Beyond the Basics, Bringing Concussion Out of the Dark

Kristina Wilson, MD, MPH, CAQSM, FAAP
Medical Director, Brain Injury and Concussion Program
Barrow Neurologic Institute at Phoenix Children’s Hospital
Medical Director, Pediatric and Adolescent Sports Medicine
Center for Pediatric Orthopaedics and Sports Medicine
Phoenix Children’s Hospital
Assistant Clinical Professor, Department of Child Health
University of Arizona School of Medicine - Phoenix
Objectives

• Recognize different types of concussion based on symptomatology
• Define prolongation of symptoms in concussion
• Identify risk factors for prolonged recovery after a concussion
• Predict which patients may benefit from earlier referral into a pediatric concussion program
• Review treatment options for persistent symptoms of concussion
Traumatic Brain Injury by the Numbers

- 1.7 million TBIs annually
- Recovery for school age children typically occurs within 3 weeks
Symptom Resolution

• 2011 study of U.S. High Schools with athletic trainers for the 2009-2010 school year
  – 23.5% symptom resolution in less than 24 hours
  – 33.8% between 1 and 3 days
  – 20.6% between 4 and 6 days
  – 19.6 between 7 and 30 days
  – 2.8% more than a month
Pediatric TBI Recovery

- Time Interval Between Concussions and Symptom Duration
- Prospective cohort
- 11-22 years
- 280 patients
- Results
  - No previous concussion: 12 days
  - Previous concussion: 24 days
  - Previous concussion in past year: 35 days
Persistent Symptoms

• Standardized definition
  – Greater than 4 weeks in children
  – Greater than 10-14 days in adults

• May be linked to coexisting and/or confounding factors
  – Do not necessarily reflect ongoing physiological injury to the brain
Evaluation for Persistent Symptoms

• Insufficient evidence in clinical setting
  – EEG
  – Advanced neuroimaging techniques
  – Genetic testing and biomarkers

• Encouraged to use in a research setting
Who is at Risk for Prolonged Recovery

• Severity of initial symptoms in the first day, or initial few days, after injury
• Low level of symptoms in the first few days = favorable prognostic indicator
• Development of subacute problems
  – Migraine headaches
  – Depression
• Children with premorbid history
  – Mental health
  – Migraines
• Teenage years
• Female sex
Concussion Clinical Trajectories

- Cognitive/fatigue
- Vestibular
- Ocular
- Post-traumatic migraine
- Cervical
- Anxiety/Mood
Cognitive/fatigue

- Decreased concentration
- Increased distractibility
- Difficulty learning/retention
- Decreased multitasking abilities
- Increased fatigue as the day progresses
Vestibular

- Altered ability to interpret motion
- Difficulty coordinating head and eye movements
- Difficulty with stabilization of vision upon head movement
- Affect 1/3 of patients
- Initial deficit presentation predicts prolonged recovery > one month
- Neurocognitive vestibular motor speed deficits
Vestibular System

• Primary function
  – Stabilize vision while the head moves
  – Provide information to help maintain balance

• Symptoms with dysfunction
  – Dizziness
  – Difficulty focusing
    • Blurring
    • Double vision
  – Difficulty maintaining balance
  – Motion sickness
  – Difficulty functioning in busy environments
Ocular

- Movement of the eyes in tandem or binocular eye movement is affected
- Difficulties bringing the eyes together
- Difficulties with tracking motion
- Approximately 1/3 concussions
- Frontal headache
- Symptoms triggered by tasks at school with math and science
- Reaction time and visual memory affected
Post-traumatic migraine

- Headaches
- Nausea
- Sensitivity to light or noise
- Often take the longest to recover
- Neurocognitive deficits in memory
Cervical

- Concussive blow affects the extra-cranial region including neck and/or spinal cord
- Whiplash type injury
- Can cause cervicogenic dizziness
- On-going headaches
Anxiety/Mood

- Difficulties with turning thoughts off
- Often with excessive worry or concern
- No neurocognitive deficits
Evidence Based Treatments

• Individualized symptom-limited aerobic exercise program
  – Autonomic instability
  – Physical deconditioning

• Targeted physical therapy program with cervical spine or vestibular dysfunction

• Collaborative approach for mood/behavior
  – Cognitive behavioral therapy
Rehabilitation of Concussion

• Interventions supported by the literature
  – Psychological
  – Cervical
  – Vestibular
  – Active rehabilitation programs
    • Controlled sub-symptom threshold, submaximal exercise
      – Safe
      – May facilitate recovery
  – Collaborate treatment approach
    • Controlled cognitive stress
    • Pharmacological treatment
    • School accommodations
Pharmacotherapy

- Limited evidence to support use
- Return to play
  - Careful consideration if on pharmacological agents/medications that may mask or modify symptoms
Cognitive

• Neuropsychological evaluation
  – Administered by neuropsychologist
  – Speech therapist
• Academic accommodations
• Behavior modification
Behavior Modification

• Sleep hygiene
• Optimize nutrition
• Optimize hydration
• Stress management
• Stepwise progression back to exercise
• Medication may be prescribed
  – Amantadine – off label
Sleep Hygiene

• No screen time 1-2 hours prior to bedtime
• Consistent to bed and wake up time
• Sleep ONLY activity in bed
• Quiet relaxing activities 1 hour prior to bed
  – Low lighting
  – Minimize noise
• No caffeine after 2 PM
• No large meals 2 hours prior to bed
## Sleep guidelines

<table>
<thead>
<tr>
<th>AGE</th>
<th>AMOUNT OF SLEEP</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 to 12 months</td>
<td>12 to 16 hours (including naps)</td>
</tr>
<tr>
<td>1 to 2 years</td>
<td>11 to 14 hours</td>
</tr>
<tr>
<td>3 to 5 years</td>
<td>10 to 13 hours</td>
</tr>
<tr>
<td>6 to 12 years</td>
<td>9 to 12 hours</td>
</tr>
<tr>
<td>13 to 18 years</td>
<td>8 to 10 hours</td>
</tr>
</tbody>
</table>

American Academy of Sleep Medicine, 2016
Cognitive Therapy

• Assessment
  – Cognitive status
    • Processing speed
    • Attention
    • Reading comprehension
    • Memory
    • Planning
    • Reasoning/judgment
    • Safety awareness
    • Higher level executive function
Cognitive Therapy

• Deficits addressed
  – Attention
  – Memory
  – Focus
  – Comprehension
Cognitive Therapy

• Treatment
  – Recommendations
    • Compensatory strategies
    • Classroom accommodations (504 plan)
  – Cognitive Impairments
    • Development of compensatory strategies for community re-entry

• Collaborate with school for re-entry process
• Administered by speech therapist
Vestibular

• Vestibular rehabilitation
  – Testing
    • Balance
      – Balance master
    • Vestibular
  – Screening
    • Musculoskeletal impairments
    • Neuromotor impairments
  – Treatment of impairments
  – Assist with return to activity/sports
  – Build exercise tolerance
  – Administered by a physical therapist
Ocular-motor

- Vestibular therapy
- Vision therapy
- Administered by
  - Occupational therapist
  - Physical therapist
Vision Therapy

- Correct visual-motor or perceptual-cognitive deficits
- Enhance brain’s ability to control eye alignment, teaming, and movement
- Focusing abilities and visual processing
- Administered by neuro-optometrist
Occupational Therapy

• Assessment
  – Visual motor impairments
  – Visual spatial impairments
    • School work
  – Ability to complete activities of daily living (ADL)
    • Home routine
    • School work
  – Ability to regulate state for concentration

• Treatment
  – Visual impairment
  – Promotion of ADLs for community re-entry
Occupational Therapy

- Deficits addressed
  - Noise desensitization
  - Light desensitization
  - Organization
  - Taking
  - Ocular therapy
  - Navigating various environments
  - Stress management
    - Relaxation techniques
Occupational Therapy

• Assist
  – Return to classroom
    • Adaptations or accommodations
    • Help to develop 504 plan

• Collaborate with school for re-entry process
Post-Traumatic Migraine

- Treat vestibular dysfunction first
- Behavior management
- Medications
  - Amitriptyline/nortriptyline
    - Initial dose 10-25 mg QHS
    - Black box warning for increased suicidality
    - Associated sleep disturbance
  - Topiramate
    - Initial dose 25 mg QHS x 1 week, then increase to BID
    - No sleep disturbance
  - Verapamil
    - Initial dose 20 mg BID x 1 week, then increase to 40 mg BID
    - Associated vestibular component
  - Propranolol
    - Initial dose 20 mg QDay x 7 days, then increase to 40 mg QDay
Cervical

• Treat the neck
• Physical therapy
  – Posture correction exercises
• Osteopathic manipulative treatment
  – Mobilization techniques
• Biofeedback
  – Coping strategies for pain management
Anxiety/Mood

• Exertion therapy
  – Daily exercise plan

• Psychology
  – Cognitive behavioral therapy
Exertional Therapy

- Return to activity
- Progressive exertion by heart rate monitoring
- Progressive cognitive and physical demands
- Stepwise approach
The Link Between School and TBI

• Cognitive difficulties
  – Learning new tasks
  – Remembering previously learned material

• School environment
  – Bright lights
  – Exposure to screens
  – Noise
Return to Learn

• Best practice guidelines based on expert opinion

• Insufficient data to advocate the ideal way
  – Individualized approach
    • Minimize additional stressors for unneeded restrictions
<table>
<thead>
<tr>
<th>Stage</th>
<th>Aim</th>
<th>Activity</th>
<th>Goal of each step</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Daily activities at home that do not give the child symptoms</td>
<td>Typical activities of the child during the day as long as they do not increase symptoms. Start with 5–15 min at a time and gradually build up</td>
<td>Gradual return to typical activities</td>
</tr>
<tr>
<td>2</td>
<td>School activities</td>
<td>Homework, reading or other cognitive activities outside of the classroom</td>
<td>Increase tolerance to cognitive work</td>
</tr>
<tr>
<td>3</td>
<td>Return to school part-time</td>
<td>Gradual introduction of schoolwork. Partial school day or with increased breaks during the day</td>
<td>Increase academic activities</td>
</tr>
<tr>
<td>4</td>
<td>Return to school full time</td>
<td>Gradually progress school activities until a full day can be tolerated</td>
<td>Return to full academic activities and catch up on missed work</td>
</tr>
</tbody>
</table>
Barriers in Return to Learn

• Lack of provider education
• Lack of physical manifestations of their symptoms
  – Poor buy-in from
    • Teachers
    • Administrators
    • Peers
    • Coaches
• Computerized neuropsychology testing
  – not routinely been applied systemically to determine when and how the student is ready to return to cognitive demand of school
Impact of Symptoms

• Headache
• Dizziness/lightheadedness
• Visual symptoms
  – Light sensitivity
  – Double vision
  – Blurry vision
• Noise sensitivity
• Difficulty concentrating or remembering
• Sleep disturbances
Headache

- Most common symptom
- Distract the student from concentration
- Vary throughout the day
- Often have triggers
  - Fluorescent lighting
  - Loud noises
  - Focusing on tasks
Dizziness/lightheadedness

- May be an indication of injury to the vestibular system
- Difficulty with standing quickly or walking in crowded environment
- Provoked by visual stimulus
  - Rapid movements
  - Videos
Visual Symptoms

• Light sensitivity
• Double vision
• Blurry vision
Visual Symptoms

• Trouble with various aspects of the environment
  – Slide presentations
  – Movies
  – Smart boards
  – Computers
  – Tablets
  – Artificial lighting
  – Difficulty reading and copying
  – Difficulty paying attention to visual tasks
Noise Sensitivity

• Trouble with various aspects of the building
  – Lunchroom
  – Shop class
  – Music classes
  – Physical education class
  – Hallways
  – Organized sport practices
Difficulty concentrating or remembering

- Challenges learning new tasks and comprehending new materials
- Difficulty with recalling and applying previously learned material
- Lack of focus in the classroom
- Trouble with test taking
- Trouble with standardized testing
- Reduced ability to take drivers education safely
Sleep Disturbance

- Excessive fatigue
  - Hamper memory for new or past learning or ability to attend and focus
- Insufficient sleep
  - Tardiness
  - Excessive absences
- Difficulty getting to sleep/frequent waking
  - Sleeping in class
- Excessive napping due to fatigue
  - Further disruptions in the sleep cycle
Return to Learning Team

- Assigned staff at the school
- Communication
- Ideally one member per team
- Family team
- Medical team
- School academic team
- School physical activity team
Family Team

- Role and responsibility
  - Enforce rest
  - Reduce stimulation
  - Parent makes ultimate decision on return to learn

- Student
- Parents
- Guardians
- Grandparents
- Peers
- Teammates
- Family friends
Medical Team

• Role and responsibility
  – Evaluate
  – Assess
    • Lesional injury
    • Neurologic injury
  – Treatment
    • Cognitive rest
    • Physical rest

• Emergency department
• Primary care provider
• Concussion specialist
  – Primary care sports
  – Neurology
  – Neurosurgery
• Clinical psychologist
• Neuropsychologist
• Team and/or school physician
School Academic Team

- Role and responsibility
  - Coordinate return to cognitive exertion
  - Facilitate appropriate level of academic adjustments
  - Understand effects of concussion on learning

- Teacher
- School counselor
- School psychologist
- Social worker
- School nurse
- School administrator
- School physician
School Physical Activity Team

• Role and Responsibility
  – Safeguard the student from further injury
  – Immediate removal for suspected injury
  – Follow stepwise return to activity progression

• School nurse
• Athletic trainer
• Coach
• Physical educations teacher
• Playground supervisor
• School physician
Assessment of Readiness to Learn

- No return
  - Inability to concentrate or tolerate stimulation for up to 30 minutes
    - Light mental activities
      - TV
      - Reading
      - Interaction with family
      - Minimal computer, text, video games

- Return with appropriate adjustments
  - Student able to comfortably tolerate symptoms up to 30-45 minutes
Educational Terminology

• Academic adjustment
  – Non-formalized adjustments
  – Weeks 1 to 3
  – Do not jeopardize curriculum
  – No alterations in standardized testing

• Academic accommodations
  – Beyond 3 weeks
  – Formalized into 504 plan

• Academic modifications
  – Permanent changes
  – IEP
Academic Adjustments

• Signed parental release of information
• Individualized plan
• Level of adjustments determined by
  – Parent
  – School
  – Primary care provider
• Level of adjustments based on
  – Severity of symptoms
  – Type of symptoms
  – Duration of symptoms
• Reassess at weekly intervals
Classroom Strategies

• Individualized approach
• Assess in private
Strategies to Control Symptoms

• Headaches
  – Frequent breaks
  – Identify aggravators
    • Reduce exposure
  – Rest periods
    • Quiet environment

• Dizziness
  – Put head down
  – Early dismissal
    • Avoid crowded hallways
Strategies to Control Symptoms

• Visual symptoms
  – Reduce exposure to screens
  – Reduce brightness to screens
  – Permit hat/sunglasses
  – Audiotapes of books
  – Turn off fluorescent lights
  – Seat in center of classroom
Strategies to Control Symptoms

• Noise
  – Lunch in quite area with one classmate
  – Avoid choir, band, shop classes
  – Avoid gym
  – Ear plugs
  – Early dismissal
Strategies to Control Symptoms

• Difficulty concentrating or remembering
  – Avoid testing
  – No completion of major projects
  – Extra time for nonstandardized tests
  – Postpone standardized testing
  – One test per day
  – Preprinted notes, notetaker, scribe
  – Reader for oral tests
Strategies to Control Symptoms

• Sleep disturbance
  – Late start
  – Shortened school day
  – Rest breaks
Summary

• Patients can experience more than one type of concussion
• Identify risk factors for prolongation of symptoms
• Individualized treatment plan
  – Based on specific triggers
  – Return to learn
  – Return to activity
Summary

• Target specific factors
  – Medical
  – Physical
  – Psychosocial

• Communication

• Balance

• Reassess weekly

• Refer early
PCH Concussion Program

• Orthopaedics/Sports Medicine
  – Kristina Wilson, MD, MPH (MT/NW)
• Neurosurgery
  – David Adelson, MD (MT)
  – Katie Klas, PNP (MT/Scottsdale/EV)
• Neurology
  – Javier Cardenas, MD (MT)
  – Reena Restogi, MD (AV)
• Neuropsychology – Michael Lavoie, PhD
• Osteopathic manipulative treatment
  – Eric Bowman, DO (EV/MT)
• Sleep Medicine – Matt Troester, MD
• Neurorehabilitation
• Neuroradiology
• Injury Prevention
Barrow Concussion Network

• Telemedicine outreach program
  – Baseline concussion testing
  – Professional education
  – Concussion research
  – Concussion consultation

• Athletic trainers access to specialists

• Expansion to primary care providers
  – If interested please email me
    kwilson@phoenixchildrens.com