Team Management of Concussion

Lauren Mann AuD CCC - A
Susan Jackson PhD L/CCC - SLP
Joshuua Allison - Burbank ABD L/CCC - SLP
Jamie Johnson MA L/CCC - SLP
Meet the Team
DISCLOSURES

All speakers are paid employees of the University of Kansas and/or The University of Kansas Health System

All speakers received a conference registration waiver for this presentation

Lauren Mann and Joshuua Allison-Burbank are doctoral students at the University of Kansas

Lauren Mann and Jamie Johnson are paid care providers on the KU Center for Concussion Management team
Objectives
AT THE END OF THIS SESSION, LEARNERS WILL BE ABLE TO:

- Describe and model the team-based care approaches used at the KU CCM

- Select appropriate AUD & SLP diagnostic tools for the assessment of concussion and support their application with current literature and clinical trends

- Recommend evidence-based management strategies for concussion symptoms
AGENDA

- Overview of KU-CCM process
- Evidence-based SLP/AUD diagnostic assessment of concussion
- Evidence-based SLP/AUD treatment of concussion
- A Very Personal Concussion Case Study
KU Center for Concussion Management
KU-CCM
What is a Concussion?

- Traumatically induced transient disturbance of brain function that involves a complex pathophysiologic process.\(^1\)

- Subset of mild TBI, which is classified based on acute injury characteristics at the less severe end of the brain injury spectrum.\(^1\)

- The clinical signs and symptoms of concussion cannot be otherwise explained by drug, alcohol, medication use, other injuries (such as cervical injuries or peripheral vestibular dysfunction), or other comorbidities (psychological or medical conditions).\(^3,4\)

Harmon et al 2019 AMSSM Guidelines
Harmon et al 2019 AMSSM Guidelines

General Recommendations:

- Monitor for exacerbation of pre-existing conditions.

Symptom-Focused Thorough Clinical Examination:

- Vestibular
  - Physical Examination
  - Impaired balance/gait
  - Abnormal vestibular–ocular reflex
  - Abnormal visual motion sensitivity or other abnormal vestibular testing

- Ocular
  - Physical Examination
  - Abnormal near point convergence; impaired accommodation
  - Abnormal pursuits
  - Abnormal saccades
  - Symptom provocation with above tests

- targeted treatment
  - Ocular rehabilitation
  - Lens changes

- Concussion Symptoms
  - Dizziness
  - Feeling like "in a fog"
  - "Don't feel right"
  - Nausea or vomiting
  - Difficulty remembering
  - Difficulty concentrating
  - Confusion
  - Feeling slowed down

- Headache-Migraine
  - Physical Examination
  - Normal
  - Avoidance reaction to bright light
  - Occipital tenderness
  - Neck tenderness
  - Tight neck muscles

- targeted treatment
  - Manual therapy
  - Treatment of HA disorder

- Anxiety-Mood
  - Physical Examination
  - Normal
  - Apathy
  - Anxiety
  - Flat affect
  - Teardrop

- Fatigue
  - Physical Examination
  - Normal
  - Tired or subtle appearance
  - Decreased arousal
  - Somnolence

- targeted treatment
  - Cognitive behavioral therapy
  - Graded exertional tolerance training in chronic setting

- Cognitive
  - Physical Examination
  - Normal
  - Confusion
  - Disorientation
  - Poor performance on in-office cognitive testing

- targeted treatment
  - Academic modifications
  - Formal neurocognitive evaluation/rehabilitation

- Sleep Hygiene

- Subsymptom Threshold Academic Exercise

- Counsel regarding expectation of recovery
Injury is Unique Each Time

Polinder et al., 2018
Neuro Assessment

Physician* conducts a physical and neuro exam, and develops the treatment plan

- Team assessments and treatment are assigned as needed per this evaluation

+ Care is directed and monitored by one provider
- Care is asynchronous
Symptom Review & Physical

- Concussion Symptom Checklist (Lovell & Collins 1998)
- Constitution
- Eyes
- Gastrointestinal
- Genitourinary
- Musculoskeletal
- Neurological
- Psychiatric
Symptom Checklist Roundup

- **Standardized Assessment of Concussion** (McCrea, 2001)
- **Rivermead Post-Concussion Symptom Questionnaire** (King et al, 1995)
- **Sport Concussion Assessment Tool 3rd Edition** (Zurich Concussion in Sport Conf)
- **Acute Concussion Evaluation** (ACE; Gioia & Collins 2006)
- **Concussion Symptom Checklist** (Lovell & Collins 1998)
- **Concussion Symptom Inventory** (Randolph, et. Al 2008)
Neurological Exam

- Mental Status
- Speech
- Cranial Nerves
- Motor Function
- Coordination
- Gait
Vestibulo - Ocular Exam (VOMS)

- Smooth pursuit
- Saccades (horizontal & vertical)
- Convergence (near point)
- VOR (horizontal & vertical)
- Visual motion sensitivity test
Team Referrals

The KU-CCM Process Overview
Physical Therapy

- Additional vestibular assessment
  - CTSIB-M
  - Functional Gait Assessment (or BESS ≤ 25)

- Vestibular rehabilitation
- Cervical PT
“Labyrinthine Concussion” ? “Cochlear Concussion” ?

- **Vestibular Assessment**: > 60% of patients report dizziness
- Dix-Hallpike screening for BPPV once cervical spine is cleared
- **Sound Sensitivity & Tinnitus** < 10% reported
- **Hearing loss** (hydrops, perilymph fistula, disarticulation, temporal bone fracture, eardrum perforation)
- **Ototoxic medications**

(Guskiewicz, Weaver, Padua, & Garrett, 2000; Zuckerman et al., 2016; Folmer and Griest, 2003; Segel et al, 2003)
Neuro-Ophthalmology

Treatment regimens encompass medically necessary non-compensatory lenses and prisms with and without occlusion.

Studies show that 90% of Traumatic Brain Injury patients suffer from Visual Dysfunctions such as:

- Blurred Vision
- Sensitivity to Light
- Reduction or Loss of Visual Field
- Headaches with Visual Tasks
- Reading Difficulty
- Difficulties with Eye Movements

https://noravisionrehab.org/
Neuropsych & SLP

- Neuropsychologists evaluate patients to determine cognitive and emotional functioning to provide:
  1. Accommodation recommendations
  2. Recommendations to return to work/school and driving

- SLP work with patients after concussion to identify cognitive deficits to provide:
  1. Treatment/intervention (cognitive remediation)
  2. Accommodations for return to work/school and driving
Cognitive Signs and Symptoms warranting referral to SLP

- Feeling mentally foggy
- Difficulty concentrating
- Difficulty remembering
- Repeats questions
- Can’t recall events prior to or after the hit, bump, or fall
- Forgetful of recent information
- Feeling mentally slowed down
- Confused about recent events
- Shows behavior or personality changes
When to Refer for SLP

1. When patient has cognitive symptoms that are not improving past the 3-5 week expected improvement time frame.
2. When the patient has not been able to move successfully through the stepped protocol for return to learn/school and/or activities/sports.
3. When the patient has had multiple concussions.
4. When the patient needs to return to work or school and needs accommodations and/or treatment intervention for cognitive problems (e.g., cognitive remediation).
SLP Evaluation

History taking from patient and family/significant others
Observation of patient’s behavior during testing

Examination of basic areas of cognitive functioning:
  - Attention
  - Memory
  - Response speed
  - Language
  - Visual Spatial Abilities
  - Problem-Solving, Decision-Making, Executive Functioning
  - NP: mood/emotional functioning
How do SLPs and AUDs contribute to concussion assessment?
SLP Assessment - Overview

1. Interview & Symptom Checklist
2. Standardized Assessments
3. Non-standardized Assessments
SLP Assessment - Symptom Checklists

- Neurobehavioral Symptom Inventory (NSI; Cicerone & Kalmar, 1995)


- Self-Awareness of Deficits Interview (Fleming et al., 1996)

- Cognitive-Communication Checklist for Acquired Brain Injury (CCCABI; McDonald, 2015) [https://brainandcommunication.ca/cccabi/](https://brainandcommunication.ca/cccabi/)
SLP Assessment - Types of Attention

- **Sustained Attention:** Focus on ONE specific task for a continuous amount of time without distraction
- **Selective Attention:** Ability to select from many factors or stimuli and focus on only the one you want while filtering out other distractions
- **Alternating Attention:** Ability to switch your focus back and forth between tasks that require different cognitive demands
- **Divided Attention:** Ability to process two or more responses or react to two more different demands simultaneously. Multi-tasking!
SLP Assessment - Standardized Tests: Attention

- Test of Everyday Attention (TEA; Robertson et al, 1994)
- Trail Making Tests A and B (Reitan & Wolfson, 1985)
- Moss Attention Rating Scale (MARS; Hart, 2008)
  http://www.tbims.org/
SLP Assessment - Adult Cognitive Evaluation

Speech Pathology:
- Montreal Cognitive Assessment –MoCA screening
- Wechsler Memory Scale III -Auditory Working and Verbal Memory
- Attention Processing Test -Attention
- RIPA-2/RIPA G-2
- Functional Assessment of Verbal Reasoning & Executive Strategies (FAVRES)
- Cognitive Linguistic Quick Test
- Assessment of Language-Related Functional Activities (ALFA) -Functional ADLs
- Reading Comprehension Battery for Aphasia (RCBA)

NeuroPsychology:
- Neuropsychological Evaluations vary regarding the extent of the need for recommendations
- Most often includes portions of or whole IQ testing for purposes of evaluating verbal and visual abilities, attention, and processing speed.
- Includes other attention and memory tests.
- Includes verbal and motor response speed tasks, executive functioning tasks, and visual-spatial tasks
- May also include academic achievement tests (for youth).
- Includes screens for depressed mood and anxiety
SLP Assessment - Standardized Tests: Executive Functions


- Behavioral Rating Inventory of Executive Function (BRIEF and BRIEF-A; Gioia et al., 2000; Roth et al., 2005)

- Behavioral Assessment of the Dysexecutive Syndrome (BADS; Wilson et al., 2005)
SLP Assessment - Standardized Tests: Memory

- Rivermead Behavioural Memory Test - 3rd edition (RBMT-3; Wilson et al., 2008)
- California Verbal Learning Test (CVLT; Delis et al., 2000)
- Everyday Memory Questionnaire-Revised (Royle & Lincoln, 2008)

https://www.tandfonline.com/doi/pdf/10.1080/09638280701223876?needAccess=true
SLP Assessment - Standardized Tests: Social Communication


- The LaTrobe Communication Questionnaire and Informant Report (LCQ; Douglas et al., 2000) [https://www.sralab.org/rehabilitation-measures/la-trobe-communication-questionnaire](https://www.sralab.org/rehabilitation-measures/la-trobe-communication-questionnaire)
SLP Assessment - Standardized Tests: Language

- The Controlled Oral Word Association Test (COWA, FAS; Benton et al., 1994)
- Animal Naming
- Boston Naming Test (Goodglass et al., 2001)
SLP Assessment - Non-standardized Assessment

- Coehlo, Ylivasker, & Turkstra (2005)
- Assess discourse, social cognition, communication in everyday contexts, skills of the communication partner
- Monologic discourse - productivity and efficiency of verbal output, content accuracy and organization, story grammar, coherence
- Conversational discourse - content & topic management
AUD Assessment - Overview

1. Vestibular

2. Hearing Evaluation Considerations

3. Tinnitus and Sound Sensitivity
AUD Assessment: Vestibular

- Dix-Hallpike screening for BPPV once cervical spine is cleared
- Common for vestibular assessment to be done by PT and patient started on vestibular rehab
- AUD assessment of vestibular system for BPPV, 3rd-window effects, or other otologic concerns

Ontario Neurotrauma Foundation 2018 Guidelines for Concussion/ Mild TBI
AUD Assessment

Hearing Assessment

- Standard assessment procedures with consideration of test order
- Important that case history asks about sound sensitivity and tinnitus
- Considerations for transducer type depending on date of injury

Fuller et al., 2017; Fernandez et al., 2015
AUD Assessment: Tinnitus & DST

Tinnitus & Decreased Sound Tolerance

*No standard procedure, but common practice:*

1. **Includes standardized symptom battery**
   - Tinnitus Handicap Inventory (THI; Newman et al 1996)
     https://www.ata.org/sites/default/files/Tinnitus_Handicap_Inventory.pdf
   - Tinnitus Questionnaire (TQ; Goebel & Hiller 1994)
     http://www.auditio.com/tinnitus/aaa2000/
   - Tinnitus Functional Index (TFI; Meikle et al 2012)
     https://apps.ohsu.edu/research/tech-portal/technology/view/1004796

Fuller et al., 2017; Fernandez et al., 2015
AUD Assessment: Tinnitus & DST

2. Audiological Assessment: audiometry

3. Psychoacoustic measures of tinnitus not included in 5 clinical guidelines but common in practice
   • Pitch & Loudness Matching, Minimum Masking Level

Fuller et al 2017 Systematic Review
AUD Assessment: Tinnitus & DST

4. Distortion-product otoacoustic emissions (DPOAEs)

- May be more reduced or absent than non-tinnitus ears with hearing loss (Gentil et al., 2015; Assaf et al., 2010)
- Higher amplitude in tinnitus with normal hearing? (Sztuka et al., 2010; Husain et al., 2013)
- Lower amplitude in normal hearing? (Modh et al., 2014; Ozimek et al., 2006)
5. Acoustic Reflex Thresholds (ARTs) & Loudness Discomfort Levels (LDLs)

- LDLs recommended 250 – 8kHz and tinnitus pitch
- ARTs when tolerated (following LDLs at ART freq.)
- Amplitude may strengthen utility of ART versus threshold where no effect is seen (Guest et al., 2019)

<table>
<thead>
<tr>
<th>Hyperacusis</th>
<th>Dynamic Range</th>
<th>Loudness Discomfort Level</th>
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</thead>
<tbody>
<tr>
<td>None/Negative</td>
<td>60 dB or greater all frequencies</td>
<td>95 dB or greater all frequencies</td>
</tr>
<tr>
<td>Mild</td>
<td>50-55 dB at any frequency</td>
<td>80-90 dB at 2 or more frequencies</td>
</tr>
<tr>
<td>Moderate</td>
<td>40-45 dB at any frequency</td>
<td>65-75 dB at 2 or more frequencies</td>
</tr>
<tr>
<td>Severe</td>
<td>35 dB or less at any frequency</td>
<td>60 dB or lower at 2 or more frequencies</td>
</tr>
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</table>

(Goldstein & Shulman 1996; Wojtczak et al., 2017; Guest et al., 2019)
How do SLPs and AUDs contribute to concussion symptom treatment?
Kathryn Hardin

- Changes 2009- to present

- Turning point:
  2013   Journal of Head Trauma Rehabilitation

  - Too much inactivity slows down the total recovery time and can make symptoms more severe.
  - After acute period of neurotoxicity has passed the brain must begin functional activity to encourage recovery.
“Tracking the Triggers”
ASHA Leader June 2018

Goal:
- Increase awareness of when symptoms START to escalate
- Stay at a sub-threshold level

- Trigger Tracking
- Journaling
AUD Treatment

- No evidence supporting use of any particular treatment for tinnitus (VA/DoD Guidelines, AAOHNS Guidelines)
- Particle Repositioning Maneuvers (PRM)
- Short-term ‘specific visual, vestibular, proprioceptive therapeutic exercises’
- Directed by PT, OT or vestibular-trained provider as appropriate
AUD Treatment

- No guidelines or definitive evidence for treatment of tinnitus other than Cognitive behavioral therapy (CBT)

- Although many patients (~58%) report central symptoms of auditory impairment following concussion, this is out of the scope of billing for audiology as a diagnostic profession (currently)

VA/DoD Guidelines; Tunkel et al 2014 Guidelines; Hesser et al., 2011
AUD Treatment: Amplification

- Cochrane Review 2014 found one RCT (n=91) suitable for inclusion (Parazzini 2011)
  - Both hearing aids and sound generators reduced tinnitus per THI score
  - No difference was seen between treatments

- Schaette 2010 showed tinnitus was reduced when found within hearing aid’s frequency range

Hoare et al., 2014; Parazzini 2011
AUD Treatment: Sound Therapy

- Cochrane Review 2010: Jastreboff Tinnitus Retraining Therapy Method (TRT)

- Cochrane Review 2018: Sound Therapy
  - no difference between sound therapy and hearing aids, both clinically reduced tinnitus
  - no difference between sound therapy and combination units (again tinnitus is reduced)

Phillips et al., 2010; Jastreboff 1999, 2004; Sereda et al., 2018
Case Example
Background of the Client & Injury

- J.A. is a 31-year old bilingual male (Navajo and English)
- He is a doctoral student in speech-language pathology
- He sustained a mild TBI with no loss of consciousness when he was hit in the forehead with a flying projectile at a cultural event at San Felipe Pueblo, NM in July 2018
- J.A. had 7 stitches to his head
Speech-Language Pathology Clinical Question

What cognitive-communicative and psychosocial difficulties is J.A. experiencing, and what recommendations are appropriate?
Speech-Language Pathology Assessment

- Susan Jackson assessed J.A. approximately 3 weeks after his TBI at his request
- During the interview, J.A. reported being more emotional and having a short fuse post-TBI, with both symptoms getting better over 3 weeks
- During the interview, J.A. reported experiencing some dizziness and light-sensitive headaches
- J.A. had seen his regular doctor the week before the assessment and was planning to see a neurologist the week after the assessment
Speech-Language Pathology Assessment

J.A. reported word-finding difficulty

- Three tests of word retrieval were administered
  - Boston Naming Test (BNT) - assesses confrontation naming
  - The F-A-S Test - assesses generative naming
  - Animal Naming - assesses generative naming

J.A. reported mild memory difficulty

- The Story Retelling subtest (immediate and delayed) from the Arizona Battery for Communication Disorders in Dementia was administered
- The Repetition subtest from the Arizona Battery for Communication Disorders of Dementia was administered
Speech-Language Pathology Assessment

Confrontation Naming Results

- 54/60 on the BNT - within normal limits (M = 55.8, SD = 3.8)
- J.A. said that he should have known three items he could not name
- Qualitative data - one self-correction, one syllable repetition, one 5-sec delay, one hesitation, a gestural response plus verbal description led to the correct response

Generative Naming Results

- F-A-S Test score = 35 total - 20th percentile
- Naming items that began with “A” was a little better in Navajo than in English (11 vs. 8)
- Animal Naming score = 32 - 90th percentile
Speech-Language Pathology Assessment

Memory Testing Results

● 13/17 on Story Retelling Immediate - within normal limits (M = 14.9, SD = 2.1)
● 12/17 on Story Retelling Delayed - almost 2 standard deviations below the mean (M = 14.9, SD = 1.6)
● 50/75 on the ABCD Repetition subtest - more than 3 standard deviations below the mean (M = 73.7, SD = 2.2)
● Qualitative data for the Repetition subtest - in general, performance was worse as the strings of words to be repeated became longer
Speech-Language Pathology Recommendations

1. Consider disclosing to others the difficulty you are having
2. Circumlocute or gesture when you are experiencing a word retrieval difficulty
3. Pause before speaking so that you give yourself time to gather your thoughts
4. Write things down - what you did, what someone else said, and actions to do in the future
5. Take rest breaks
6. Step away when you become frustrated
Speech-Language Pathology Re-assessment
Approximately 6 Months Later

- J.A. reported that most of his post-TBI symptoms had subsided, and that he experienced tremendous benefit from sessions with a psychologist to address his symptoms and his reaction to his symptoms
- memory testing was not conducted
- confrontation naming had improved (from 54/60 to 57/60 on the BNT) and was still within normal limits
- there were fewer qualitative errors on the BNT: two self-corrections
- the Animal Naming score was exactly the same: 32, 90th percentile
- the F-A-S Test score was 1 point higher: 36 total, still 20th percentile
- similar to 6 months prior, J.A. named a few more words beginning with the letter “A” in Navajo compared to English (11 vs. 7)
Implications for Students

- Students may not be comfortable sharing the difficulties they experience, especially with mental health
- Students may benefit from a reintegration plan
  - Students may require guidance on understanding how mTBI can impact their learning and mental health
  - Academic programs should have guidelines for helping students to understand their injury
  - It may be worth exploring risk factors for recovery - substance abuse, stress, etc.
Audiology Clinical Question

JAB did not report sound sensitivity or tinnitus but did experience imbalance after the injury.

Would an audiological evaluation show any clinical signs of his concussion?
**Audiology Assessment 1**

![Audiology Assessment 1 Diagram](https://example.com/Audiology-Assessment-1-Diagram.png)

**DICHOTIC DIGITS**

<table>
<thead>
<tr>
<th>Age of patient</th>
<th>LE</th>
<th>RE</th>
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<tbody>
<tr>
<td>7-7 years, 11 months</td>
<td>63%</td>
<td>82%</td>
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<td>8-8 years, 11 months</td>
<td>65%</td>
<td>75%</td>
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<tr>
<td>9-9 years, 11 months</td>
<td>75%</td>
<td>80%</td>
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<tr>
<td>10-10 years, 11 months</td>
<td>78%</td>
<td>85%</td>
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<tr>
<td>11-11 years, 11 months</td>
<td>88%</td>
<td>90%</td>
</tr>
<tr>
<td>12 years and older (adult)</td>
<td>90%</td>
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Audiology Assessment 1

![Graphs showing auditory assessment data for left and right ears.](image-url)
First AUD Assessment Summary

6 days post-injury

- Elevated ARTs and missing DPOAEs in the LEFT ear (peripheral)
  - Despite normal hearing thresholds & normal tympanometry

- Lower than expected Dichotic Digits for both ears (central)
  - Right-ear advantage stayed intact (unexpected)

- Concussion Symptom Score: 58
Audiology Assessment 2

DICHOTIC DIGITS

LEFT | RIGHT
--- | ---
85% (63%) | 95% (82%)


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<th>RE 55%</th>
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<td></td>
<td>8-8 years, 11 months</td>
<td>65%</td>
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<td>9-9 years, 11 months</td>
<td>75%</td>
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<td></td>
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<td>78%</td>
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<td></td>
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<td>90%</td>
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90 dB

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<tr>
<th>Frequency (Hz)</th>
<th>IPSI IP</th>
<th>1 kHz</th>
<th>2 kHz</th>
<th>4 kHz</th>
<th>BBN</th>
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<td>500 Hz</td>
<td>0.04</td>
<td>0.05</td>
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<tr>
<td>1 kHz</td>
<td>0.01</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
<td>0.05</td>
</tr>
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THE HEARING JOURNAL

Audiology Assessment 2

LEFT 1

LEFT 2
Second AUD Assessment Summary

208 days post-injury

- Elevated ARTs and missing DPOAEs in the LEFT ear persist (peripheral)
  - Despite normal hearing thresholds & normal tympanometry
  - Is the injury not recovered or is the periphery independent from the injury?

- Dichotic Digits improved but still abnormal for the left ear (central)
  - Right-ear advantage stayed intact (unexpected)

- Concussion Symptom Score: 26
FINAL THOUGHTS
THE PATIENT’S PERSPECTIVE
Final Thoughts

Concussion symptoms:
Many
Pervasive over time
Requires Multiple Expertise

Theadom et al., 2016
Thank You!
Practice Guidelines

  
  https://www.healthquality.va.gov/guidelines/Rehab/mtbi/mTBICPGFullCPG50821816.pdf

- Ontario Neurotrauma Foundation 2018 Guidelines (3rd edition)
  
  https://braininjuryguidelines.org/concussion/

- Consensus Statement on Concussion in Sport: The 4th Int. Conference on Concussion in Sport, Zurich, Nov 2012
  
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3715021/
ASHA TBI Practice Portals

SLP

• https://www.asha.org/Practice-Portal/Clinical-Topics/Traumatic-Brain-Injury-in-Adults/

• https://www.asha.org/Practice-Portal/Clinical-Topics/Pediatric-Traumatic-Brain-Injury/

AUD

• https://www.asha.org/articlesummary.aspx?id=8589960983
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• Anderson T, Heitger M, Macleod A D. Concussion and Mild head injury. Practical Neurology 2006; 6:342-357m
• Brain Injury in Children and Youth: A Manual for Educators Colorado Department of Education
• cdc.gov/concussion
• Canlearnociety.ca
• Understood.org
Selected References

• Krug, H., Turkstra, L. Assessment of Cognitive-Communication Disorders in Adults with Mild Traumatic Brain Injury. Perspective on Neurophysiology and Neurogenic Speech and Language Disorders. Vol 25, January 2015. ASHA.
