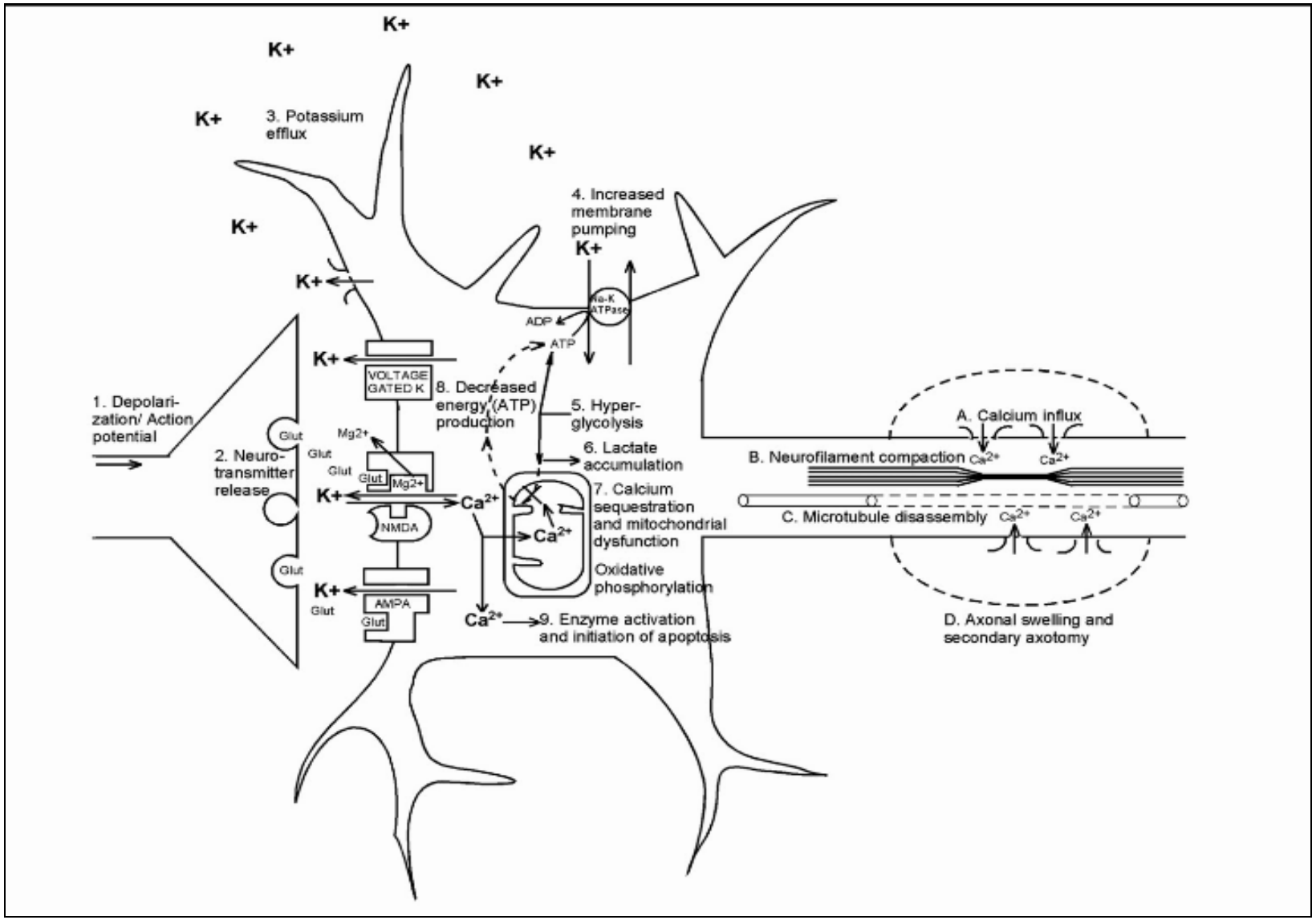
Macroscale Brain Movement

Cellular Level Injury



- Challenges in Translation
  - Mechanistic differences
  - Individual characteristics
  - Pre-morbid functioning
  - Post-injury intervention

Ng 2017, Steenerson 2017



MacFarlane 2015, Barkhoudarian 2016

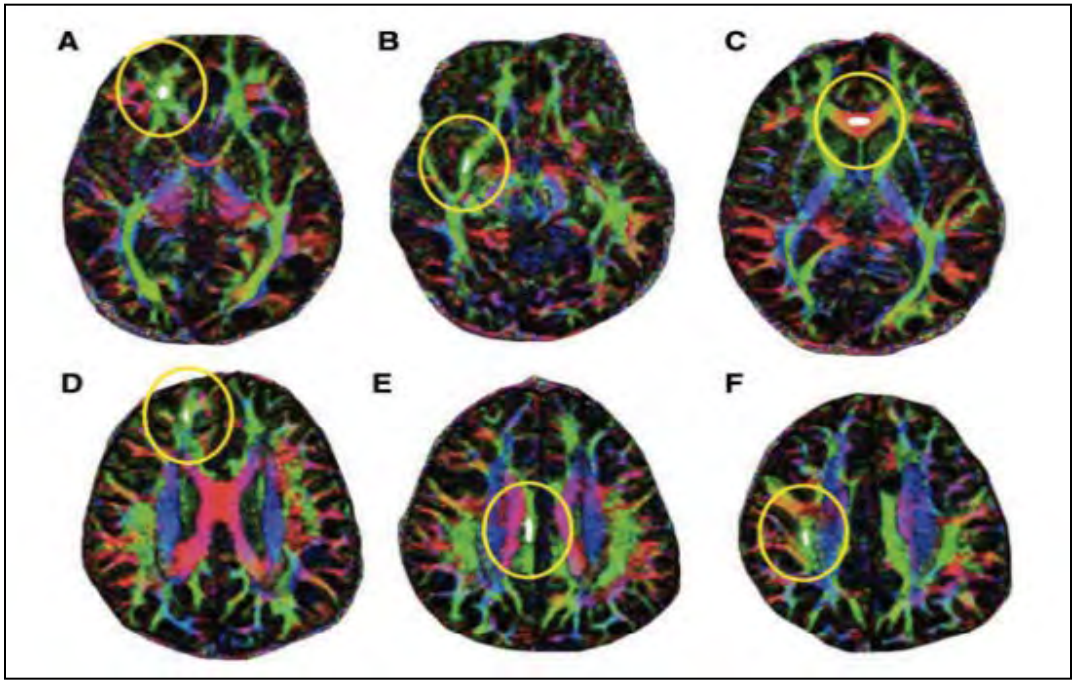
Acute

- Biochemical Cascade
- Neurotransmitter Dysregulation
- Cerebral Blood Flow
- Microstructural Injury

Modifiers

- Genetic Tendency
- Psychiatric Propensity
- Post-Injury Management
- PTSD

Biomarkers?



- Large age range
- Mechanisms vary
- Pre-existing morbidities
- 1-53 month post injury

Niogi 2008

Challenges in Data Interpretation

Pediatric Sports-Related Concussion Produces Cerebral Blood Flow Alterations

Maugans 2012

Hippocampal and Cerebral Blood Flow after Exercise Cessation in Master Athletes

Alfini 2016

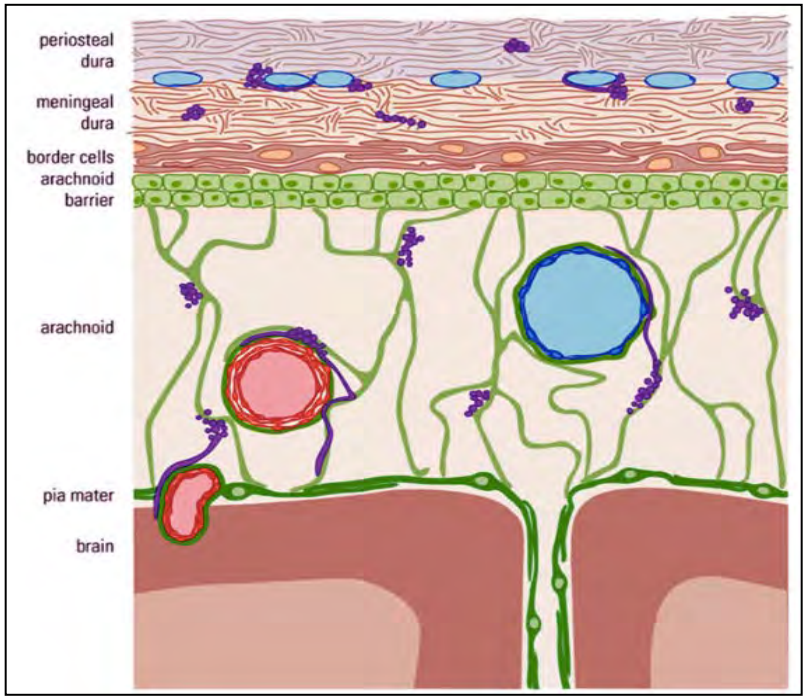
Resting cerebral blood flow alteration in severe obstructive sleep apnoea: an arterial spin labelling perfusion fMRI study

Nie 2017

Second Impact Syndrome?

Second Impact

- *Controversial*
  - If occurs, extremely rare
  - Unclear if related to a *second* impact, or just an impact
  - Younger individuals
- Unknown mechanism(s)
- Associated with fulminant brain swelling, increased ICP, and death



"If SIS actually exists, then its occurrence is vanishingly rare."

Squire 2012, Mcrory 2012,Mclendon 2016

Post-Concussion days→weeks

- **Somatic or medical**
  - Headache
  - Fatigue
  - Low energy
  - Sleep disturbance
  - Dizziness
  - Sensitivity to light/noise
  - Nausea

Cognitive

- Slowed thinking
- Distractability
- Learning/memory impairment
- Problem solving difficulties

Emotional/Behavioral

- Irritability
- Emotional lability
- Depression
- Anxiety
- Personality changes

Sleep Impairments

- EDS
- Fragmented nighttime sleep

Post Concussive Syndrome

Table 2
The postconcussion symptom scale

	Symptom	None	Minor		Moderate		Severe	
*	Headache	0	1	2	3	4	5	6
	Nausea	0	1	2	3	4	5	6
	Vomiting	0	1	2	3	4	5	6
	Balance problems	0	1	2	3	4	5	6
	Dizziness	0	1	2	3	4	5	6
	Fatigue	0	1	2	3	4	5	6
	Trouble falling asleep	0	1	2	3	4	5	6
*	Sleeping more than usual	0	1	2	3	4	5	6
	Sleeping less than usual	0	1	2	3	4	5	6
	Drowsiness	0	1	2	3	4	5	6
	Sensitivity to light	0	1	2	3	4	5	6
*	Sensitivity to noise	0	1	2	3	4	5	6
	Irritability	0	1	2	3	4	5	6
	Sadness	0	1	2	3	4	5	6
*	Nervousness	0	1	2	3	4	5	6
	Feeling more emotional	0	1	2	3	4	5	6
	Numbness or tingling	0	1	2	3	4	5	6
	Feeling slowed down	0	1	2	3	4	5	6
	Feeling mentally "foggy"	0	1	2	3	4	5	6
*	Difficulty concentrating	0	1	2	3	4	5	6
	Difficulty remembering	0	1	2	3	4	5	6
	Visual problems	0	1	2	3	4	5	6

Clinically similar to…

Depression
Chronic Fatigue
POTS
Fibromyalgia
Myofascial Pain

Lovell 2008

Military Recommendations 2017

WHAT SHOULD I DO?

After Mandatory 24 Hours of Recovery:

❑ **Stage 1: Rest**

Rest or do very light activity for another 24 hours. Only do basic things like eating, using the bathroom, resting and sleeping.

- Keep your head above your heart (when you put on your shoes, bring your foot to your knee).
- Sit down when dressing and showering if needed.
- Walk on level surfaces at an easy pace.
- Limit head movements that cause symptoms.
- Stay in a quiet environment with low lighting.
- Watch periods of television with rest breaks each hour.
- Sleep as needed.
- Dress comfortably.

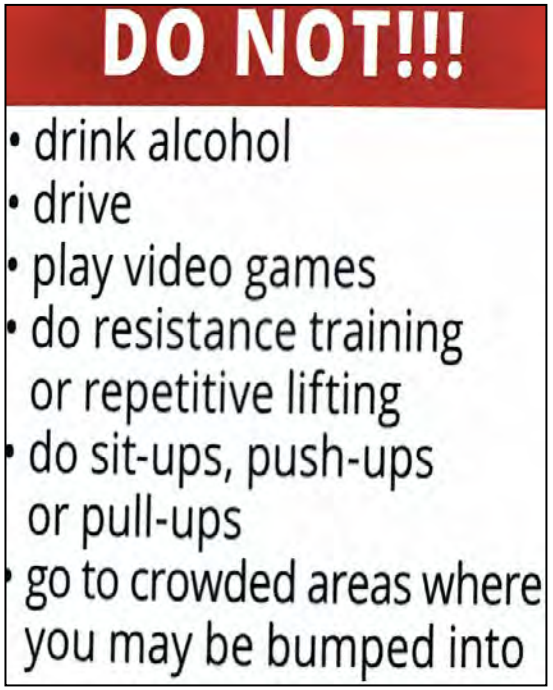
DO NOT!!!

- work or study
- drink alcohol
- exercise
- drive
- hold your breath or grunt*
- exert yourself to the point of making your heart race
- play video games

*Pay attention to whether you are holding your breath when you bend over or are under stress.

After this stage, see your primary care manager to discuss symptoms and determine next steps.

If your heart starts to race, immediately STOP what you are doing and rest.



DO NOT!!!

- drink alcohol
- drive
- play video games
- do resistance training or repetitive lifting
- do sit-ups, push-ups or pull-ups
- go to crowded areas where you may be bumped into

DVBIC

Peds Specific Military Recommendations

- Rest
- Withdrawal
- Breaks
- Wearing glasses

Concussion-related Symptoms[2, 3, 4, 5]

Physical Abilities	Thinking (Cognitive) Skills	Emotional/ Behavioral Issues	Sleep
feeling dizzy/loss of balance	poor concentration, easily distracted	feeling anxious or tense	difficulty falling/staying asleep
numbness or tingling	forgetfulness, difficulty remembering things	feeling depressed or sad	getting tired easily
headaches	difficulty making decisions	irritability, easily annoyed	sleeping more than usual
nausea	slowed thinking	feeling easily overwhelmed by things	sleeping less than usual
vision problems	difficulty getting and staying organized	something just doesn't feel right	
sensitivity to light and/or noise	difficulty finding the right words		
hearing trouble			
loss of or increased appetite			

Tip

The best indicator of how much is too much is whether your child starts to have symptoms. If your child does not experience symptoms during an activity, then it is OK to continue that activity. If your child starts to feel symptoms, then he or she must stop that activity right away and rest. Symptoms are a sign that the brain is being overtaxed.[2, 8, 9]

DVBIC

The Psychology of Recovery

- Perception of Injustice
- Kinesophobia
- Cephalagiaphobia
- Cogniphobia

"Although avoiding precipitating factors can be adaptive to some degree, excessive avoidance can lead to marked lifestyle changes, psychological comorbidity, as well as sensitize patients to headache triggers such that headache is elicited more readily when triggers cannot be avoided."

Peres 2007, Suhr 2012, Vlaeyen 2013, Silverberg 2017, Iverson 2018

Self perpetuating

- Anxiety/fear regarding exacerbating symptoms
- Heightened sense of vulnerability
- Avoidance of exacerbating situations
- Increased sedentary behaviors
- Worsened symptoms, diminished conditioning

- Exercise – “neurologic” symptoms – dizziness, headache, etc
- Experimental Bed Rest
  - 3-6 days: Headache, dizziness, mood changes, restlessness, poor sleep

Alla 2010, Fortney 2011, Silverberg 2016

Goals of Management

- Prevention of concussion
- Prevent serious injury/exacerbation after concussion
- Maintain function
- Prevent long-term dysfunction
- Be mindful of neurodegenerative conditions

Treatment/Intervention

- Reassurance
- Refrain from excessive restriction
  - Social, academic
- Engage in exercise

The Effect of Physical Exercise After a Concussion

Lal 2017

What's wrong with rest?

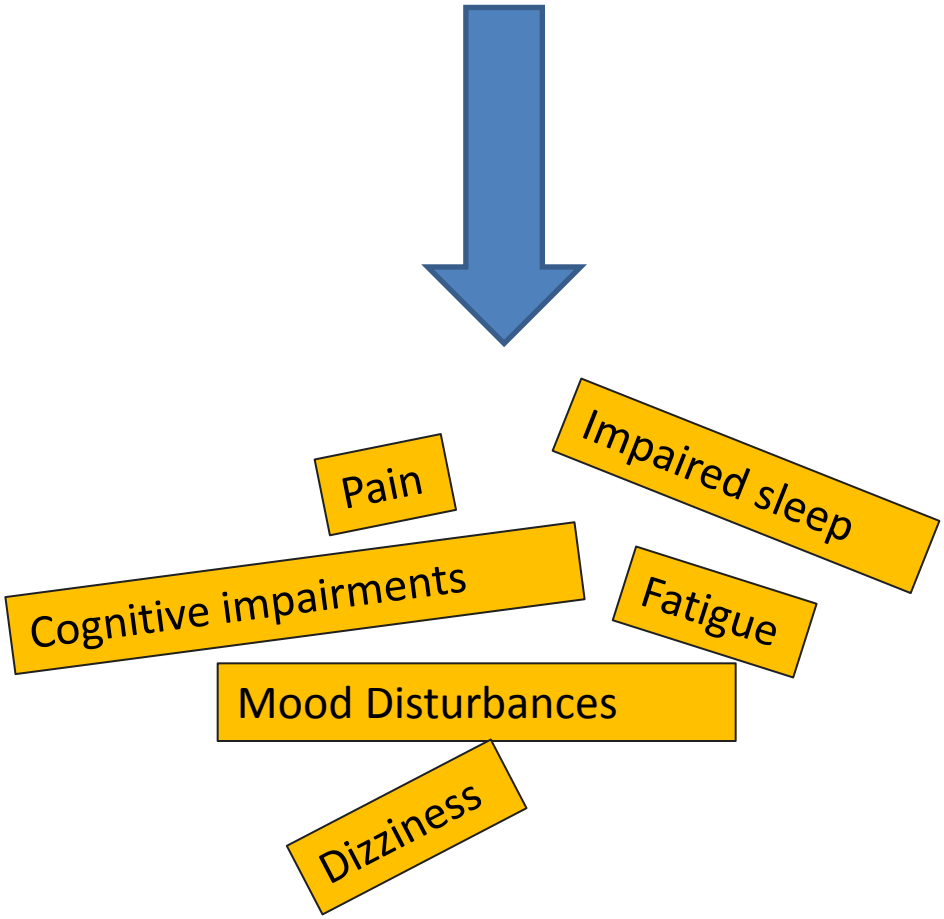
Bed rest: a potentially harmful treatment needing more careful evaluation

– *"Published results give little support for bed rest as a form of management in a wide range of settings, and suggest that it may actually delay recovery and even harm the patient."*

Allen 1999

Final common Pathway?

Fibromyalgia POTS Myofascial Pain Lyme Concussion



Exercise and Neuroprotection: The Role of the Neurologist in Public Health?

Physical activity prescription: a critical opportunity to address a modifiable risk factor for the prevention and management of chronic disease:

Physical fitness and academic performance in middle school students

Ronald W Bass (bassr@district87.org), Dale D Brown, Kelly R Laurson, Margaret M Coleman

Illinois State University, School of Kinesiology and Recreation, Bloomington, IL, USA

Interactive report

Neuroprotective signaling and the aging brain: take away my food and let me run[1]

Mark P. Mattson*

Matton 2000, Bass 2013, Thornton 2016

“Thank you very much, Dr. DiFazio. Wow, you have no idea how happy I was to hear what you had to say. *Jude seemed a bit disappointed as he has been convinced something is terribly wrong. Teachers and coaches all feed into the whole picture.* With your permission, I would like to forward to the coaches at GP. Thank you again.”

Final word

1. Is there data to support strict rest/withdrawal – i.e., does it hasten recovery?
2. Is there data that indicates a return of clinical symptoms is an exacerbation of underlying brain injury and a contraindication to exercise/return to play/school/life?
3. Is there evidence that cumulative injury in childhood leads to CTE in adulthood?
4. Can we cause injury by restricting activity?
5. Is there evidence that exercise enhances brain function?

Neurology and SCORE: Why not urgent care?

- Sarah E – 1 ½ years out of school
- Michael P – stroke risk?
- Early referral to Neurology for acute concerns, reassurance/reinforcement of your teaching

SCORE

Detailed neuropsychiatric assessments, education, GREAT educational assistance

Ongoing research on best practice

Benefit: Complex/complicated patients

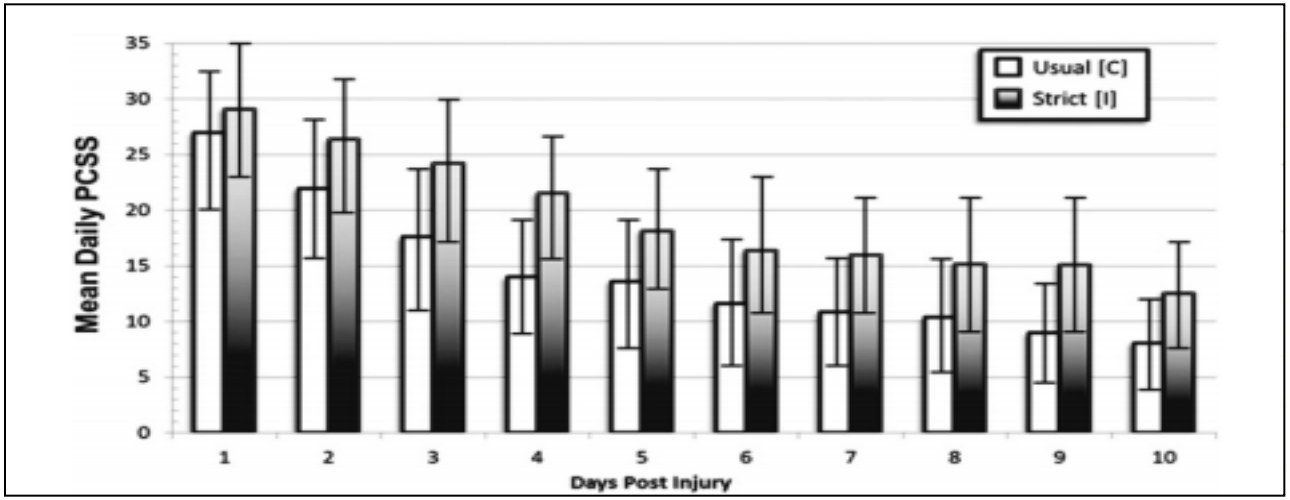
Gerard A. Gioia, PhD

Thanks for your Attention!

Addendum

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

Danny George Thomas, MD, MPH[a], Jennifer N. Apps, PhD[b], Raymond G. Hoffmann, PhD[a], Michael McCrea, PhD[c], Thomas Hammeke, PhD[b]



- Worsened outcomes (more symptoms of PCS) with longer periods of enforc
VS usual care.

Thomas 2015

Acute Cognitive and Physical Rest May Not Improve Concussion Recovery Time

Thomas A. Buckley, EdD, ATC; Barry A. Munkasy, PhD; Brandy P. Clouse, MS, ATC

Buckley 2015

Prolonged Activity Restriction After Concussion: Are We Worsening Outcomes?

Marc DiFazio, MD[1], Noah D. Silverberg, PhD[2,3], Michael W. Kirkwood, PhD[4,5], Raquel Bernier, MD[1], and Grant L. Iverson, PhD[6,7,8,9]

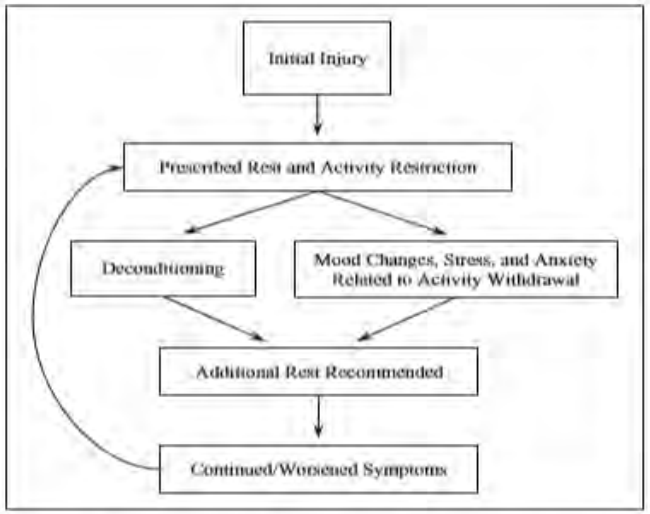
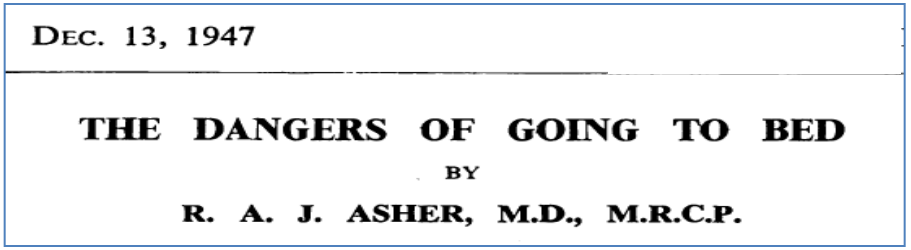


Figure 1. Theoretical model for prolonged rest and activity restriction contributing to persistent symptoms.

DiFazio 2016

Are we worsening symptoms?



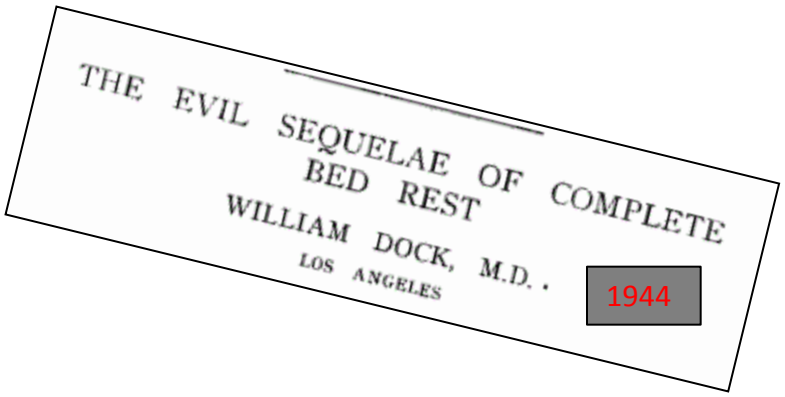
DEC. 13, 1947

THE DANGERS OF GOING TO BED

BY

R. A. J. ASHER, M.D., M.R.C.P.

- *"Lastly, consider the mental changes, the demoralizing effects of staying in bed. At the start it may produce fussiness, pettiness, and irritability. The patient may acquire an exaggerated idea of the seriousness of his illness and think, " Surely I must be very ill if I am kept in bed ? " At a later stage a dismal lethargy overcomes the victim."*

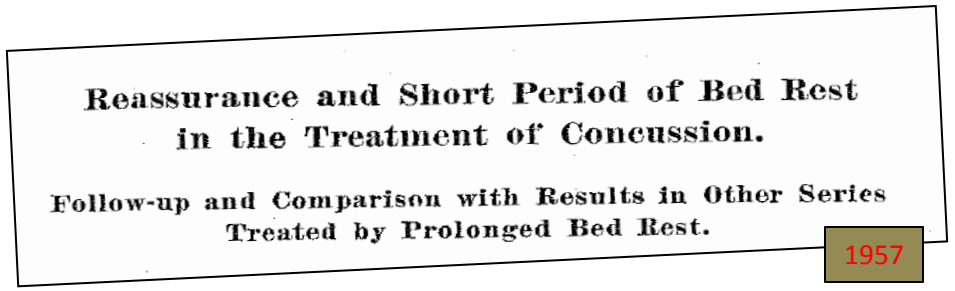


THE EVIL SEQUELAE OF COMPLETE BED REST

WILLIAM DOCK, M.D.

LOS ANGELES

1944



Reassurance and Short Period of Bed Rest in the Treatment of Concussion.

Follow-up and Comparison with Results in Other Series Treated by Prolonged Bed Rest.

1957

2016

Physical Activity Level and Symptom Duration Are Not Associated After Concussion

Howell

Division III Collision Sports Are Not Associated with Neurobehavioral Quality of Life

Meehan

Cognitive Rest and Graduated Return to Usual Activities Versus Usual Care for Mild Traumatic Brain Injury: A Randomized Controlled Trial of Emergency Department Discharge Instructions

Varner

Suicide and Chronic Traumatic Encephalopathy

Iverson

Resilience Is Associated with Outcome from Mild Traumatic Brain Injury

Losoi

Factors Associated With Concussion-like Symptom Reporting in High School Athletes

Iverson

Rest and treatment/rehabilitation following sport-related concussion: a systematic review

Schneider 2017

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- Early referral to Neurology for acute concerns, reassurance/reinforcement of your teaching

  - SCORE
    - Detailed neuropsychiatric assessments, education, GREAT educational assistance

Gerard A. Gioia, PhD

Merufilm.com

Concussion in Kids: Update on Management

Gerard A. Gioia, Ph.D.
Pediatric Neuropsychologist
Chief, Division of Pediatric Neuropsychology
Director, Safe Concussion Outcome, Recovery & Education (SCORE) Program
Children's National Health System
Professor, Pediatrics and Psychiatry & Behavioral Medicine
George Washington University School of Medicine
Washington, DC

Objectives

1. Update concussion management – Berlin conference, CDC guidelines
    - Active rehabilitation
2. Berlin School update
    - Recommendations
3. CAST program highlights
    - Next year?

Children's National

Mild TBI 15-20 Years Ago

- Little understanding of mTBI
- Few treating healthcare providers
- Few medical tests or tools
- Minimal research/funding
- Little public awareness of risks
- No rules to protect athletes
- Passive model of management (rest only)

Children's National

Berlin (2016)

Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

What is the difference in concussion management in children as compared with adults? A systematic review

Gavin A Davis,[1] Vicki Anderson,[1] Franz E Babl,[1] Gerard A Gioia,[2] Christopher C Giza,[3] William Meehan,[4] Rosemarie Scolaro Moser,[5] Laura Purcell,[6] Philip Schatz,[7] Kathryn J Schneider,[8] Michael Takagi,[1] Keith Owen Yeates,[9] Roger Zemek[10]

ABSTRACT

Aim To evaluate the evidence regarding the management of sport-related concussion (SRC) in children and adolescents. The eight subquestions included the

statement on the management of SRC in 2001,[5] but this paper did not include any child-specific recommendations. The CISG meeting in Prague in 2004 briefly referred to the paediatric popula-

CDC

Report from the Pediatric Mild Traumatic Brain Injury Guideline Workgroup:

Systematic Review and Clinical Recommendations for Healthcare Providers on the Diagnosis and Management of Mild Traumatic Brain Injury Among Children

How Long Does it Take to Recover from a Concussion?

Factors in Recovery

- History (developmental, medical, social/psychiatric)
- Nature of the Injury
- Symptom burden/ type
- Individualized management

Epidemiology of Recovery
Our Best Guess

- Research literature is still limited with respect to understanding concussion recovery outcomes across full age range, and for boys and girls (IOM, 2013).
- Largest pediatric study (Zemek et al., 2016; n>3,000; age 5-18) indicates 70 +/-% symptom recovery within 4 weeks.

Children's National

General Principles of Recovery

- No additional forces to head/ brain
- Get good sleep
- Progressive Activity Management
  - Not over-exerting body or brain
  - Not under-exerting body or brain
  - Avoid activities that produce symptoms

Ways to over-exert

- Physical
- Cognitive! (concentration, learning, memory)
- Emotional

Children's National

Historic Approach(es) to Concussion Treatment

- REST
- REST
- REST

TIME

(CISG, AAP, etc.)

Active Treatment

Michael W. Collins, PhD*
Anthony P. Kontos, PhD*
David O. Okonkwo, MD, PhD‡
Jon Almquist, ATC, VATL, ITAT§
Julian Bailes, MD¶
Mark Barisa, PhD‖
Jeffrey Bazarian, MD, MPH#
O. Josh Bloom, MD, MPH**

Statements of Agreement From the Targeted Evaluation and Active Management (TEAM) Approaches to Treating Concussion Meeting Held in Pittsburgh, October 15-16, 2015

Consensus statement on concussion in sport—the 5th international conference on concussion in sport held in Berlin, October 2016

Paul McCrory,[1] Willem Meeuwisse,[2] Jiří Dvorak,[3,4] Mark Aubry,[5] Julian Bailes,[6] Steven Broglio,[7] Robert C Cantu,[8] David Cassidy,[9] Ruben J Echemendia,[10,11] Rudy J Castellani,[12] Gavin A Davis,[13,14] Richard Ellenbogen,[15] Carolyn Emery,[16] Lars Engebretsen,[17] Nina Feddermann-Demont,[18,19] Christopher C Giza,[20,21] Kevin M Guskiewicz,[22] Stanley Herring,[23] Grant L Iverson,[24] Karen M Johnston,[25] James Kissick,[26] Jeffrey Kutcher,[27] John J Leddy,[28] David Maddocks,[29] Michael Makdissi,[30,31] Geoff Manley,[32] Michael McCrea,[33] William P Meehan,[34,35] Sinji Nagahiro,[36] Jon Patricios,[37,38] Margot Putukian,[39] Kathryn J Schneider,[40] Allen Sills,[41,42] Charles H Tator,[43,44] Michael Turner,[45] Pieter E Vos[46]

Robert Heyer, MD###
Gillian Hotz, PhD****
Grant L. Iverson, PhD‡‡‡‡
Barry Jordan, MD, MPH§§§§

neurology, neurosurgery, sp
physical therapy, athletic traini
military, and public health org
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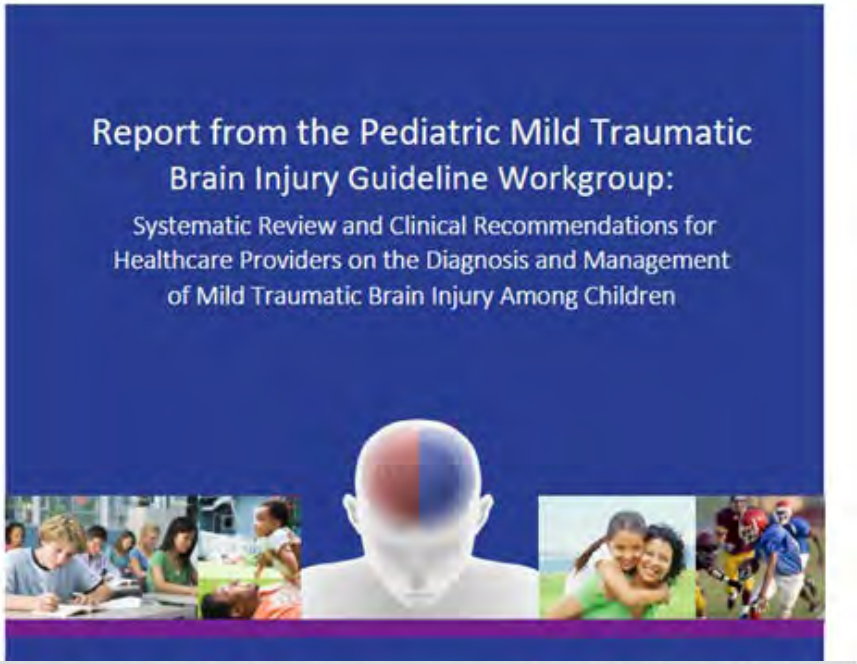


CDC CLINICAL RECOMMENDATION FOR HEALTHCARE PROVIDERS
Treatment

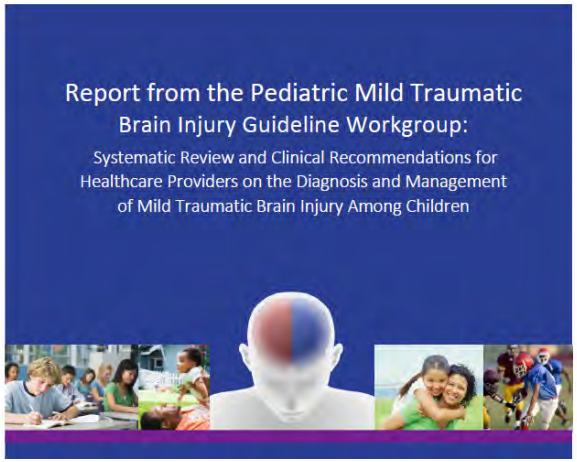
General areas of treatment for patients and families

A. Patient/ Family Education and Reassurance

B. Cognitive/ Physical Rest and Aerobic Therapy

C. Psychosocial/ Emotional Support

D. Return to School



CDC Clinical Recommendations

A. Patient/Family Education and Reassurance

24. In providing education and reassurance to the family, the healthcare provider should include the following information:

- Warning signs of more serious injury
- Description of injury and expected course of symptoms and recovery
- Instructions on how to monitor postconcussive symptoms
- Prevention of further injury
- Management of cognitive and physical activity/rest
- Instructions regarding return to play/recreation and school
- Clear clinician follow-up instructions (Level B)

Children's National

PEDIATRICS

Impact of Early Intervention on Outcome After Mild Traumatic Brain Injury in Children

Jennie Ponsford, Catherine Willmott, Andrew Rothwell, Peter Cameron, Gary Ayton, Robyn Nelms, Carolyn Curran and Kim Ng

Pediatrics 2001;108;1297-1303
DOI: 10.1542/peds.108.6.1297

Use of Modified Acute Concussion Evaluation Tools in the Emergency Department

Noel S. Zuckerbraun, MD, MPH, Shireen Atabaki, MD, MPH, Michael W. Collins, PhD, Danny Thomas, MD, MPH, and Gerard A. Gioia, PhD

(doi: 10.1542/peds.2013-2600)

CDC Clinical Recommendations
B. Cognitive/Physical Rest and Aerobic Treatment

25. Healthcare providers should counsel patients to observe more restrictive physical and cognitive activity **during the first several days** following mTBI in children. (Level B)

26. Following these first several days, healthcare providers should counsel patients and families to **resume a gradual schedule of activity that does not exacerbate symptoms**, with close monitoring of symptom expression (number, severity). (Level B)

CDC Clinical Recommendations
B. Cognitive/Physical Rest and Aerobic Treatment

27. Following the successful resumption of a gradual schedule of activity (see 26), healthcare providers should **offer an active rehabilitation program of progressive reintroduction of noncontact aerobic activity that does not exacerbate symptoms**, with close monitoring of symptom expression (number, severity). (Level B)

28. Healthcare providers *should* counsel patients to return to full activity when they return to premorbid performance if they have remained symptom free at rest and with increasing levels of physical exertion (see 25-27). (Level B)

"Active" Aerobic Rehabilitation

- Aerobic Activation (Gagnon et al., 2009; Leddy et al, 2010)
- Structured and monitored subsymptom threshold exercise to facilitate healing.
- Progressive "controlled" exercise below level that produces symptom occurrence or worsening.

A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome

John J. Leddy, MD,† Karl Kozlowski, PhD,‡ James P. Donnelly, PhD,§*
*David R. Pendergast, EdD,¶ Leonard H. Epstein, PhD,‖ and Barry Willer, PhD***

Objective: To evaluate the safety and effectiveness of subsymptom threshold exercise training for the treatment of post-concussion syndrome (PCS).

Design: Prospective case series.

Setting: University Sports Medicine Concussion Clinic.

Participants: Twelve refractory patients with PCS (6 athletes and 6 nonathletes).

Intervention: Treadmill test to symptom exacerbation threshold (ST) before and after 2 to 3 weeks of baseline. Subjects then exercised

Conclusions: that appears to treatment basel

Key Words: tr blood pressure

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Active rehabilitation for children who are slow to recover following sport-related concussion

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"Active" Aerobic Rehabilitation

A Preliminary Study of Subsymptom Threshold Exercise Training for Refractory Post-Concussion Syndrome

John J. Leddy, MD,† Karl Kozlowski, PhD,‡ James P. Donnelly, PhD,§*
*David R. Pendergast, EdD,¶ Leonard H. Epstein, PhD,‖ and Barry Willer, PhD***

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Objective: To evaluate the safety and effectiveness of subsymptom threshold exercise training for the treatment of post-concussion syndrome (PCS).

Design: Prospective case series.

Setting: University Sports Medicine Concussion Clinic.

Conclusions: Treatment with controlled exercise is a safe program that appears to improve PCS symptoms when compared with a no-treatment baseline. A randomized controlled study is warranted.

Key Words: traumatic brain injury, exertion, symptoms, physiology, blood pressure

(*Clin J Sport Med* 2010;20:21–27)

Benefits of Aerobic Activity

I. *Aerobic Activity*

Increase brain-derived neurotrophic factor (BDNF)
Synaptogenesis
Increased cardiovascular activity
Altered cerebral vascular function and brain perfusion
Increased endorphin release
Improved brain autoregulation
Improve overall fitness level
Reduce fatigue/improve energy levels
Reduce stress, worry and anxiety
Improve mood
Improve cognition
Improve self-efficacy and performance

When Recovery Doesn't Go Smoothly: Targeting Clinical Profiles

- Concussions fall within spectrum of many clinical profiles suggesting need for varied, targeted treatments based on patient-specific presentation
- More than one concussion subtype may contribute to a patient's clinical presentation. For ex., patient may have a predominantly vestibular subtype but also have elements of the headache subtype
- Refer for more indepth evaluation of the clinical profile to guide treatment recommendations.

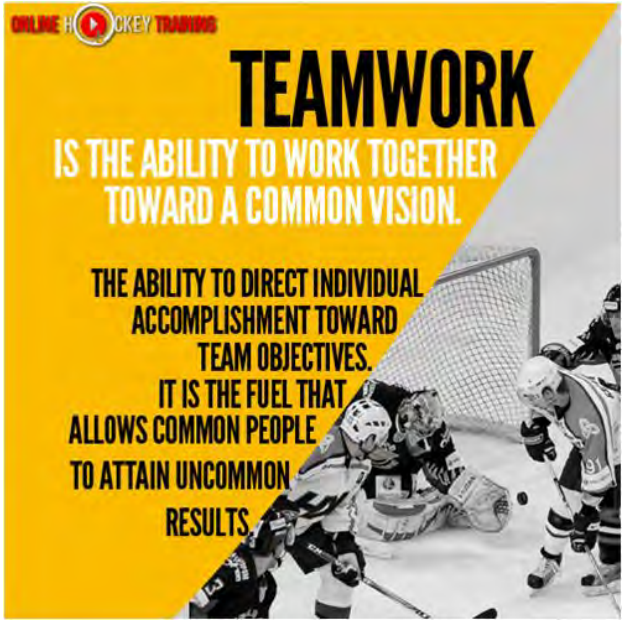
Targeting Clinical Profiles

- Concussion Subtypes:
  - Cognitive
  - Ocular-Motor
  - Headache/Migraine
  - Vestibular
  - Anxiety/Mood
- Subtype-Associated conditions:
  - Sleep Disorder
  - Cervical-spinal strain

Medical ⟺ School

The Handoff

Communication
Coordination
Collaboration



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Medical System Responsibility
"Discharge" Education (Preparation):
Key Components (all providers)

1. Educate about concussions (definition, risks)
2. Reasons to go/return to Emerg. Dept. (red flags)
3. Safety restrictions: sports, other risk activities
4. Activity restriction & management
5. School/ work return guidance
6. Medical follow up

POST-CONCUSSION RETURN TO SCHOOL LETTER

Dear School Staff:

[Student]_____ sustained a concussion on ___[Date]_____

Recovery typically takes between several days to several weeks. The student should return to school as soon as they can tolerate it but many students will benefit from some accommodations to their school program as they recover. As symptoms resolve and the student's learning/cognitive functioning returns to normal, s/he can gradually progress to their normal school day with reduced supports

Current Symptoms: The student is currently reporting the following symptoms as indicated by the (√) below. These can be viewed as targets for supportive classroom accommodations to assist a successful return. See suggested supports for these symptoms on page 2.

PHYSICAL		COGNITIVE	EMOTIONAL
□ Headaches	□ Fatigue	□ Feeling mentally foggy	□ Irritability
□ Sensitivity to light	□ Sensitivity to noise	□ Memory problems	□ Anxiety/ nervousness
□ Blurry/double vision	□ Nausea/vomiting	□ Slowed thinking/ performance	□ Sadness
□ Balance Problems	□ Dizziness	□ Difficulty concentrating	□ Feeling more emotional

Return to School: The student can return to school when

(1) S/he can concentrate on school work for 30 minutes before symptoms worsen significantly.
(2) Symptom exacerbation reduces/resolves with cognitive rest breaks, allowing return to activity.

Based on the current symptoms, he/she is ___ *permitted to return to school.*
___ *is excused for* ____ *days*

Safety Restrictions: To reduce risk for re-injury, there should be
* No physical (risk) activity during recess *No Physical Education (Gym) class
* No sports participation *Other _____

Physical Activity: Mild-moderate symptom-limited exercise (walking) daily is permitted.

Health Care Provider Signature_____ Date_____

Contact Information_____

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- No Physical Education (Gym) class
- Other:_____

Physical Activity: Mild-moderate symptom-limited exercise (walking) daily is permitted.

Health Care Provider Signature _____ Date_____

Contact Information_____

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CDC Clinical Recommendations
D. Return to School

30. To assist children returning to school following mTBI, medical and school-based teams should counsel the student and family regarding the process of gradually increasing the duration and intensity of academic activities as tolerated, with the goal of increasing participation without significantly exacerbating symptoms. (Level B)

31. Return to school protocols should be customized based on the severity of postconcussion symptoms in children with mTBI as determined jointly by medical and school-based teams. (Level B)

32. For any student with prolonged symptoms that interfere with academic performance, school-based teams should assess the educational needs of that student and determine the student's need for additional educational supports, including those described under pertinent federal statutes (eg, Section 504, IDEA).C137 (Level B)

CDC Clinical Recommendations
D. Return to School

33. Postconcussion symptoms and academic progress in school should be monitored collaboratively by the student, family, healthcare provider, and school teams, who jointly determine what modifications or accommodations areneeded to maintain an academic workload without significantly exacerbating symptoms. (Level B)

34. The provision of educational supports should be monitored and adjusted on an ongoing basis by the school-based team until the student's academic performance has returned to preinjury levels. (Level B)

35. For students who demonstrate prolonged symptoms and academic difficulties despite an active treatment approach, healthcare providers should refer the child for a formal evaluation by a specialist in pediatric mTBI. (Level B)

What Berlin has to say about School Return

What factors must be considered in 'return to school' following concussion and what strategies or accommodations should be followed? A systematic review

Laura K Purcell,[1] Gavin A Davis,[2] Gerard A Gioia[3]

ABSTRACT

Objective To evaluate the evidence regarding (1) factors affecting return to school (RTS) and (2) strategies/accommodations for RTS following a sport-related concussion (SRC) in children and adolescents.

Design A systematic review of original studies specifically addressing RTS following concussion in the paediatric and sporting context.

Data sources MEDLINE (Ovid), Embase (Ovid), PsycInfo (Ovid) electronic databases and the grey literature OpenGrey, ClinicalTrials.gov and Google Advanced.

Eligibility criteria Studies were included if they were original research on RTS following SRC in children aged 5–18 years published in English between 1985 and 2017.

Results A total of 180 articles were identified; 17 articles met inclusion criteria. Several factors should be considered for RTS after concussion, including: symptomatology; rest following injury; age/grade; and course load. On RTS after concussion, 17%–73% of students were provided academic accommodations or experienced difficulty with RTS. Students were more likely to obtain academic accommodations in schools with a

support. However, postconcussion cognitive symptoms such as impaired memory, attention and concentration, and somatic symptoms such as headaches, dizziness and fatigue may negatively impact students' ability to RTS.[8–10] Students with more numerous/severe symptoms may have symptom exacerbation with RTS.[11]

Several consensus/position statements and guidelines have addressed RTS after concussion.[12–16] Following the Fourth International Consensus Conference on Concussion in Sport, the Child-SCAT3 assessment tool was developed for children aged 5–12 years, with a child-specific symptom scale and recommendations for RTS. The Concussion in Sport Consensus Statement also addressed children's cognitive requirements and need for school accommodations.[17] However, these resources have been based on limited empirical research. Many areas of RTS lack evidence-based guidelines.

Therefore, this systematic review addressed two questions:

1. What factors must be considered in 'return to

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What Berlin has to say about School Return

Five factors influence return to school post-concussion:

1. Age: Adolescents tend to take longer to recover and return to school; adolescents more concerned about the negative academic effects of concussion than younger children.
2. Symptom load/severity: Students with greater number/ severity of symptoms tend to take longer to return to school, require more academic accommodations, longer to recover
3. Course load: Certain subjects pose greater problems for students returning to school: math (#1) reading/language arts (#2), then science, social studies.

Berlin & School (cont.)

4. Medical follow-up: Students who receive RTS letter in ED, medical follow-up after ED more likely to receive academic accommodations
5. School resources: Schools with concussion policies that include student/ parent concussion education tend to…
   - practice best-practice guidelines for concussion mgt.
   - provide more accommodations and greater variety of accommodations to students
   - be more likely to form concussion management teams at school to facilitate return to school
   - have students and parents who are more knowledgeable about concussion (Glang et al. 2014)

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Berlin Recommendations

1. All schools encouraged to have concussion policy that includes education on concussion prevention and management for teachers, staff, students, parents; should offer appropriate academic accommodations and support to students
2. Upon diagnosis of concussion, students should be provided with medical RTS letter to facilitate provision/receipt of necessary academic accommodations
3. Students should have early/ongoing medical follow-up to identify symptom targets, monitor recovery and help with return to school.
4. Students may require temporary absence from school after injury
5. Clinicians should assess risk factors/modifiers that may prolong recovery and require more/prolonged/formal academic accommodations. Adolescents may require more academic support during recovery
6. Further research is required to determine the appropriate return to school accommodations for children and adolescents with prolonged symptoms.

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Symptom Targeted Academic Management Plan (STAMP)

Below, please see the symptoms they are currently experiencing. To promote recovery, the student will be provided with the following classroom accommodations that support their academic learning and performance:

Symptom (check)	**Functional school problem**	**Accommodation/ management strategy** (select)
Cognitive Symptoms		
Attention & concentration difficulties	Short focus on lecture, classwork, homework	Shorter assignments (odd/even problems, requiring outline or bullet points instead of full written responses) Break down tasks and tests into chunks/segments Lighter work load: Max. nightly homework (including studying): ___ min
Working memory (short-term memory)	Trouble holding instructions, lecture, reading material, thoughts in mind	Repetition Written instructions Provide student with teacher generated class notes
Memory consolidation/ retrieval	Accessing learned information	Smaller chunks/segments to learn, repetition Recognition cues
Processing speed		
Cognitive Fatigue/ Fogginess		
Physical Symptoms		
Headaches	Interferes with concentration Increased irritability	Intersperse rest breaks, shortened day if symptom does not subside Allow for short naps in quiet location (e.g., nurse's office)
Light/ noise sensitivity	Symptoms worsen in bright or loud environments	Wear sunglasses/hat, seating away from bright sunlight Limit exposure to SMART board, computers, provide class notes Avoid noisy/crowded environments such as lunchroom, assemblies, chorus/music class, and hallways. Leave class early. Allow student to wear earplugs as needed
Dizziness/ balance/ nausea	Unsteadiness when walking Nausea or vomiting	Elevator pass Class transition before bell
Sleep disturbance	Decreased arousal, shifted sleep schedule, trouble falling asleep	Later start time Shortened day or rest breaks
Fatigue	Lack of energy	Periodic rest breaks, short naps in quiet location Passive participation

Targets for Student Support and Treatment

Summary

- Most children & adolescents recover from concussion within 1-4 weeks

ACTIVE TREATMENT APPROACH:

- Initial restriction of activity with good nighttime sleep
- Individualized progressive cognitive and physical activity with monitored symptom management
- Return to School requires medical-school teamwork
- Schools need Concussion Management Teams to provide systematic, coordinated support services

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Concussion Academy Skills Training (CAST) Program

Dr. Gerard Gioia
Dr. Jeffrey Strelzik
Kerin Webber

Goals/ Intended Outcomes for Providers

- Increase frequency of providing (at least) initial concussion care for your child and adolescent patients
- Increase skill & confidence in clinical evaluati
  management, using clinical pathw
- Improve communicati .ool, assist with return
- Solidify u g of recovery criteria, return to risk
  ate complex cases and make appropriate referral for specialty care

Concussion Learning Sessions

- September, 2017
  - Kickoff General Overview: Primary Concussion Care
  - Diagnosis & initial education/ management (incl. triage/red flags)
- November, 2017
  - Management principles & practice
- January, 2018
  - Return to School: communication & management issues
- March, 2018
  - Criteria for Recovery & Return to Risk (Sport, etc.)
- June, 2018
  - Rehabilitation & specialty medical management