BARROW CONCUSSION NETWORK

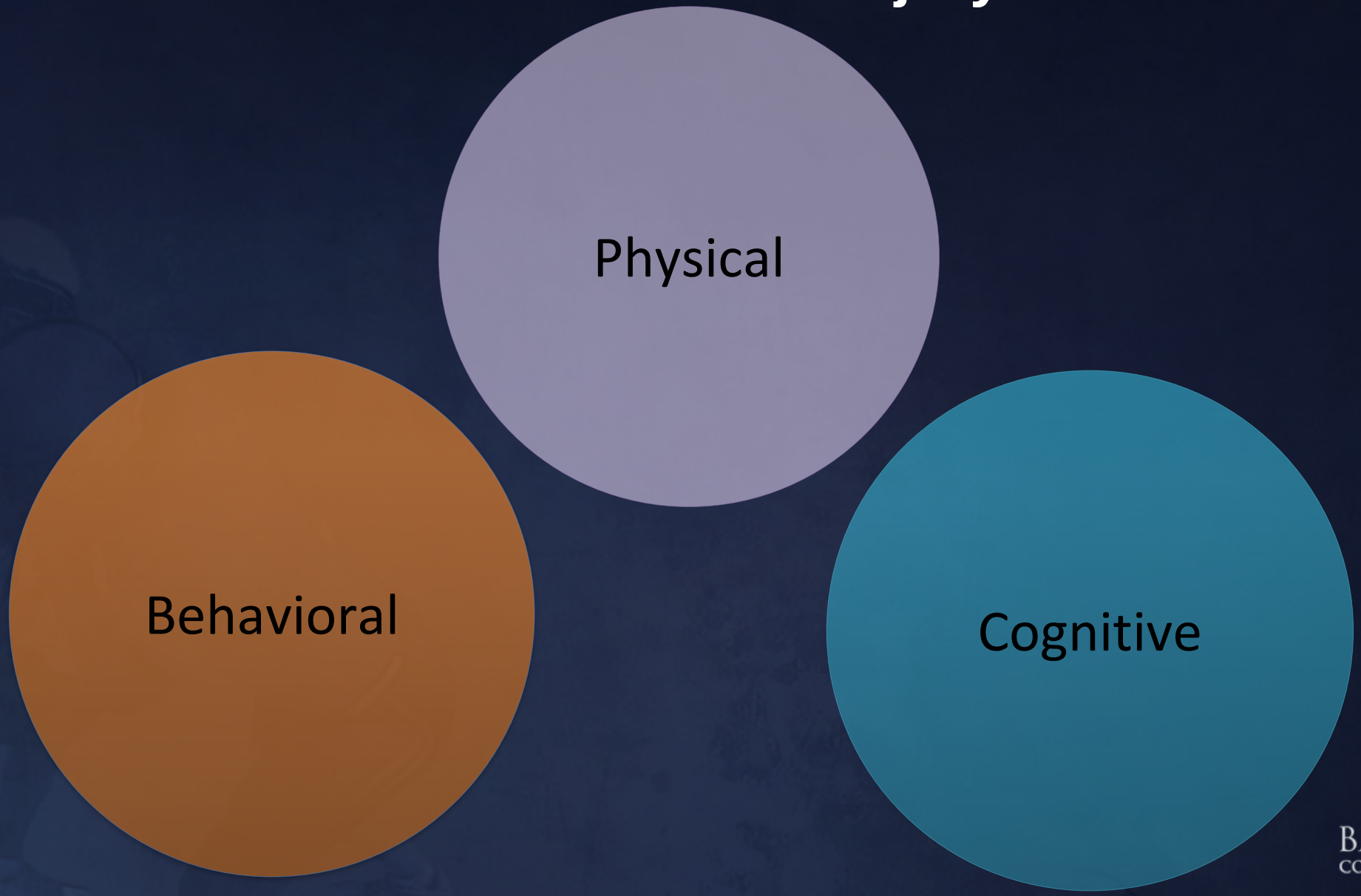
# The Road to Recovery: The Impact of the Barrow Concussion and Brain Injury Center

Javier Cárdenas, MD
Barrow Neurological Institute
Director, The Barrow Concussion Network

# History

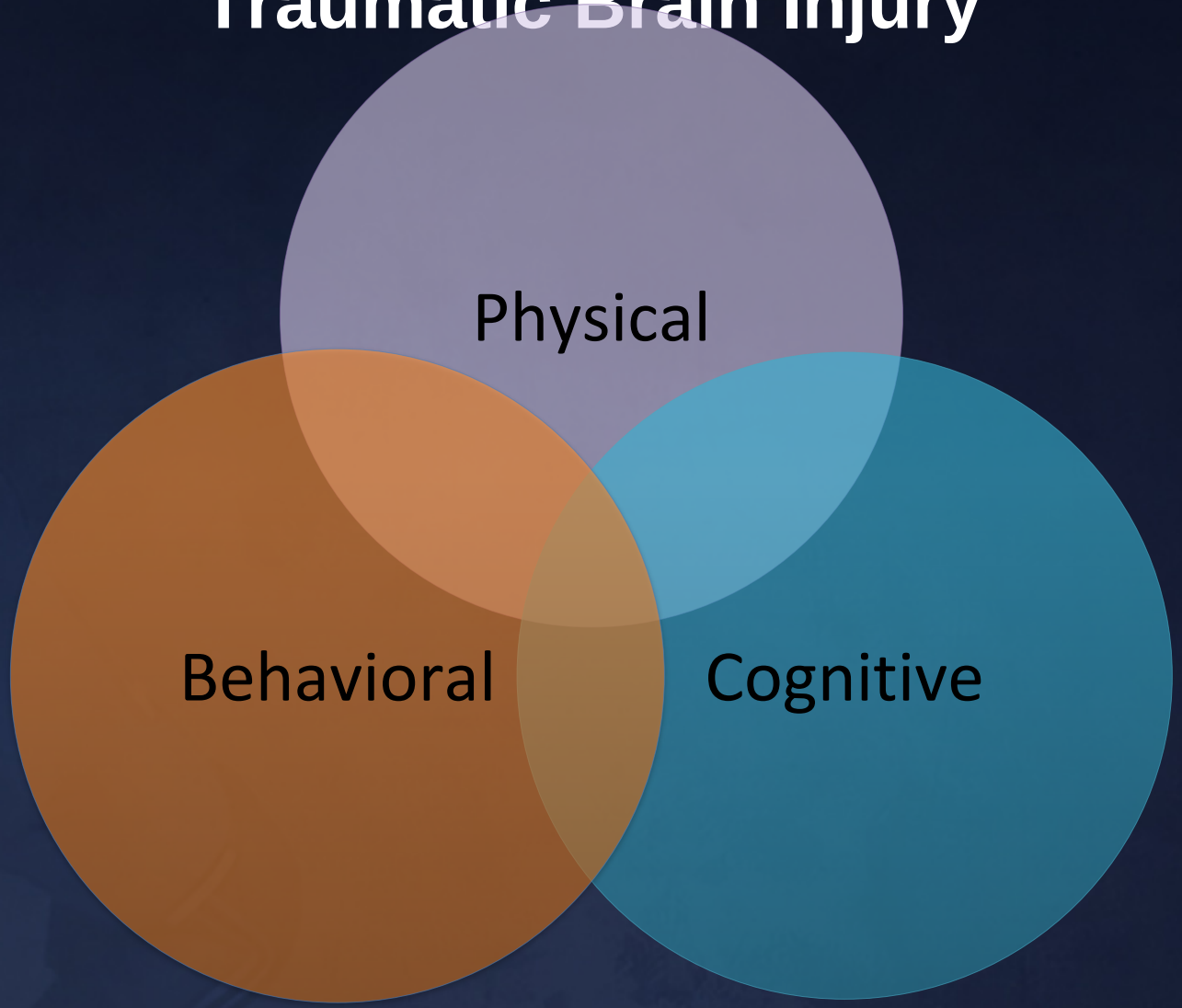

BARROW
CONCUSSION NETWORK

# Traumatic Brain Injury




BARROW CONCUSSION NETWORK

# Traumatic Brain Injury



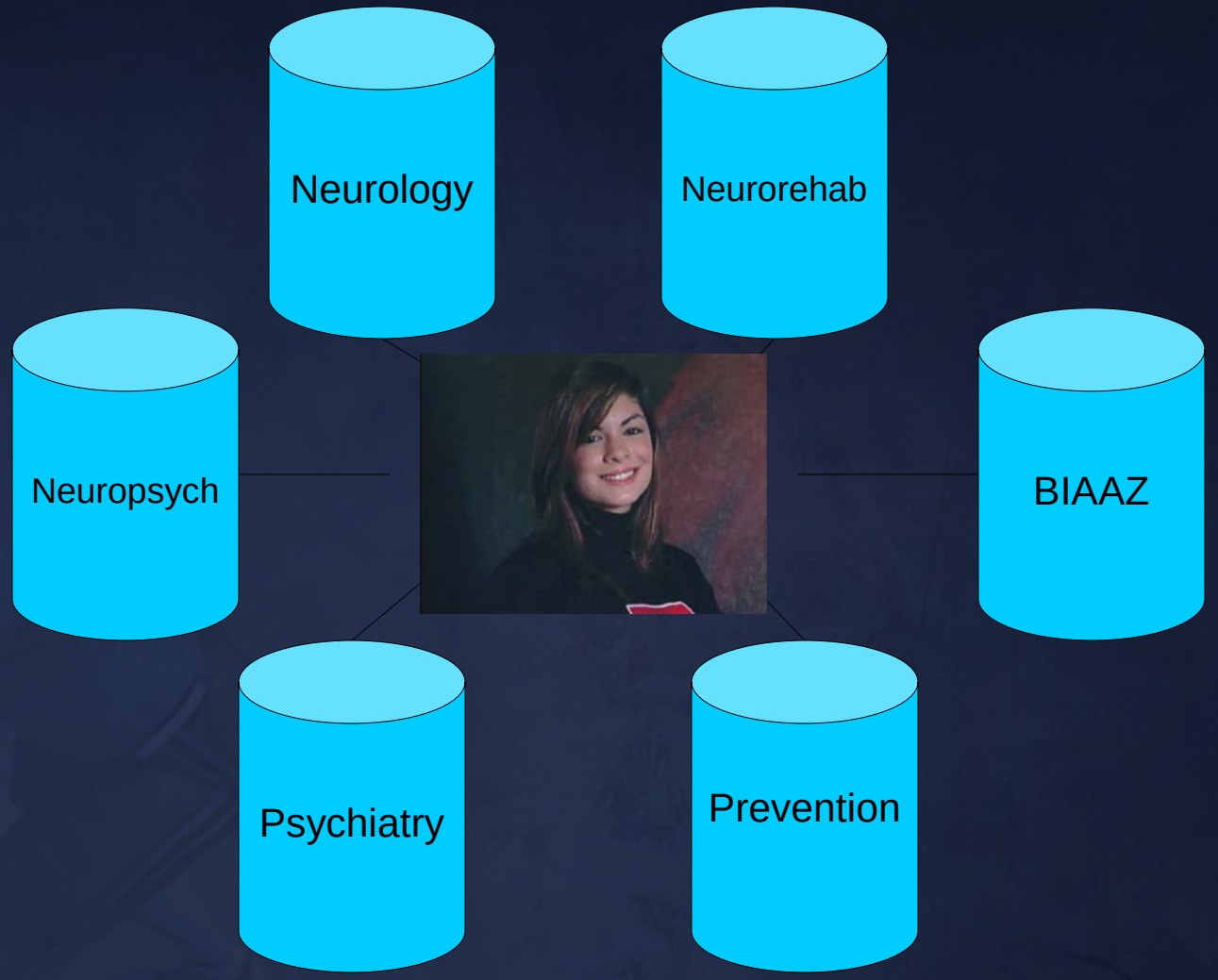

BARROW
CONCUSSION NETWORK

# Barrow Concussion and Brain Injury Center

- Mission
- To improve outcomes of those who suffer from neurological injury through;
  - comprehensive, patient centered care
  - collaboration
  - research


BARROW CONCUSSION NETWORK

# Barrow Concussion and Brain Injury Center

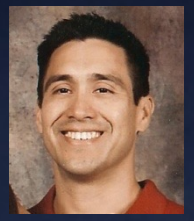



BARROW CONCUSSION NETWORK

# Clinical Team

St. Joseph's Hospital and Medical Center.
A Dignity Health Member

BARROW Neurological Institute®



Neurology

Neurorehabilitation

BIAAZ

Prevention

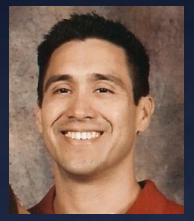
Brain Injury Alliance ARIZONA

BARROW CONCUSSION NETWORK

# Clinical Team

St. Joseph's Hospital and Medical Center.
A Dignity Health Member

BARROW Neurological Institute®

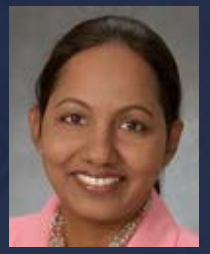


Neurology

Neurorehabilitation

Neuropsychology

BIAAZ



Psychiatry

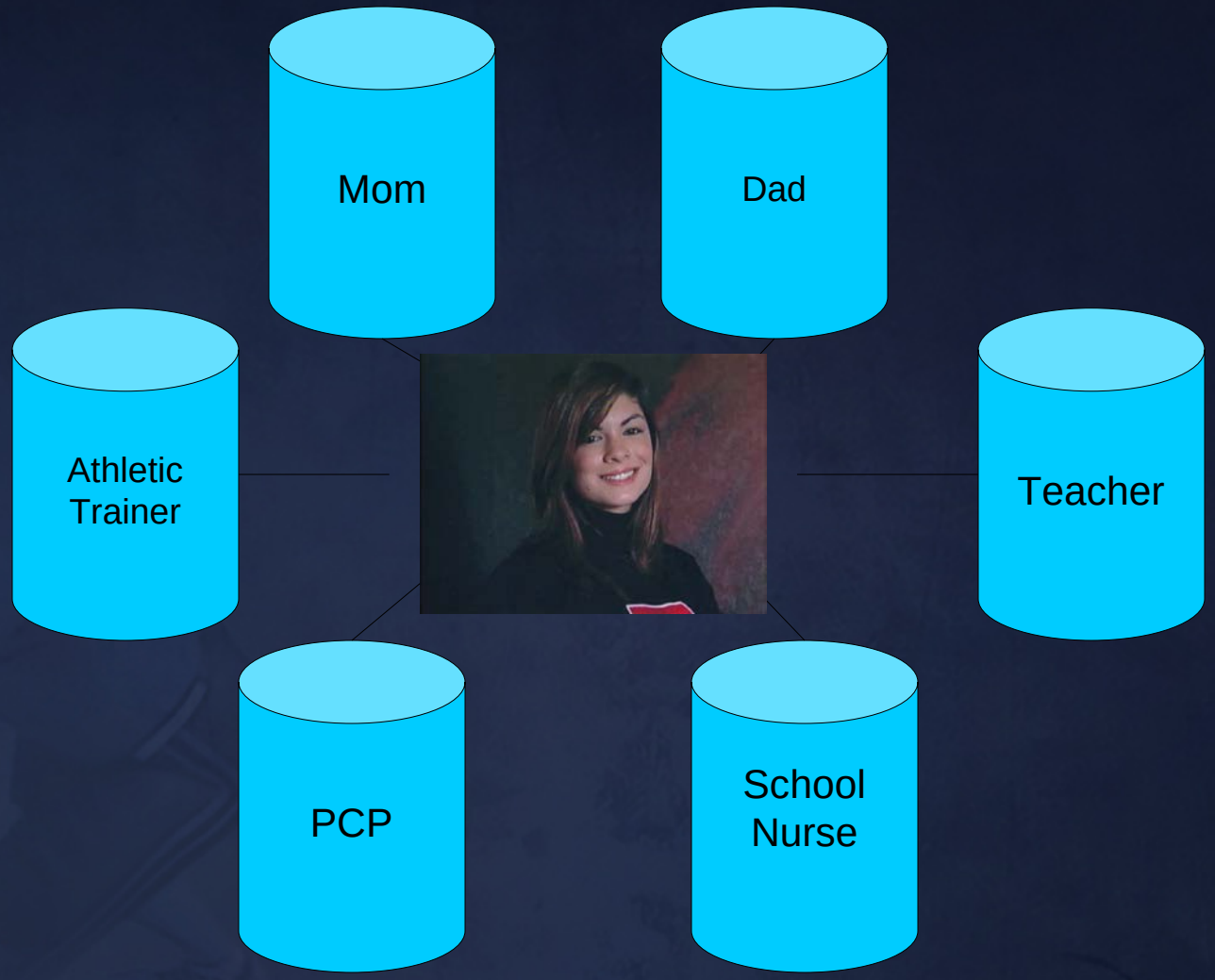

Social Work

Prevention

Brain Injury Alliance ARIZONA

BARROW CONCUSSION NETWORK

# Student Athlete Centered Care




BARROW CONCUSSION NETWORK

# The Cardiac Genetics Clinic: a model for multidisciplinary genomic medicine

**Dominica Zentner**
MB BS(Hons), FRACP, PhD[1]

**Tina N Thompson**
BNurs[1]

**Paul A James**
MB ChB, DPhil, FRACP[1]

**Alison Trainer**
MB ChB, MSc, PhD[1]

**Lesley C Adès**
MB BS, FRACP, MD[2]

**Ivan Macciocca**
BSc, MHSc(GenCouns), FHGSA[3]

**Jessica A Taylor**
BSc, MGenCouns[1]

**Kirsty Mann**
BSc, MGenCouns[1]

**Michael Bogwitz**
BSc(Hons), GradDipGenCouns, PhD[1]

**Nigel Lewis**
MB ChB, MRCP, CCDS[1]

Inherited heart disease can be well managed by preventive strategies if detected early. Building on an expanding body of literature on the contribution of hereditary heart disease to sudden cardiac death (SCD)[1-3] and the well-validated principles of predictive gene testing in other single-gene disorders, the Cardiac Genetics Clinic (CGC) was formally established at the Royal Melbourne Hospital in 2007. Published data have supported the benefit of clinical screening in such clinics.[4] However, detection of a causative mutation, where possible, also allows identification of individuals who are currently clinically unaffected.

The CGC embodies a multidisciplinary model for translating research into international best-practice care.[5] This model exemplifies the translation of genetics to genomics in practice, and also aims to educate and inform individuals, allowing them to assume responsibility for their own ongoing care and health.

The CGC is a joint undertaking by the clinical genetics and cardiology units at the Royal Melbourne Hospital. It is managed by a cardiac trained

## Abstract

**Objectives:** To describe patient characteristics, standard operating procedure, and uptake of genetic testing at the multidisciplinary Cardiac Genetics Clinic (CGC) at the Royal Melbourne Hospital during its first 6 years.

**Design:** Database exploration of referral diagnoses, sex, number of clinic visits and incidence of genetic testing in a population of individuals attending the CGC.

**Setting:** Tertiary referral hospital (Royal Melbourne Hospital) providing cardiac genetics services to the state of Victoria.

**Participants:** All individuals initially attending the clinic between July 2007 and July 2013, either as the proband or as an at-risk family member.

**Main outcome measures:** Classification of patients into diagnostic categories, number of probands and at-risk relatives assessed, incidence and outcomes of genetic testing.

**Results:** 1170 individuals were seen for the first time over the 6-year period; 57.5% made only one visit. The median age was 39 years. Most were encompassed within four broad diagnostic categories: cardiomyopathy (315 patients), aortopathy (303 patients), arrhythmia disorders (203 patients) and resuscitated cardiac arrest and/or family history of sudden cardiac death (341 patients); eight patients had "other" diagnoses. Genetic testing (mutation detection or predictive testing) was undertaken in 381 individuals (32.6%), and a pathogenic mutation was identified in 47.6% of tests, representing 15.3% of the total population.

**Conclusion:** The CGC fulfils an important role in assisting clinicians and patients by reviewing genetic cardiac diagnoses. Clinical practice during the study period moved from a selected candidate gene approach to broader gene panel-based testing. This move to next-generation sequencing may increase the detection of mutations and variants of unknown significance. A major contribution by the clinic to the care of these individuals and their families is the provision (or negating) of a diagnosis, and of a plan for managing risks of predictable cardiac disease.

qualitative analysis

# Why a multidisciplinary model?

J Neurosurg Pediatr. 2014 Jan;13(1):82-9. doi: 10.3171/2013.10.PEDS13241. Epub 2013 Nov 15.

**Establishment of a multidisciplinary concussion program: impact of standardization on patient care and resource utilization.**

Wilkins SA[1], Shannon CN, Brown ST, Vance EH, Ferguson D, Gran K, Crowther M, Wellons JC 3rd, Johnston JM Jr.

Author information

**Abstract**

**OBJECT:** Recent legislation and media coverage have heightened awareness of concussion in youth sports. Previous work by the authors' group defined significant variation of care in management of children with concussion. To address this variation, a multidisciplinary concussion program was established based on a uniform management protocol, with emphasis on community outreach via traditional media sources and the Internet. This retrospective study evaluates the impact of standardization of concussion care and resource utilization before and after standardization in a large regional pediatric hospital center.

**METHODS:** This retrospective study included all patients younger than 18 years of age evaluated for sports-related concussion between January 1, 2007, and December 31, 2011. Emergency department, sports medicine, and neurosurgery records were reviewed. Data collected included demographics, injury details, clinical course, Sports Concussion Assessment Tool-2 (SCAT2) scores, imaging, discharge instructions, and referral for specialty care. The cohort was analyzed comparing patients evaluated before and after standardization of care.

**RESULTS:** Five hundred eighty-nine patients were identified, including 270 before standardization (2007-2011) and 319 after standardization (2011-2012). Statistically significant differences ($p < 0.0001$) were observed between the 2 groups for multiple variables: there were more girls, more first-time concussions, fewer initial presentations to the emergency department, more consistent administration of the SCAT2, and more consistent supervision of return to play and return to think after adoption of the protocol.

**CONCLUSIONS:** A combination of increased public awareness and legislation has led to a 5-fold increase in the number of youth athletes presenting for concussion evaluation at the authors' center. Establishment of a multidisciplinary clinic with a

# Clinic algorithm

When did TBI/ concussion occur?

Greater than 3 months

See in Neuro clinic

Less than 3 months

Has the patient been evaluated by a neurologist or concussion specialist?

yes

See in Neuro clinic

no

Schedule acute injury clinic visit

BARROW CONCUSSION NETWORK

BJSM Online First, published on April 26, 2017 as 10.1136/bjsports-2017-097699



# 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]

# Rest

the same. The critical message may be that rest is important

Twenty-five (12%) athletes reported a recurrence of concussion symptoms while resuming physical activity after having been symptom free at rest (Table 1). While

Michael J. O'Brien,*†‡ MD, David R. Howell,§‖ PhD, ATC, Michael J. Pepin,¶ MA, and William P. Meehan III,§‖# MD

*Investigation performed at Boston Children's Hospital, Division of Sports Medicine, Boston, Massachusetts, USA*

Days Post Injury

**FIGURE 5**

Mean PCSS with 95% confidence interval over time. Patients in the intervention group experienced higher total symptoms over the course of follow-up with the greatest difference in mean symptoms on day 4 (13.95 [C] vs 21.51 [I], $P < .03$).

BARROW CONCUSSION NETWORK

# Recovery:
# Metabolic needs after concussion

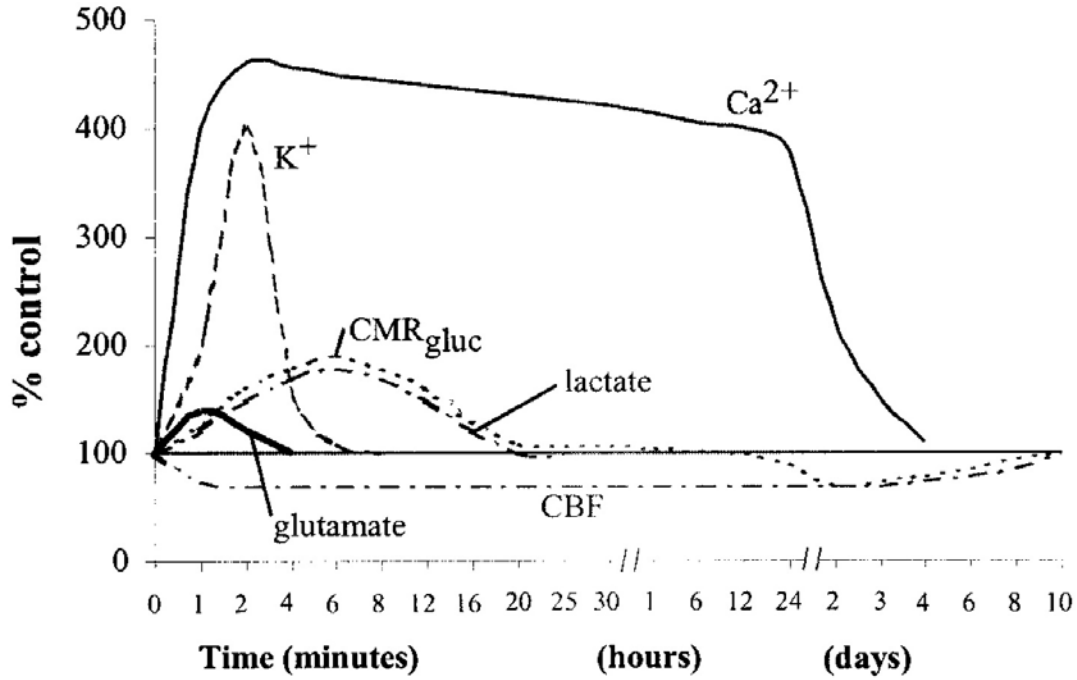
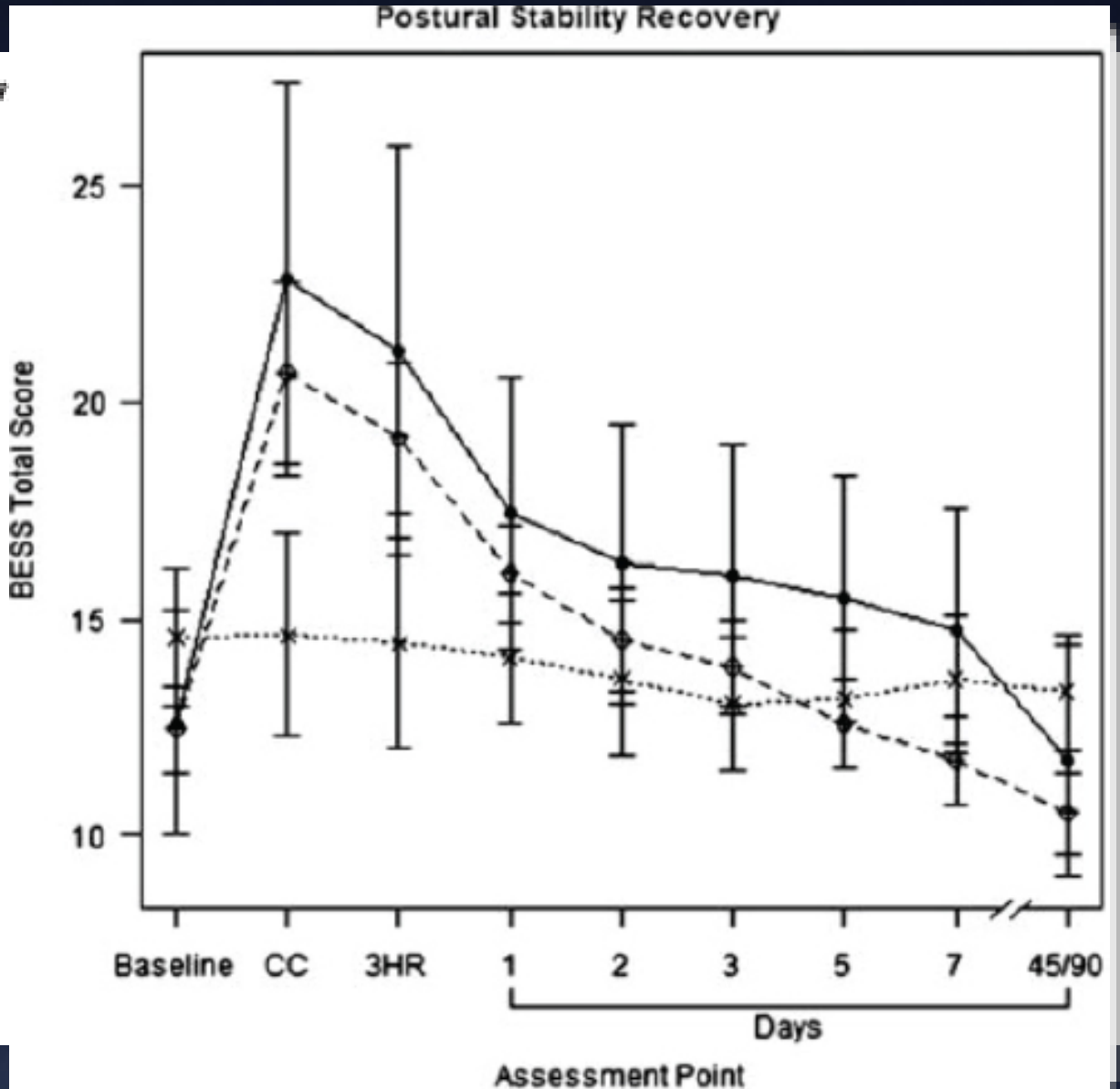



**Figure 1. Neurometabolic cascade following experimental concussion. $K^+$, potassium; $Ca^{2+}$, calcium; CMRgluc, oxidative glucose metabolism; CBF, cerebral blood flow. (Reprinted with permission. Giza CC, Hovda DA. Ionic and metabolic consequences of concussion. In: Cantu RC, Cantu RI.** *Neurologic Athletic and Spine Injuries.* **St Louis, MO: WB Saunders Co; 2000:80–100.).**

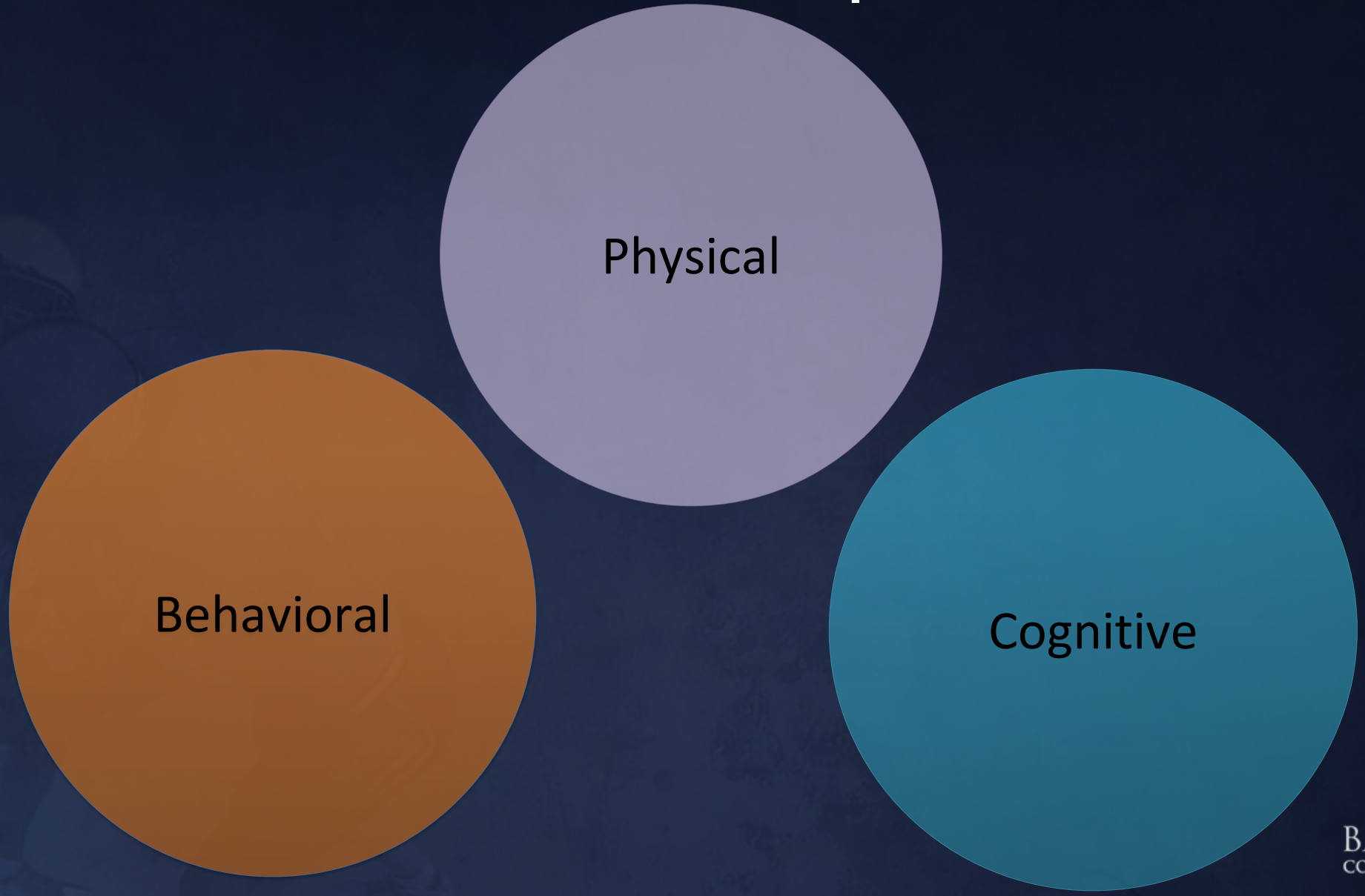
BARROW CONCUSSION NETWORK

# Recovery



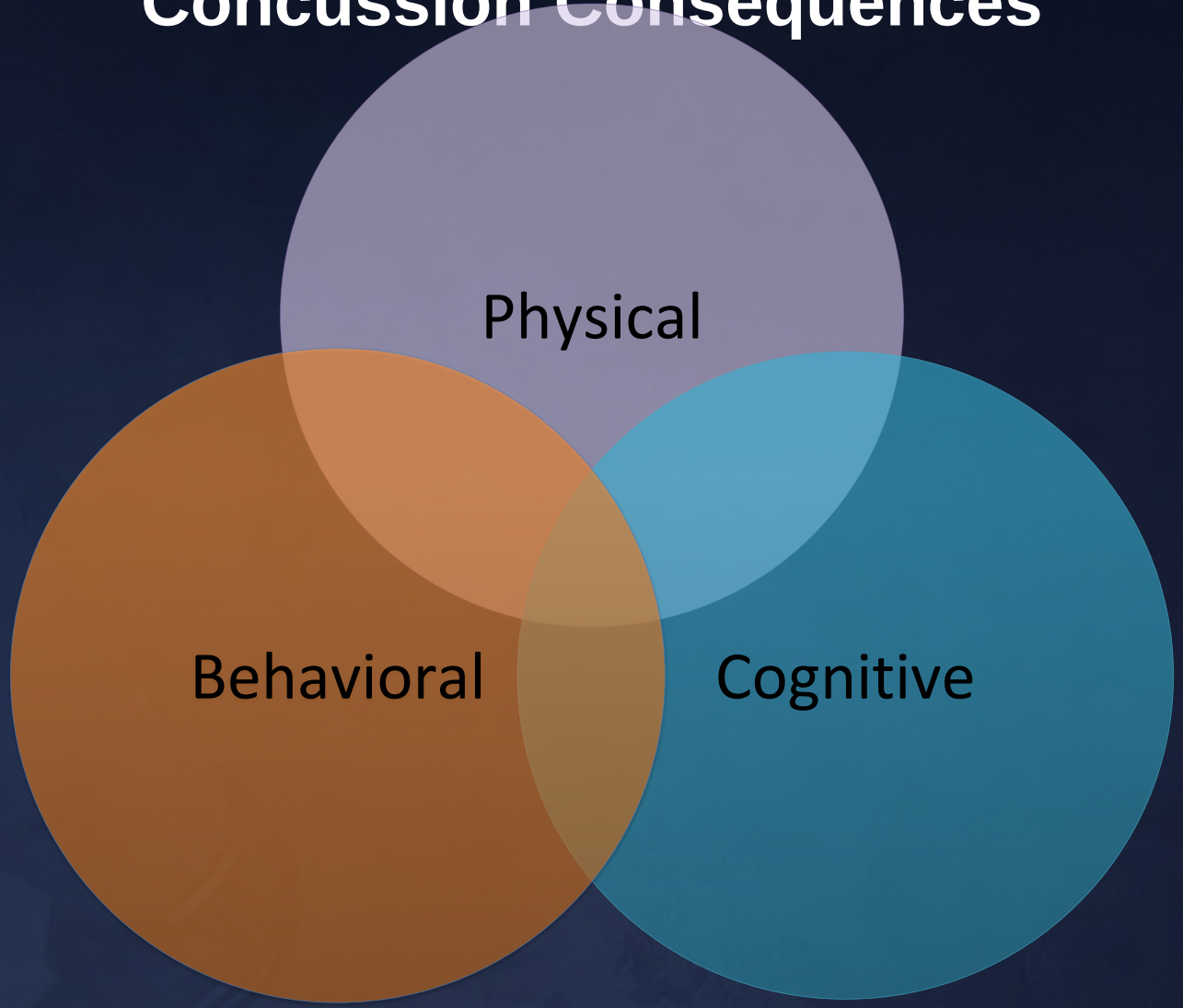

BARROW CONCUSSION NETWORK

# Concussion Consequences

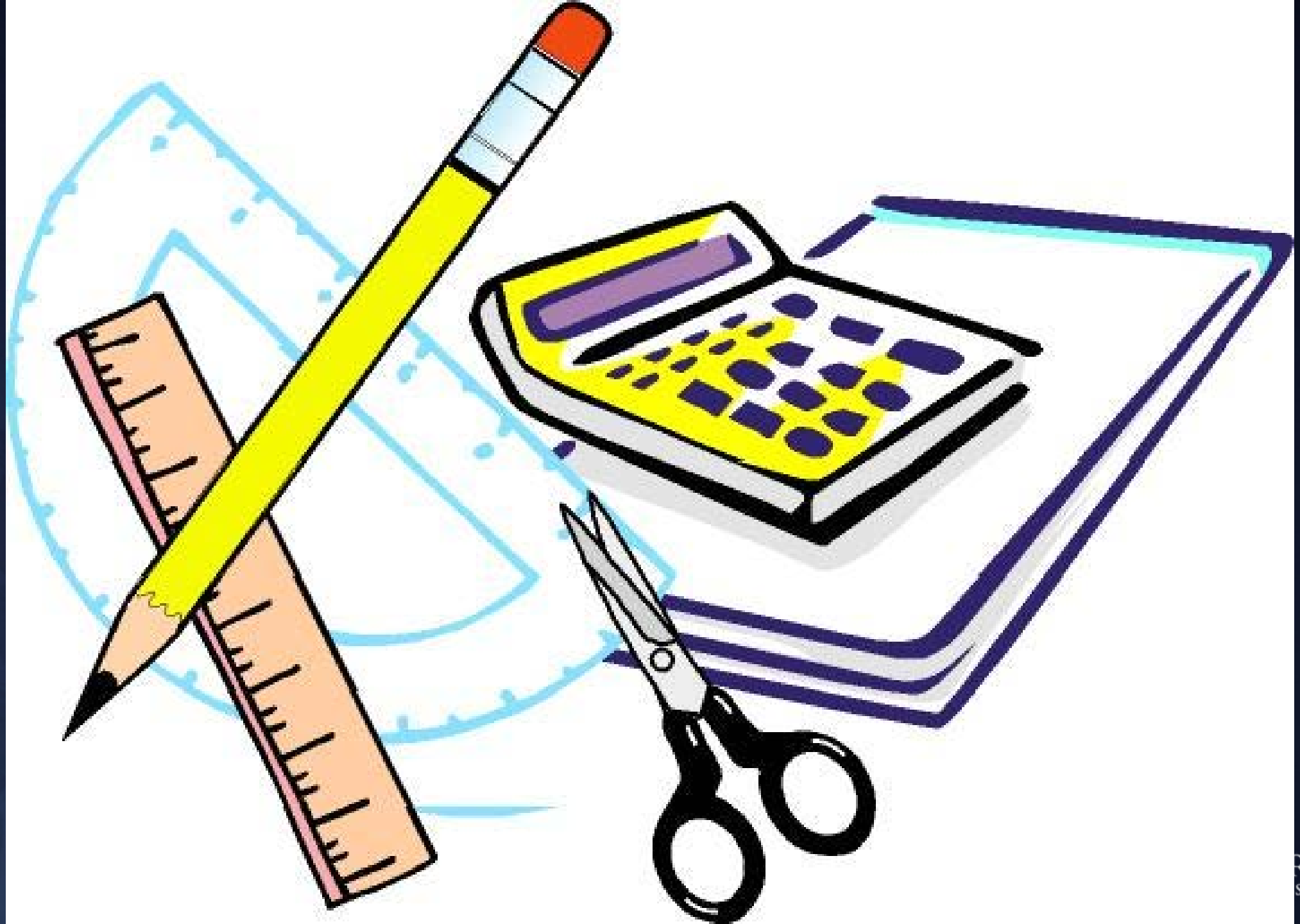



BARROW CONCUSSION NETWORK

# Concussion Consequences




BARROW CONCUSSION NETWORK



# Physical Symptoms

- Headache - most common physical symptom. Acutely most like that of migraine (photophobia, phonophobia, etc)
- Dizziness - Second most common physical symptom. Poorly characterized. Postural vs vertiginous.
- Vision change- Convergence abnormalities, tracking, vestibular-ocular.
- *Sleep - hypersomnia, insomnia, generalized fatigue

BARROW CONCUSSION NETWORK

# Behavioral Symptoms

- Irritability - most common behavioral symptom.
- Anxiety - tachycardia, panic attacks
- Depression - lack of motivation, late hypersomnia.

# Cognitive Symptoms

- Inability to focus - most common cognitive symptom.
- Memory - short term, not long term. Poorly characterized. When tested, most commonly a reflections of inattention.
- Slow processing speed - Increased time to comprehend and respond.
- Word finding - Mentally searching for words.

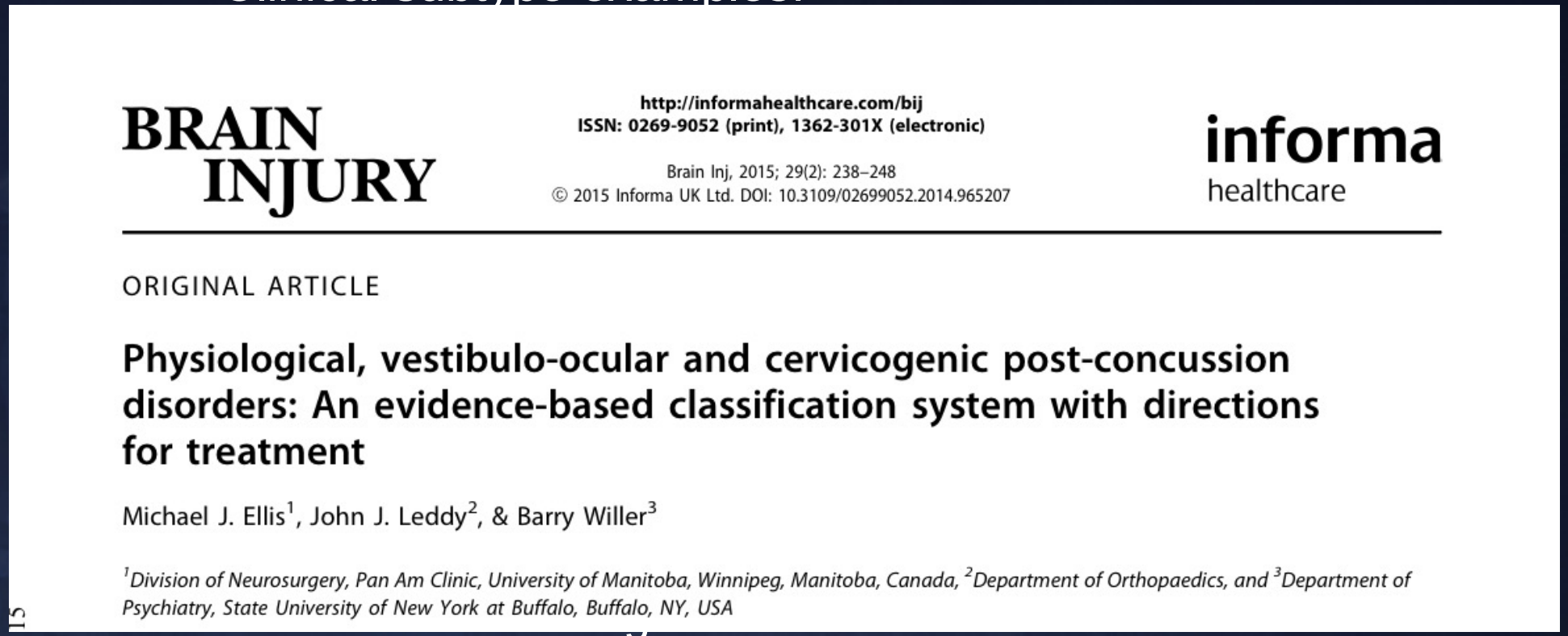
# Concussion Clinical Subtypes

- Post-injury presentation of concussion patients is not uniform.
- Cluster of symptoms/physical examinations findings may indicate a specific clinical phenotype
- Clinical subtypes of concussion may dictate:
- - Clinical recovery trajectory
- - Research Methods
- - Treatment

BARROW CONCUSSION NETWORK

# Concussion Clinical Subtypes

- Clinical subtype examples:



BRAIN INJURY

http://informahealthcare.com/bij
ISSN: 0269-9052 (print), 1362-301X (electronic)

Brain Inj, 2015; 29(2): 238–248
 DOI: 10.3109/02699052.2014.965207

informa
healthcare

ORIGINAL ARTICLE

**Physiological, vestibulo-ocular and cervicogenic post-concussion disorders: An evidence-based classification system with directions for treatment**

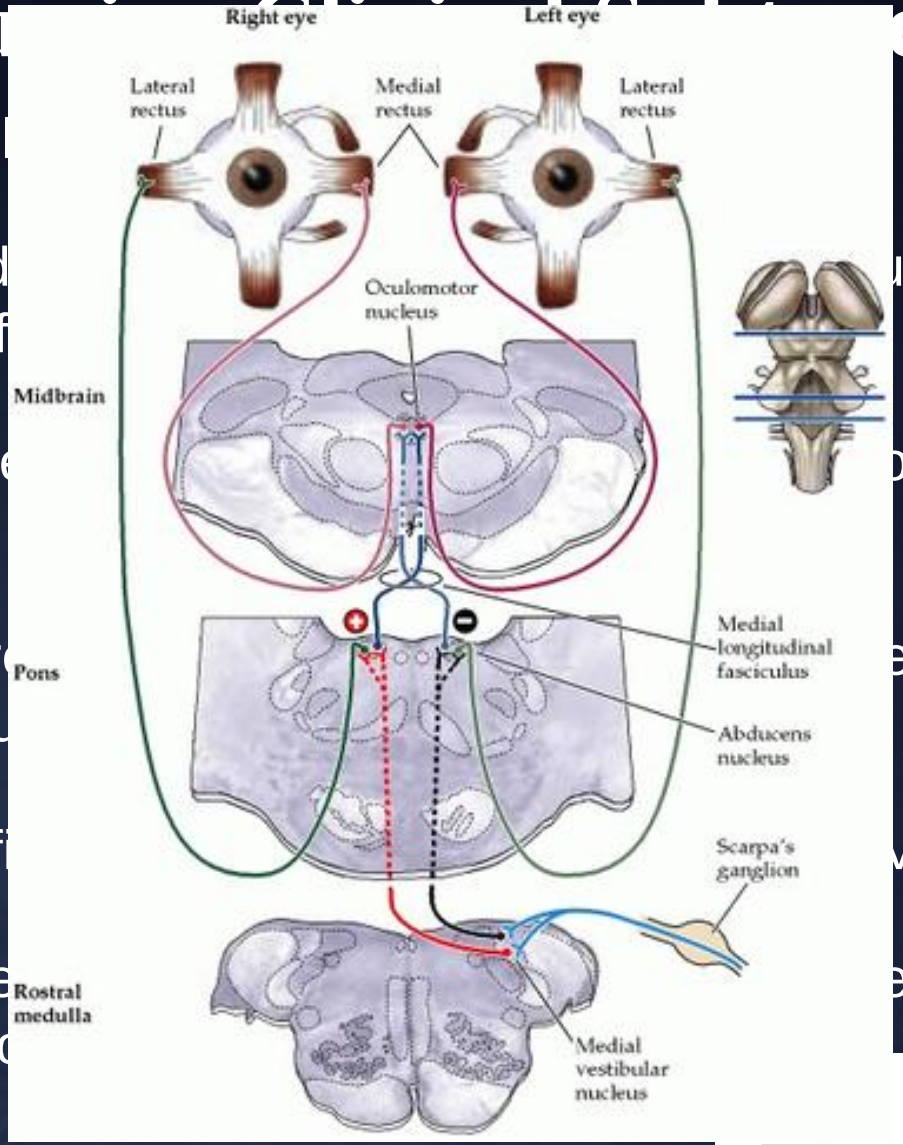
Michael J. Ellis[1], John J. Leddy[2], & Barry Willer[3]

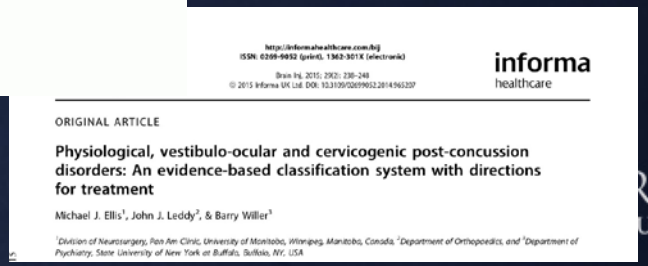
*[1]Division of Neurosurgery, Pan Am Clinic, University of Manitoba, Winnipeg, Manitoba, Canada, [2]Department of Orthopaedics, and [3]Department of Psychiatry, State University of New York at Buffalo, Buffalo, NY, USA*

- Treatment - initial rest followed by supervised exercise

# Concu es

- Vestibulo-ocu
- Characterized used by dysfunction of
- Disorder of the osensory systems
- Clinical featur e vision, tracking difficu
- Examination f VOR, tracking.
- Treatment: Ve emic accommodatio



informa
healthcare

ORIGINAL ARTICLE

Physiological, vestibulo-ocular and cervicogenic post-concussion disorders: An evidence-based classification system with directions for treatment

Michael J. Ellis[1], John J. Leddy[2], & Barry Willer[3]

[1]Division of Neurosurgery, Pan Am Clinic, University of Manitoba, Winnipeg, Manitoba, Canada, [2]Department of Orthopaedics, and [3]Department of Psychiatry, State University of New York at Buffalo, Buffalo, NY, USA

RROW
USSION NETWORK

# Concussion Clinical Subtypes

| | Physiologic PCD | Vestibulo-ocular PCD | Cerviogenic PCD |
|---|---|---|---|
| Pathophysiology | • Persistent alterations in neuronal depolarization, cell membrane permeability, mitochondrial function, cellular metabolism, and cerebral blood flow | • Dysfunction of the vestibular and oculomotor symptoms | • Muscle trauma and inflammation<br>• Dysfunction of cervical spine proprioception |
| Predominant symptoms | • Headache exacerbated by physical and cognitive activity<br>• Nausea, intermittant vomiting, photophobia, phonophobia, dizziness, fatigue, difficulty concentrating, slowed speech | • Dizziness, vertigo, nausea, lightheadedness, gait instability and postural instability at rest.<br>• Blurred or double vision, difficulty tracking objects, motion sensitivity, photophobia, eye strain or brow-ache, and headache exacerbated by activities that worsen vestibulo-ocular symptoms (i.e. reading) | • Neck pain, stiffness, and decreased range of motion<br>• Occipital headaches exacerbated by head movements and not physical or cognitive activity<br>• Lightheadedness and postural imbalance |
| Physical exam findings | • No focal neurological findings<br>• Elevated resting HR | • Impairments on standardized balance and gait testing<br>• Impaired VOR, fixation, convergence, horizontal and vertical saccades | • Decreased cervical lordosis and range of motion<br>• Paraspinal and sub-occipital muscle tenderness<br>• Impaired head-neck position sense |
| Graded treadmill test | • Graded treadmill tests are often terminated early due to symptom onset or exacerbation | • Patients typically reach maximal exertion without exacerbation of vestibulo-ocular symptoms on graded treadmill tests | • Patients typically reach maximal exertion without exacerbation of cervicogenic symptoms on graded treadmill tests |
| Management options | • Physical and cognitive rest<br>• School accommodations<br>• Sub-symptom threshold aerobic exercise programs should be considered for adolescent and adult athletes | • Vestibular rehabilitation program<br>• Vision therapy program<br>• School accommodations<br>• Sub-symptom threshold aerobic exercise programs should be considered for adolescent athletes | • Cervical spine manual therapy<br>• Head-neck proprioception re-training<br>• Balance and gaze stabilization exercises<br>• Sub-symptom threshold aerobic exercise programs should be considered for adolescent and adult athletes |

PCD, post-concussion disorder; VOR, vestibulo-ocular reflex.

# Concussion Clinical Trajectories

**Risk Factor**

- Previous Concussions
- Migraine
- LD/ADHD
- Sex
- Age
- Motion sensitiivty, Ocular Hx?


**Treatment and Rehab Pathways**

# Concussion Clinical Subtypes

- Cognitive/ fatigue subtype
- Characterized by fatigue, nonspecific headache, sleep disturbance exacerbated by cognitive or physical exertion.
- Physical examination is non-specific
- Cognitive testing demonstrates global impairment
- Treatment: initial rest with sleep hygiene, followed by gradual activity. Stimulants at times.


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

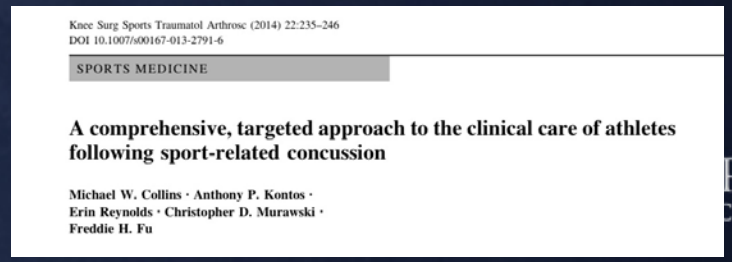
**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

RROW
CUSSION NETWORK

# Concussion Clinical Subtypes

- Vestibular subtype
- Characterized by dizziness, nausea, overstimulation
- Examination - symptomatic with head movements, VOR suppression. Imbalance present in some.
- Treatment: Vestibular therapy.


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

# Concussion Clinical Subtypes

- Ocular motor subtype
- Characterized by trouble with visual focus, frontal headaches, blurry vision, pressure behind the eyes. Symptoms exacerbated by computer screens.
- Examination findings: impaired convergence/ accommodation. Neurocognitive testing may reveal deficits in visual memory and reaction time.
- Treatment: Vision therapy


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

# Concussion Clinical Subtypes

- Anxiety/mood subtype
- Characterized by anxiety, ruminating thoughts, hypervigilance, feeling overwhelmed, sleep disturbance.
- Examination: Vestibular/ ocular screening may be provoking.
- Treatment: Exercise regimen, structured sleep/ academics. Psychotherapy, pharmacology.


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

# Concussion Clinical Subtypes

- Post-traumatic migraine subtype
- Characterized by headache with photophobia, phonophobia, nausea - exacerbated by stress, cognitive effort.
- Examination - vestiubulo-ocular screening may be provoking.
- Neurocognitive screening may demonstrate visual or verbal memory deficits.
- Treatment: pharmacology - tricyclics antidepressants, anticonvulsants, calcium channel blockers.


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

# Concussion Clinical Subtypes

- Cervical subtype
- Characterized by neck pain and headaches.
- Examination demonstrates decreased range of motion and tenderness.
- Treatment: physical therapy, pharmacology - analgesics, anti-inflammatories, muscle relaxants.


Knee Surg Sports Traumatol Arthrosc (2014) 22:235–246
DOI 10.1007/s00167-013-2791-6

SPORTS MEDICINE

**A comprehensive, targeted approach to the clinical care of athletes following sport-related concussion**

Michael W. Collins · Anthony P. Kontos · Erin Reynolds · Christopher D. Murawski · Freddie H. Fu

RROW
CUSSION NETWORK

# Critical Evaluation of Clinical Pathways

- Both groups demonstrate institutional bias.
- Both acknowledge vestibular and/or ocular subtype
- Both include cervicogenic subtype
- Physiologic subtype equivalent of migrainous subtype?
- One group includes mood subtype
- Neither group illustrates pathway for further evaluation and/or testing.
- Neither group demonstrates breakdown of subtypes in clinical setting.
- Both highlight need for validation of clinical subtype FOLLOWED by validation of clinical pathway.

# Subacute Management

- Red Flags
- Imaging - CTH

- Rest, Rest, Rest
  - Physical rest
  - Cognitive rest

- Anticipatory Guidance
  - Fewer emergency room readmissions
  - Students have better outcomes if teachers are aware of student's concussion

- Restraint!

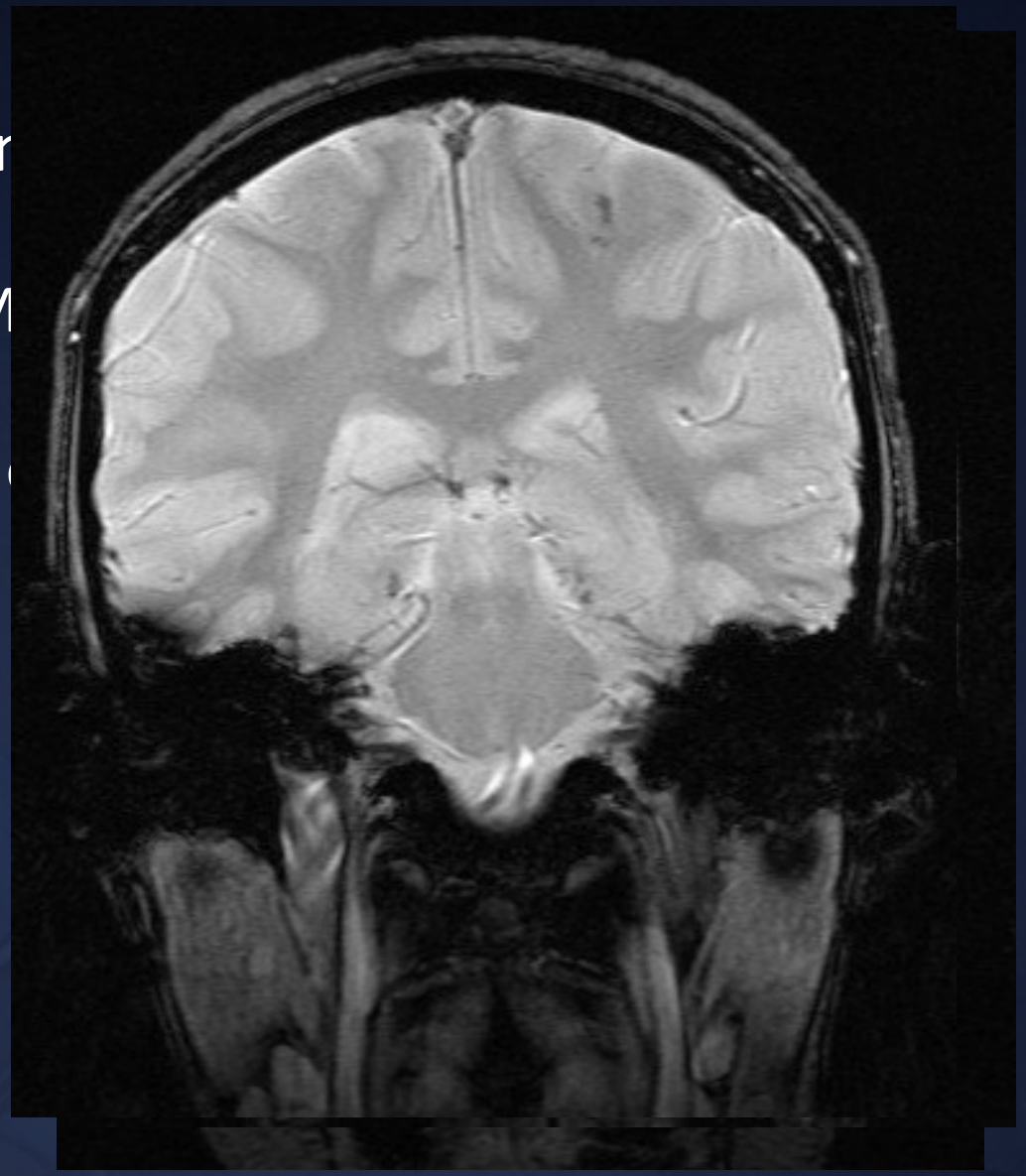
BARROW CONCUSSION NETWORK

# Recovery

- Prolonged Recovery
- Questions:
  - Was the injury worse than a concussion?
  - Is there a physical or medical condition prolonging recovery?
  - Is there an emotional condition prolonging recovery?
  - Did the concussion exacerbate an underlying condition?
    - Migraine
    - Anxiety
    - Depression
    - ADHD
    - Learning disability

# Chronic Management

- Imagir
  - M
  - N



BARROW
CONCUSSION NETWORK

# Post-traumatic headache

- Concussion
  - 90% have headache
  - Patients with mild TBI were more likely to have headache than patients with moderate or severe TBI.
  - Duration
    - Days to weeks
  - Problems
    - Prolonged PCS
      - Sleep
      - Mood
      - concentration
    - Missed work/ school


ARROW
CONCUSSION NETWORK

# Post-traumatic Headache

- Acute phenotype is most like migraine
- Chronic phenotype is most like tension-type headaches
- Risk Factors:
- female gender
- history of migraine
- family history of migraine
- premorbid psychiatric disease
- May present in isolation or part of PCS

# Headache Treatment

Headache
© 2011 American Headache Society
ISSN 0017-8748
doi: 10.1111/j.1526-4610.2011.01909.x
Published by Wiley Periodicals, Inc.

MILITARY MEDICINE, 175, 12:945, 2010

## Use of Computerized Neuropsychological Testing to Help Determine Fitness to Return to Combat Operations When Taking Medication That Can Influence Cognitive Function

*CDR Robert McLay, MC USNR*; James Spira, PhD†; Dennis Reeves, PhD‡*

Jay C. Erickson, MD

- Cognitive deficits
- Interventions
  - Tricyclic anti-depressants
  - Topiramate

- Cognitive
  - Perfor
  - Durati
- School Ac
- Simplify/s
- Give both
- Increase a
- Provide fr
- Establish
- Adapt tes

BARROW Neurological Institute®

BARROW Concussion and Brain Injury Center

222 W. Thomas Road Suite 304
Phoenix, Arizona 85018
Phone: 602-406-HEAD (4323)
Fax: 602-406-3810

## Concussion Return to Activity

Student's name:_____ Date of Birth:_____
Date of injury: _____ Today's date _____

| Returning to School |
|---|
| Concussion can affect cognition and school performance. Academic areas that can be affected include: attention, focus, memory, organization, verbal expression, comprehension, and behavior. |

**Return to School** (check all that apply):

___Return to school. No academic adjustments needed.
___ No return to school. Return on (date):___
___Return to school with the following supports
    ____Shortened day. Duration:_____
    ____Shortened classes (breaks during class). Duration:_____
    ____Extra time to complete assignments and tests.
    ____Decreased homework._____%
___Recommend formal plan:
    ___504 plan
    ___IEP

| Returning to Sports |
|---|
| 1. Student athletes should **NEVER** return to play on the same day of a concussion. |
| 1. Student athletes should **NEVER** return to play unless symptoms have returned to baseline. |

**Return to Sports** (check all that apply):

___Return to P.E. No adjustments needed.
___Do not return to P.E.
___Do not return to sports
___Return to sports using gradual return to play protocol (over)

**[ ] Christina Kwasnica, M.D.** **[ ] Glynnis Zieman, M.D.**
**[ ] Javier Cárdenas, M.D.**

_____

A Member of Dignity Health

BARROW CONCUSSION NETWORK

# Postconcussive Syndrome

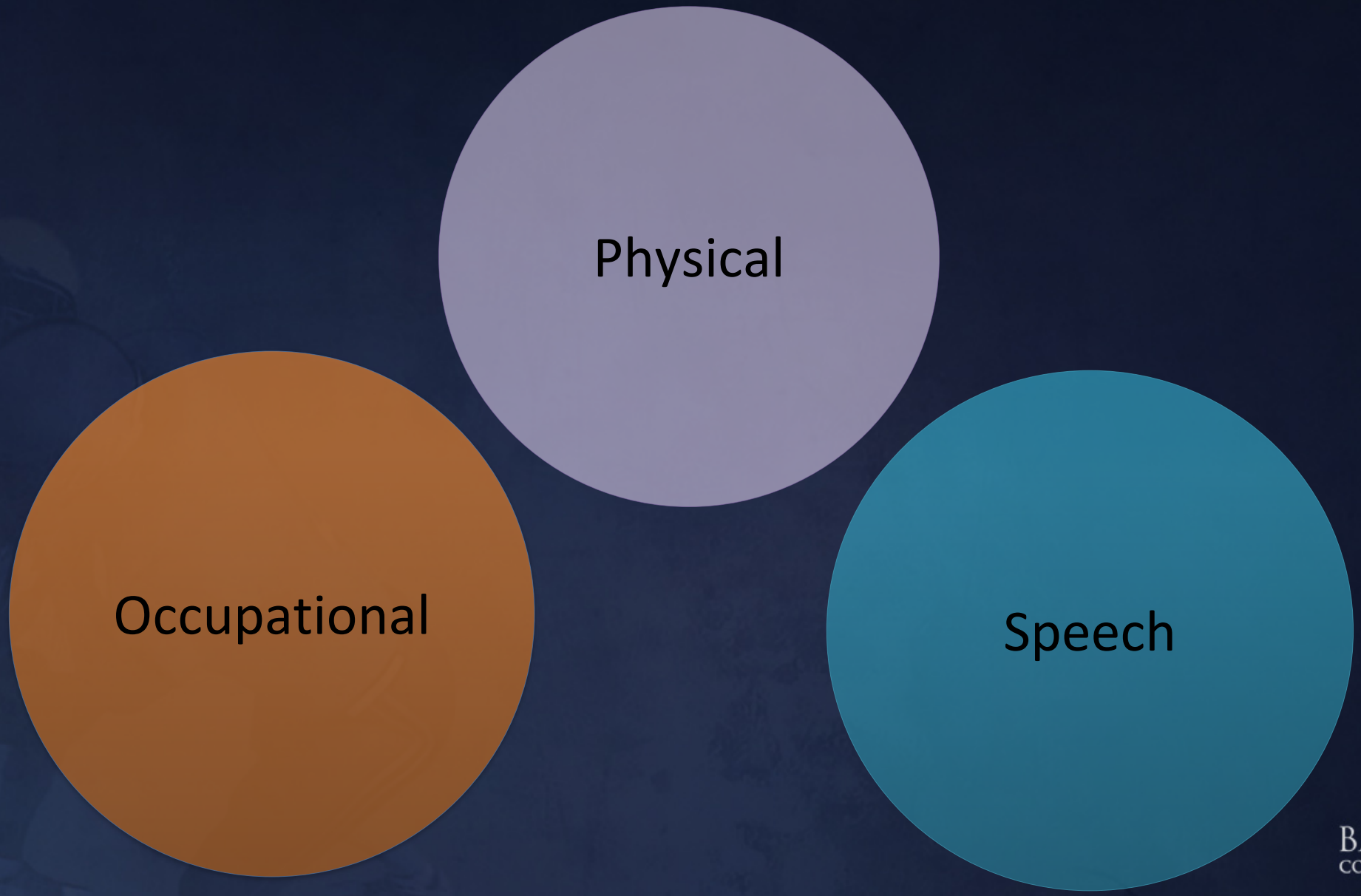
**The current status of postconcussion syndrome**
George P. Prigatano and Shawn D. Gale

- Emotional/ behavioral
  - Irritable, frustrate
- Cognitive
  - Slowed thinking, distractibility, poor learning and memory

**Current Opinion in Psychiatry** 2011, 24:243–250

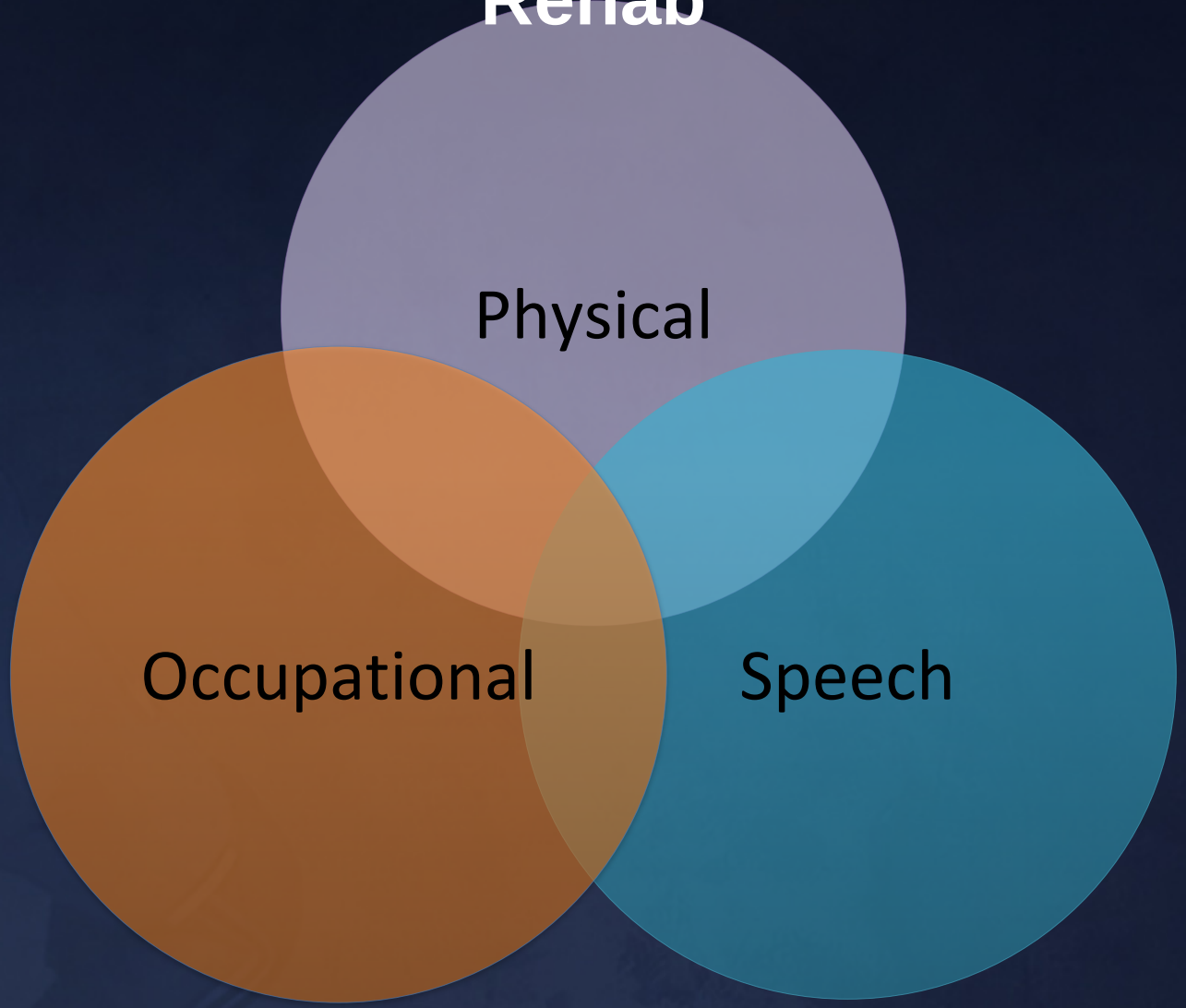
- Lasting up to 3 months
  - Most recover within weeks
  - Up to 15% can have long lasting or permanent symptoms
- Neuropsychological testing is often indicated
- Accommodations in the classroom are needed for those whose symptoms persist
  - Children perform better overall when their teacher is aware that they have suffered a TBI

# Rehab




BARROW
CONCUSSION NETWORK

# Rehab




BARROW CONCUSSION NETWORK

# Rehab


Neuro-Rehabilitation Center
Take the next step in your recovery.

# Rehab

*Scand J Med Sci Sports 2015: ••: ••–••*
*doi: 10.1111/sms.12441*


Published by John Wiley & Sons Ltd

SCANDINAVIAN JOURNAL OF MEDICINE & SCIENCE IN SPORTS

## A pilot study of active rehabilitation for adolescents who are slow to recover from sport-related concussion

**I. Gagnon[1,2,3], L. Grilli[2], D. Friedman[2,3,4], G. L. Iverson[5,6,7,8]**

*[1]School of Physical and Occupational Therapy, Faculty of Medicine, McGill University, Montreal, Quebec, Canada, [2]Trauma Center, The Montreal Children's Hospital, McGill University Health Center, Montreal, Quebec, Canada, [3]Department of Pediatrics, Faculty of Medicine, McGill University, Montreal, Quebec, Canada, [4]Canadian Hospitals Injury Reporting and Prevention Program, Montreal, Quebec, Canada, [5]Department of Physical Medicine and Rehabilitation, Harvard Medical School, Boston, Massachusetts, USA, [6]Spaulding Rehabilitation Hospital, Boston, Massachusetts, USA, [7]Mass General Hospital for Children Sports Concussion Program, Boston, Massachusetts, USA, [8]Red Sox Foundation and Massachusetts General Hospital Home Base Program, Boston, Massachusetts, USA*
*Corresponding author: Isabelle Gagnon, PT, PhD, Trauma Programs C-833, Montreal Children's Hospital, 2300 Tupper, Montreal, QC H3H 1P3, Canada. Tel: 514 412 4400 x22001, Fax: 514 412 4398, E-mail: Isabelle.gagnon8@mcgill.ca*

Accepted for publication 31 January 2015

**The purpose of this study was to examine the effectiveness of an active rehabilitation intervention for adolescents who are slow-to-recover after a sport-related concussion. Ten adolescents (three girls and seven boys) seen at the Montreal Children's Hospital Concussion Clinic participated in this case series. Adolescents who were symptomatic more than 4 weeks after the injury were provided with an active rehabilitation intervention (M = 7.9 weeks following injury; range = 3.7 to 26.2 weeks). The rehabilitation program includes gradual, closely monitored light aerobic exercise, general coordination exercises, mental imagery, as well as reassurance, normalization of recovery, and stress/anxiety reduction strategies. The program continued until complete symptom resolution and readiness to begin stepwise return to activities. The primary outcome of the study was evolution of post-concussion symptoms. Secondary outcomes included mood, energy, balance, and cognition. After the intervention, post-concussion symptoms significantly decreased for the group of participants. They also had decreased fatigue and improved mood after 6 weeks of initiating the rehabilitation intervention. This case series shows that postconcussive symptoms and functioning in adolescents following sports-related concussion can be improved after participation in an active rehabilitation intervention. The introduction of graded light intensity exercise in the post-acute period following concussion is safe, feasible and appears to have a positive impact on adolescents' functioning.**

BARROW CONCUSSION NETWORK

# Take Home Messages

- Multidisciplinary models of care are effective
- Treatment should be patient centered and individualized
- Patients should participate in their own recovery

BARROW CONCUSSION NETWORK

# Take Home Message

BARROW CONCUSSION NETWORK