Concussion Training Day

Evaluation of Concussion and PCS: Medical Perspective

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Objectives

• Understand key elements that make up the Physical Examination

• Be aware of the reliability of these elements

• Adapt these elements to suit the clinical situation

• Be aware of differences in children

The initial approach

No Injury | Concussion | Emergency
The Physical Examination of Concussion: A Paradigm Shift in Diagnosis

- Clinical tools must be reliable and readily adaptable to suite the clinical situation
- Approach must be structured, following a hierarchy of assessment
- Use tasks that commonly precipitate or exacerbate concussion symptoms
- Fall within two clinical domains
  1. Screening Examination
  2. Focussed Concussion Examination

Screening Examination

**Initial evaluation** - Assess ABC’s (Primary survey), Cervical spine, Consciousness, Mental status (MMSE), Seizures, Focality  
**EMS response** - Repeated vomiting, Severe or progressive headache, Seizure, Abnormal gait, Sturred speech, Weakness or numbness in extremities, Unusual behavior, skull fracture, AMS, Somethings not quite right  
**Clinical history** - Mechanism of injury (SCAT)  
Obtain some clinical history from observers  
Assess for concussion if head, face, or neck injuries present  
Prior concussion history— inquire about previous symptoms of concussion and number of concussions.  
**Evaluate for symptoms** (Pocket CRT/SCAT)

Screening Examination

**Neurological exam** - Neck exam, 3’ neurologic exam; assess pupillary reflexes, cranial nerves, motor strength; perform gait/station tests for balance (Romberg), palpate for neck pain  
**Mental status** (SAC/SCAT)  
- Attention span (immediately repeat four numbers forwards; at 2 minutes, repeat months of year backwards or repeat five digits forwards and backwards)  
- Short-term memory (three objects at 5 minutes)  
  i. “What team are you playing?”  
  ii. “What is the score of the game?”  
  iii. “What are the colours of the uniforms of the team you are playing?”  
- Assess for anterograde amnesia  
- Assess long-term memory  
**Secondary survey** - lacerations, faciomaxillary & other system injury
Focussed Concussion Examination

Four pillars

History
Cognitive function
Vestibular Ocular control
Balance control

Focussed Concussion Examination

History
Define injury characteristics
Mechanism of injury
Post-injury symptoms
Define risk
Co-morbidities
Risk factors

Post-concussion Symptom Scoring

Symptom evaluation
- 22 symptoms
- Like
- Self

Symptom Burden
Sensitive 96%, Specificity 63%
JAMA 2016

Symptom severity score: Mikel协, S. J. A. 2013
Focussed Concussion Examination

History

Co-morbidities & Risk factors
- Previous concussion, headaches, ADHA, LD, psychiatric conditions, previous spinal injury, neuro-ophthalmologic conditions, other conditions e.g. epilepsy, neuro-structural

Family history

Past medical history

School and social factors

Focussed Concussion Examination

Cognitive function

Orientation (time, place or person)

Concentration (digital backwards)

Memory (word tasks)

Reaction time

Cognitive function

Standardized Assessment of Concussion (Sensitivity 94%, Specificity 91%)
- Orientation
- Immediate memory
- Concentration
- Delayed recall

Maddock Q's

Abbreviate- Westmead Post-Traumatic Amnesia Score
A-WPTAS

Hayter, Appl Neuropsychol 2016
What advanced or novel tests can assist in the evaluation of concussion?

### Cognitive Performance - Computer

![Graph showing cognitive performance over time](image1)

**McClure N, Kibler W, 2012. 5th International Consensus Conference on Concussion in Sport.**

**Sensitivity** vs. **Specificity**

### Cognitive Performance - Reaction Time, Clinical

**Drop Stick Test**
- Sits, dominant hand neutral over desk
- 8 recorded dropping of stick
- Record distance dropped

\[
RT (ms) = 1000 \times \sqrt {\frac{2 \times \text{distance in cm}}{980 \text{cm/s}^2}}
\]


### Focussed Concussion Examination

**Vestibular Ocular Control**
- Visual acuity
- Smooth pursuits
- Eye Saccades
- Near Convergence
- Vestibulo-ocular reflex
- Visual Motor Sensitivity

Sensitivity 91.7%, Specificity 81.7%

**Focussed Concussion Examination**

**Balance control**

- Station
- Single leg stance
- Tandem stance
- Tandem gait
- Dual tasking

**Balance Error Scoring System**

- **BESS**
  - Sensitivity 91%, Specificity 64%

- **m-BESS**
  - Sensitivity 91%, Specificity 71%

**m-BESS: Balance Error Scoring System**

- Postural Stability on a firm surface
- 20 seconds each
- Count errors to score
  - Eyes opening
  - Movement
  - Hands off hips
- Unable to hold or a minimum of 5sec, maximum score
- Abnormal response, ≥5 during each trial

- **m-BESS**
  - Sensitivity 95%, Specificity 71%

- Combining m-BESS/VOMS-
  - Sensitivity 96%, accuracy 84.4%
Balance Exam- Tandem walking / Dual-tasking

1. Tandem walking-forward
2. Tandem walking-backwards

Specificity of 91%

On Field Assessment

- If unconscious, ABCs, C-spine, Seizure, Level of consciousness, Focality

- Important observations
  - Unresponsive, LOC
  - Clutching or shaking head
  - Slow to get up
  - Vacant staring or gaze
  - Gait ataxia
  - Seizure like activity

Sideline assessment

- Is there likely to be a structural brain injury?
- Is there likely to be a concussion? **SCAT-4**

**High yield**
- Spontaneous nystagmus
- Vertical eye discordsance
- Dynamic vision
- Romberg/m-BESS
- Positional maneuvers
- Neck examination

**SCAT elements**
- Observed signs
- Symptom reporting
- SAC elements
- Orientation
- Immediate memory
- Concentration
- Delayed recall
- Balance
- Neck assessment

Any one symptom or any one sign should result in immediate exclusion and withdrawal from the game

No next day return until re-evaluated
**Emergency Department Assessment**

Exclude significant injury- trauma examination

Neuroimaging

Make a diagnosis of concussion

Focused Concussion Exam

Document neck pain

Commence a short period of rest

Organise appropriate follow-up- HEAD BUMPS

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**Primary care- Subacute assessment**

Rule out other injury and/or potential subtle structural brain injury

Confirm the diagnosis, focused concussion exam

Define the deficits, systems not pathway specific

Tailor treatment

Consider need for referral to a specialist service

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**Complex concussion / Post Concussion Syndrome**

- Cardiology
- Exercise therapy
- Sleep medicine

- Neurology
- Neurosurgery
- Rehabilitation

- Psychiatric
- Psychological
- Behavioural therapy
Orthostatic / Dynamic vital signs

Orthostatic
- Hypotension
- Tachycardia
- Heat intolerance

Dynamic, exercise induced
- Tachycardia
- Autonomic dysfunction

Exercise intolerance

Help differentiate from Concussion mimics

Provocation testing to risk stratify patients

Concussion
- Initial Assessment
  - Subacute phase physiology

Secondary Assessment
- Graded exercise test
  - Recovered
  - Physiologic PCD
  - Graded exercise test
  - Physiologic PCD
  - Target symptom

Recovery procedures

Subthreshold Exercise Program

Targeted therapy

Tertiary Imaging in complex concussion

- Possible indications for imaging-
  - Suspicion of IC injury
  - Dramatic worsening of symptoms
  - Prolonged symptoms

- High quality MRI, MRA/MRV, DTI
  - Micro-structural injury that may suggest prolonged recovery or vascular injury
  - DAI, vascular injuries and WM structure
  - Pooling, highly sensitive for WM tract abnormalities (98%) but not very specific (45%)

- PET scanning for dementia

McCrea, M. October 27th 2016 - 5th International Consensus Conference on Concussion in Sport,

What advanced or novel tests can assist in the evaluation of concussion?
Paediatric concussion - Special considerations

1. Physiological development
2. Impact forces and protective ability
3. Physical and cognitive recovery
4. Effects on school and learning
5. Everyday environmental influences and demands
6. Potential for long-term sequelae

Catastrophic injury  Second impact

- **Second Impact Syndrome** - genetic basis / Ca++
  - CACNA1A mutation, potential for cerebral oedema after a relatively minor brain injury, familial hemiplegic migraine
  - Catastrophic injury, Second Impact Syndrome - genetic basis / Ca++
    - CACNA1A mutation, potential for cerebral oedema after a relatively minor brain injury, familial hemiplegic migraine
- Athletes carrying a specific genotype (CACNA1E rs704326) have a much greater risk of a prolonged recovery following concussion
  - History of migraine increases the risk of severe injury or prolonged recovery
    - McDevitt. AOSSM March 2016
- Brain impact, amplified in young brains
  - Increased of Ca++ and Na+ influx induced by glutamate-triggered over activation of the NMDA receptors & AQ4P mediated oedema

Developmental conundrum

Integrate unique elements into assessment
- Developmental
- Medical
- Psychological
- Family / Environmental
- Academic / School

Standardised Assessment of Concussion - >6 years
A-WPTAS - > 6 years

Multimodal assessment
Developmentally adapted assessment

- Cognition
- Balance
- Strength
- Agility / Motor skills
- Social / Psychological / School

Gioia et al. Brain Injury 2015; Reed et al. J. Vis. Exp., e51892, 2014

Condensed model of care including GXT

Area under ROC curve = 0.8928

Borisova UMK Pediatr 2012

What characteristics in kids determine RTA?

- Adolescents with headache on ED admission, requiring hospitalisation at ED encounter, at risk persistent PCS

- Subacute GXT (2 days of rest)
  - Exercise tolerant - commence activity, active rehab, normal recovery
  - Exercise intolerant - facilitated activity, progressive rehab, slow recovery
  - Extreme exercise intolerant, extended rest, facilitated activity, rehab, very slow recovery

- Westmead step test

Browne et al Pediatric 2016
Bogg. PhD in Science 2016
Take home messages

• PE is central to the assessment of concussion
  - tools we use need to be adapted to suit the clinical situation

• Complex concussion
  - higher level of evaluation is often needed, this best undertaken in a referral centre with appropriate interdisciplinary support systems

• Children are different
  - Risk can be mitigate through early diagnosis, effective treatment and education