Mild Traumatic Brain Injury: Diagnosis & Intervention
IRSG, April 2014 - Pasadena

Are our healthcare resources allocated on the basis of science?
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Outline
• Definition
• Diagnostic Issues
• Intervention

“In addition to the human toll of these injuries, mTBI costs the nation nearly $17 billion each year.” These data likely underestimate the problem for several reasons:
• No standard definitions exist for mTBI.
• CDC definitions for TBI surveillance are designed for hospital use and likely greater severity.
• mTBI is most often treated in ED and non-hospital settings where data are not well captured.
• Hospital and ED data do not provide LT prognostics

CDC, Report to Congress on MTBI, 2003

Definition: mTBI
ACRM mTBI Committee of the Head Injury Interdisciplinary Special Interest Group

Any period of traumatically induced:
1. Loss of consciousness (LOC) up to 30 minutes,
2. Loss of memory for events immediately pre or past <= 24 hrs.
3. Any acute altered mental state (e.g., dazed, disoriented, confused) for <= 30 minutes and,
4. Focal neurological deficit(s), transient or persistent.

But where the following are not exceeded:
1. LOC of 30 minutes
2. GCS < 13 after 30 minutes.
3. PTA > 24 hours.


Other mTBI Definitions

<table>
<thead>
<tr>
<th>Severity</th>
<th>GCS and Acute Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimal</td>
<td>15, no LOC or Amnesia</td>
</tr>
<tr>
<td>Mild</td>
<td>14; or 15 + Amnesia; or LOC &lt;= 5 min or impaired alertness, memory</td>
</tr>
<tr>
<td>Moderate</td>
<td>9-13 or LOC &gt; 5 min, or focal neurological deficit</td>
</tr>
<tr>
<td>Severe</td>
<td>5-8</td>
</tr>
<tr>
<td>Critical</td>
<td>3-4</td>
</tr>
</tbody>
</table>


ICD-10: “PCS” Criteria

• HO head trauma precedes Sx onset by max 4 wks.
• Symptoms in 3 or more of the following groups:
  o HA, dizziness, malaise, fatigue, noise tolerance
  o Irritability, depression, anxiety, emotional lability
  o Subjective concentration, memory, or intellectual difficulties without neuropsychological evidence of marked impairment
  o Insomnia
  o Reduced alcohol tolerance
  o Preoccupation with above Sxs and fear of brain damage with hypochondriacal concern and adoption of sick role


Concussion & mTBI

• Concussion can be caused by a direct blow or “impulsive” force to the head.
• Typical is rapid onset of neurologic dysfunction, with spontaneous short-term recovery.
• Neuropathologic changes appear to largely reflect functional disruption rather than structural damage.
• Symptom severity and recovery typically parallel severity of injury.
• No abnormality is expected on standard imaging.

Definition Problems

• Error of Measurement?
  o “All measurements are ‘wrong.’”
  o In complex systems, a “unitary conceptualization” has error
  o LOC < 30 ± 9
  o PTA < 24 hrs. What about 23.5 vs. 24.1. Any difference?
  o Interrater reliability of GCS?
  o Reliability of reporters/records?
  o Variability of risk factors (medical, psych, social, culture).

• “Mild” has a very large criterion range
  o “Bump on the head” versus < 30 min LOC
  o Majority of “disputes” are at questionable or 0-5 min LOC
  o Battling bias vs. rely on science

But Mild-Appearing May Not Be Trivial


Youvella, who was a 396-pound senior running back and defensive back for Higley, suffered the injury with his team trailing 66-6 in the fourth quarter. According to Williams and Obert’s report, the tackle seemed harmless at first, but Youvella’s head hit the ground hard. He remained in the game for two more plays before collapsing.

Although Youvella was conscious, alert and talking when he was taken to the hospital, his condition quickly worsened. He was in critical condition when he arrived at St. Joseph’s Hospital and Medical Center in Phoenix and ultimately passed away on Monday.

“On the way down, the back of Youvella’s head hit the ground hard,” Witnesses said. Youvella got right back to his feet and lined up for two more plays before collapsing on the field. He was conscious and talking when paramedics took him away, but by the time he arrived at St. Joseph’s Hospital and Medical Center in Phoenix he was in critical condition. He remained that way through Monday.” - Williams and Obert, USA TODAY, 11/12/13.

Epidemiology

Estimated Average Annual Number of TBI-Related ED Visits, Admits, and Deaths, U.S., 2002–2006

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A “Mixed-Severity” Label

- We will emphasize in this discussion “Uncomplicated mTBI,” that in which there are no radiological abnormalities, no fractures or hemorrhage.
- More on “Complicated mTBI” later.
- “Mild” is a very large range, from trivial to bordering on Moderate severity.
- Our major challenge is management of the lower range of objective severity.

How Far Have We Come?

- GCS 13-15 at 30 min, <4 hrs PTA, 25% with persisting impairments.
- Discrimination by standard Neuropsychological testing, weighing of subjective complaints, neurological examination.
- “Experts” disagree.
- Believers and Nonbelievers.”
- Today: Greater emphasis on Science.

But, Frustrated w/ Limited Science, a fall back to argumentum ad hominem is not rare.

Historical Limitations of Our Science Base

<table>
<thead>
<tr>
<th>Domain</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanics</td>
<td>Which events can cause mTBI?</td>
</tr>
<tr>
<td>Pathology</td>
<td>Is there a defining pathophysiology?</td>
</tr>
<tr>
<td>Diagnosis</td>
<td>What are essential criteria of mTBI?</td>
</tr>
<tr>
<td>Risk Factors</td>
<td>What predisposes mTBI?</td>
</tr>
<tr>
<td>Testing</td>
<td>Is there a neuropsychological mTBI profile?</td>
</tr>
<tr>
<td>Aggravating Factors</td>
<td>Do comorbidities complicate Dx and intervention?</td>
</tr>
<tr>
<td>Course</td>
<td>Is there an expected recovery curve and time?</td>
</tr>
<tr>
<td>Prognosis</td>
<td>What variables predict outcome?</td>
</tr>
<tr>
<td>Intervention</td>
<td>What is effective?</td>
</tr>
<tr>
<td>Outcome Risks</td>
<td>Are there long-term risk factors?</td>
</tr>
</tbody>
</table>

Nonspecificity of Symptoms

- mTBI has no necessary and specific neurocognitive profile.
- The most common valid test profile in uncomplicated cases is “normal.”
- “PCS” is not a true “syndrome.”
- Most common mTBI complaints are not specific and are common with non-neurological trauma, general medical presentations, and psychological conditions.

Base Rates:

<table>
<thead>
<tr>
<th>PCS Symptoms in Non-TBI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Headache</td>
</tr>
<tr>
<td>College Students</td>
</tr>
<tr>
<td>Chronic Pain</td>
</tr>
<tr>
<td>Depressed</td>
</tr>
<tr>
<td>PI Clients w/o TBI</td>
</tr>
<tr>
<td>mTBI</td>
</tr>
</tbody>
</table>

Iverson, Zasler & Lang, 2006: 90% of patients Dx’d with depression or fibromyalgia report Sxs that can meet ICD-10 criteria for PCS, that persons with depression and without TBI are 90% likely to meet ICD-9 PCS criteria.
Self-Reported Altered Awareness

<table>
<thead>
<tr>
<th>Condition</th>
<th>Shaken</th>
<th>Confused</th>
<th>Dazed</th>
<th>Disoriented</th>
<th>Memory Loss</th>
<th>PTA</th>
</tr>
</thead>
<tbody>
<tr>
<td>mTBI (n = 24)</td>
<td>71%</td>
<td>67%</td>
<td>52%</td>
<td>33%</td>
<td>42%</td>
<td>38%</td>
</tr>
<tr>
<td>Other Injury (n = 66)</td>
<td>88%</td>
<td>65%</td>
<td>71%</td>
<td>42%</td>
<td>36%</td>
<td>21%</td>
</tr>
</tbody>
</table>


10%-20% Miserable Minority? A Misunderstood Number vs. a Meme

- Ruff and colleagues 1994, 1995, first uses of ‘MM.’
- Alexander 1995 reported 15% unrecovered at 1 yr.
- McLean, et al 1983. Follow-up was at 1 month, not 1 year (i.e., as cited by Rohlings, Greiffenstein).
- Rutherford, et al 1979. 19/131 (14.5%) symptomatic at 1 year. Yet…
  - 10 had symptoms at 1 year that were not reported at 6 weeks; 8 in lawsuits; 6 suspected at 6 weeks of malingering; 5 in lawsuits and malingering.
- Ruff 2005 reported 10%-20% have persisting symptoms, appearing to have relied on Alexander 1995.
- McCrory et al. 2013 state 80-90% resolve in 7-10 days vs. 10-15% persist > 10 days. Citation is silent vs. no citation.

Common Collateral Noninjury Conditions

- Chronic headache
- Chronic sleep disorders
- Depression, anxiety, other mental illness
- Substance abuse: Recreational, prescription
- Psych/soc stresses: Family, job, finances, legal
- Psych/soc barriers: Language, culture
- Preexisting general medical conditions – known and unknown
- Preexisting cognitive impairments
- Neurodegenerative conditions
- Primary and secondary gain

Also…A Problem of Definition?

- “Mild Closed Head Injury (mCHI) and Mild Traumatic Head Injury (mTBI) are similar but not synonymous.
- “mCHI” encompasses TBI and/or injuries to other head structures such as: Cochlea-vestibular structures, head and neck muscles and ligaments, some blood vessels, bone and facial structures, some cranial and superficial nerves, etc.
- All CHI ≠ TBI.

Undiagnosed Conditions

- Subclinical and chronic: ADD, LD, low average and uneven cognitive development
- Sleep disorders
- Pain: Dental, arthritic, orthopedic, headache
- Chronic anxiety and depression
- Vascular disease
- Early stage of dementing illness
- Endocrine (e.g., thyroid, testosterone).
- Low vision, low hearing
- Deconditioning
- Noncompliance – avoidance of health care
mTBI Comorbidity: Challenges to Research & Prognosis

Mechanism of Injury (n = 1566)
- MVA: 55.4%
- Fall: 19.1%
- Assault: 11.9%
- Trauma: 10.0%
- MCC: 3.8%

Pre-Admit Narcotics
DSM Axis I Dx
EtOH on Admit
Psychotropics
Narcotics in ED

Confirmation Bias
- Failure to adequately consider differentials.
- “The complaints are consistent with ...”
  - Correlation does not imply causation.
- Assuming the referring diagnosis and record are accurate and complete.
- Failure to scrutinize the reasonableness of subjective complaints.

Chronic Traumatic Encephalopathy: CTE
- Are dementia, volatile mood, aggression and suicide common or expected with mTBI alone?
- Effect of 2, 4 or dozens to hundreds of mTBIs?
- Cumulative effects?
- Comorbid factors: Substance abuse, lifestyle, CAD, genetics of neurodegenerative conditions.
- Hindsight bias means, “I knew it all along.”
- Confirmatory bias.

Iatrogenics
- Sorry, but a big problem is ignorance among intelligent and well meaning providers.
- Many, many providers do not know criteria and procedures for staging and managing mTBI.
- All head injuries are not alike – all are not “severe.”
- “Rest” can be good, but damaging in excess.
- “False Memes.” Truisms that most often are not.
  - mTBI predisposes early dementia.
  - Treatments for severe TBI are indicated for mTBI.
  - “My patient is the exception, the small minority.”

“Diagnosis Threat”

Abstract: Persistent cognitive complaints are common following a mild head injury (MHI), but deficits are rarely detected on neuropsychological tests.

Prior research suggests that when MHI participants are informed they may experience cognitive difficulties, they perform worse on neuropsychological tests compared to MHI participants who are uninformed.

“Diagnosis threat” may contribute to the prevalence and persistence of cognitive complaints made by MHI individuals found in the literature, but may not have as strong of an effect on neuropsychological measures.

Other Challenges to Accurate Diagnostic Workups & Effective Intervention
“Diagnosis Threat”


**Abstract**

Persistent cognitive complaints are common following a mild head injury (MHI), but deficits are rarely detected on neuropsychological tests.

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### Problems Arise Because of Misunderstanding

- When there is a low base rate of risk for chronicity, there is reciprocal increased risk of false negatives.
- When there is an incorrectly assumed high base rate for a condition’s persistence, clinicians risk diagnostic false positives.
- Either error is can be costly to the patient, family, insurer, and employer.

### Pathophysiology & Assessment Tools

#### Neurometabolic Cascade of Concussion

![Neurometabolic Cascade of Concussion](image)

From: Giza & Hovda, J of Ath Training, 40 (2) 2017.

#### Glasgow Coma Scale

<table>
<thead>
<tr>
<th>Score</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>15-13</td>
<td>Eye opening to verbal</td>
</tr>
<tr>
<td>12-9</td>
<td>Eye opening to pain</td>
</tr>
<tr>
<td>8-3</td>
<td>No eye opening</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Motor Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5-1</td>
<td>Good to pain</td>
</tr>
<tr>
<td>2-1</td>
<td>Localized to pain</td>
</tr>
<tr>
<td>0</td>
<td>Absent or extensor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Score</th>
<th>Verbal Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>Spontaneous speech</td>
</tr>
<tr>
<td>4</td>
<td>Oriented to one or two stimuli</td>
</tr>
<tr>
<td>3</td>
<td>Oriented only to pain</td>
</tr>
<tr>
<td>2</td>
<td>Inappropriate speech</td>
</tr>
<tr>
<td>1</td>
<td>Incomprehensible</td>
</tr>
<tr>
<td>0</td>
<td>No response</td>
</tr>
</tbody>
</table>

The total score of the three tests added up to determine the patient’s overall condition.
Outcome Predictors: Effect Sizes of Early Data

- Productivity
- Global Outcome
- Quality of Life

ES: 0.2 Small, 0.5 Medium, 0.8 Large; Small ES has large control grp overlap.

Functional Imaging

- Regarding mTBI, the early promises of SPECT and PET for diagnosing persistent mTBI has not been fulfilled.
- "The medical literature is weak scientifically, sparse in quality, lacking in well-designed controlled studies, and currently does not meet the complete standards of Daubert v Merrell Dow..."
- Clear lack of correlation between functional neuroimaging of mTBI and persisting behavior, neuropsychological, or structural imaging deficits.

In Search of a Signature: PET, SPECT, QEEG, MEG, fMRI

<table>
<thead>
<tr>
<th>Procedure, Acute CHI (GCS ≤ 13) and Early Subacute Data</th>
<th>Appropriateness Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Head CT w/o contrast</td>
<td>7</td>
<td>Known low yield</td>
</tr>
<tr>
<td>Cervical XR and/or CT</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>MRI Head w/o contrast</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>MRA head &amp; neck w and/or wo cnt</td>
<td>3</td>
<td>we, Rarely indicated</td>
</tr>
<tr>
<td>CT Head w and w/o cnt</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CTA, head and neck</td>
<td>3</td>
<td>Rarely indicated</td>
</tr>
<tr>
<td>Cerebral Angiography</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>SPECT, PET</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Xenon-enhanced head CT</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>US, transcranial Doppler</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

American College of Radiology Appropriateness Criteria for Neuroimaging: 2012. AR Scale: 1=least appropriate, 4-6=may be, 7-9=usually appropriate.

Predictor Reliability: Under-prediction of Severity When GCS and LOC are Used Alone

- Penetrating wounds
- Some crushing head injuries
- Orbital and basal brain injury
- Nontraumatic brain injury
- Toxic, anoxic and other secondary injury
- Others

Glasgow Outcome Scale by GCS

<table>
<thead>
<tr>
<th>GCS* Severity</th>
<th>Glasgow Outcome Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>Persistent</td>
</tr>
<tr>
<td></td>
<td>vegetative</td>
</tr>
<tr>
<td>Severe&lt;11°</td>
<td>67</td>
</tr>
<tr>
<td>Moderate&lt;2,5°</td>
<td>17</td>
</tr>
<tr>
<td>Mild&lt;3,9°</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>103</td>
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How About with Subacute or Chronic?

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<th>Appropriateness Rating</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>MRI Head w/o contrast</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Head CT w/o contrast</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>SPECT, PET, CT head</td>
<td>4</td>
<td>For selected cases</td>
</tr>
<tr>
<td>MRA head &amp; neck w and/or wo cnt</td>
<td>4</td>
<td>For selected cases</td>
</tr>
<tr>
<td>CTA, head and neck</td>
<td>3</td>
<td>For selected cases</td>
</tr>
<tr>
<td>MRI Head w and w/o cnt</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>CT Head w and w/o cnt</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>MRI head w/o cnt</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Cerebral Angiography</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>US, transcranial Doppler</td>
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DAI?
We’ve heard a lot about that.

- Diffuse axonal injury is a real phenomenon.
- Shearing occurs with more severe injury, but cannot explain all DAI. Axons can tolerate 65% stretch.
- Injury-induced stretching may cause ionic cascade and irreversible damage.
- Grey-white junction injury may signal shearing.
- Patchy injury may signal “diffusion axonal injury” as suggested by Gaetz, 2004.
- These tissue and cell injuries apply to more severe trauma and are difficult to apply to mTBI.


QEEG


- Study of utility of portable QEEG post mTBI
- 28 athletes with mTBI + 28 matched controls
- Baseline QEEG, all subjects, sports concussion design
- Testing at days: 3, 5, 8, 45
- Recovery of Sxs, balance, cognition over week 1
- QEEG ABN at Day 8 and NML at Day 45

Take Home: Physiological evidence of injury and recovery may persist past clinical recovery, but with normal status by or before day 45.

fMRI

Abnormal Resting-State Functional Connectivity as a Marker for Diagnosing and Predicting Recovery in Mild Traumatic Brain Injury.

- Significant abn functional connectivity between brain regions after acute mTBI
- 14 areas of significantly different connectivity at 13 hrs in mTBI group
- Connectivity findings correlate with clinical results (balance, cognition)
- Findings also indicate recovery in connectivity from 13 hrs to 7 wks
- Connectivity abnormalities resolved by 7 wks


fMRI – Another Look

Acute and subacute changes in neural activation during the recovery from sport-related concussion.

- 12 concussed HS athletes, 12 controls.
- Sx ratings, postural balance, cognition.
- Event-related fMRI during working memory.
- Testing at 13 hrs and 7 wks post injury.
- Acutely, at 13 hrs, mTBI group showed R hemisphere attention networks
- Pattern reversed at 7 wks.
- Early gains of attention and PC Sxs may be mediated by compensatory change in the same networks.

Chemistry Biomarkers

Perhaps a Future Tool

“Sports-related concussion…is associated with acute axonal and astroglial injury. This can be monitored using blood biomarkers, which may be developed into clinical tools to guide sports physicians in the medical counseling of athletes in return-to-play decisions.”

Effect Size of mTBI

Effect Size of TBI:
Varied by Severity, Dose-Response

<table>
<thead>
<tr>
<th>Severity Group</th>
<th>n</th>
<th>TFC (SD)</th>
<th>Min.</th>
<th>Median</th>
<th>Max.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1: TFC &lt; 1 hr</td>
<td>166</td>
<td>0.92 (1.15)</td>
<td>-3.24</td>
<td>-0.26</td>
<td>0.20</td>
</tr>
<tr>
<td>Group 2: TFC = 1-2 hrs</td>
<td>100</td>
<td>2.22 (2.49)</td>
<td>-4.47</td>
<td>-2.21</td>
<td>-0.93</td>
</tr>
<tr>
<td>Group 3: TFC = 1-6 days</td>
<td>52</td>
<td>4.05 (2.22)</td>
<td>-9.94</td>
<td>-4.02</td>
<td>-0.99</td>
</tr>
<tr>
<td>Group 4: TFC = 7-11 days</td>
<td>37</td>
<td>0.88 (2.07)</td>
<td>-3.21</td>
<td>-0.86</td>
<td>-0.33</td>
</tr>
<tr>
<td>Group 5: TFC = 12-18 days</td>
<td>52</td>
<td>1.55 (2.47)</td>
<td>-1.67</td>
<td>-1.28</td>
<td>-0.89</td>
</tr>
<tr>
<td>Group 6: TFC = 19-28 days</td>
<td>53</td>
<td>-0.31 (1.45)</td>
<td>-2.86</td>
<td>-0.24</td>
<td>-0.83</td>
</tr>
<tr>
<td>Entire Sample</td>
<td>483</td>
<td>0.82 (1.80)</td>
<td>-3.88</td>
<td>-0.84</td>
<td>-0.26</td>
</tr>
</tbody>
</table>

TFC = Time to Follow Commands
mTBI patients administered the TFC, Dikmen et al., (1995)

Clinical Recovery & Prognosis with mTBI

WHO 2004: 120 “best evidence” mTBI prognosis studies
- Temporary Sx with full recovery in days to weeks in overwhelming majority of children and adults.
- Solid evidence for good prognosis.
- Little evidence for residual cognitive, behavioral or academic impairments.
- Persisting Sx or “PCS” may be due to noninjury/non-TBI conditions or factors, such as demographics, psychosocial, medical, situational, etc.

Natural Course of mTBI

- Functional resolution in ≤ 90 days is the norm.
- Rohling et al., 2011, meta analysis demonstrated an effect size of -0.07. This compares to a change in the WMS-IV of about 1 point, well less than the SEM.
- At effect sizes this small, any cut score chosen on a test to diagnose patients would result in more false positives than true positives. This greatly increases the risk of misdiagnosis in persons who are susceptible to misattribution, expectancy effects, and “diagnosis threat,” thereby increasing the risk of iatrogenic illness.
But!!! In My Experience!

• Case studies/observation are important sources of theory that can then be subjected to independent review and experimentally tested.
• High risks of selection bias, confirmation bias…
• Limitations to generalization of results, especially when contradicted by voluminous peer reviewed literature.
• “Exceptional cases” left in our file cabinets (Oops, sorry, many now use electronic records), *do not contribute to our shared knowledge base or advance the reliability of our opinions.*

Complicated mTBI

Now, That’s Another Matter!

• Definition
  o In the original definition (Williams, Levin, Eisenberg, 1990): Differentiated by the presence of (a) a depressed skull fracture or (b) a traumatic intracranial abnormality (e.g., hemorrhage, contusion, or edema). Other researchers have dropped the depressed skull fracture from the criteria.
  o Some are more like moderate and severe TBI.
  o Variable presentation, based on nature of injury.
  o These may account significantly for the “exceptions.”
  o This too, a large range.

mTBI may =

• Olfactory function decrement or loss
• Pituitary hormone dysfunction
• Accompanied by PTSD, phobia, other anxiety
• Accompanied by acute-stage secondary injury such as hemorrhage

Incidence and Outcome of Complicated mTBI

<table>
<thead>
<tr>
<th>First author</th>
<th>Year</th>
<th>Country</th>
<th>Total N</th>
<th>Number Scanned</th>
<th>GCS scores</th>
<th>% Abnormal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Livingston</td>
<td>1991</td>
<td>USA</td>
<td>111</td>
<td>111</td>
<td>14-15</td>
<td>14</td>
</tr>
<tr>
<td>Steen</td>
<td>1992</td>
<td>USA</td>
<td>1,518</td>
<td>1,518</td>
<td>13-15</td>
<td>17.2</td>
</tr>
<tr>
<td>Jones</td>
<td>1995</td>
<td>USA</td>
<td>712</td>
<td>702</td>
<td>15</td>
<td>8.4</td>
</tr>
<tr>
<td>Menon</td>
<td>1996</td>
<td>USA</td>
<td>300</td>
<td>96</td>
<td>13-15</td>
<td>8.3</td>
</tr>
<tr>
<td>Beattie</td>
<td>1997</td>
<td>USA</td>
<td>1,448</td>
<td>1,448</td>
<td>13-15</td>
<td>8.2</td>
</tr>
<tr>
<td>Iverson</td>
<td>2000</td>
<td>USA</td>
<td>912</td>
<td>912</td>
<td>13-15</td>
<td>15.8</td>
</tr>
<tr>
<td>Duyzeppele</td>
<td>2004</td>
<td>India</td>
<td>381</td>
<td>381</td>
<td>13-15</td>
<td>38.8</td>
</tr>
<tr>
<td>Staal</td>
<td>2005</td>
<td>Canada</td>
<td>2,707</td>
<td>2,717</td>
<td>13-15</td>
<td>12.1</td>
</tr>
<tr>
<td>Staal</td>
<td>2005</td>
<td>Canada</td>
<td>1,822</td>
<td>1,822</td>
<td>15</td>
<td>8.0</td>
</tr>
<tr>
<td>Owen</td>
<td>2007</td>
<td>Japan</td>
<td>1,064</td>
<td>1,064</td>
<td>14-15</td>
<td>4.7</td>
</tr>
<tr>
<td>Sobott</td>
<td>2007</td>
<td>France</td>
<td>682</td>
<td>682</td>
<td>15</td>
<td>6.7</td>
</tr>
</tbody>
</table>

The Miserable Minority: 15% Who Don’t Do Well

• From where did this number come?
• Contaminated research data?
  o Mixed injury severity
  o Invalid/unreliable data
  o Mixed collateral conditions
• Myth, lore?
• Expectation based on provider preconceptions?
• Patient noninjury and factors?
• Psychological and nonneurological factors?

Uncomplicated mTBI ≠

Logical Fallacies: Association Does Not Imply Causation

• Long term functionally significant changes in cognitive performance
• Rude and discourteous behavior toward providers, insurance carriers, family, public safety, public…
• Spousal or child abuse
• Personality disorders
• Alcohol or substance abuse
• Long term morbidity
• Loss of general employability
• Chronic light and/or sound sensitivity?
Validity Assessment

The Problems of Symptom & Performance Validity
- Neuropsychological Assessment (NA) is the best method for identifying cognitive functional capacity
- Reporting and performance measures rely on accuracy and adequate effort to show capacity
- Poor effort reduces NA performance more than does severe TBI
- Good effort on NA cannot be reliably determined by observation alone
- Specialized assessment of accuracy and effort are recognized requirements* of reliable NA

*See policy statements of the NAN and AACN.

Effect of Effort on Neuropsychological Testing

Does Litigation Affect Presentation?

Validity Checks for Neuropsychological Tests: Performance on 9 Internal Validity Measures

Sorry, Yes.

Litigation Does Correspond to Presentation

But…Does Matter if The Examinee was Plaintiff or Defense Referred

There was no significant difference on any test variable or Domain level.

"...although those failing SVTs produced markedly lower test performance and reported more psychological symptoms in comparison to those passing SVTs, there were no differences between plaintiff or defense referrals on test performance for those failing SVTs."

Overall failure was 14%, utilizing very conservative cutoffs set to produce no false positives.
Is Poor Effort a NP ‘Thing’ Alone?

Thirty-six consecutive medical-legal clients were administered well-researched standard symptom validity tests during the course of standardized assessment. Results revealed a failure rate on SVTs of 48%, indicating other occupational therapy formal cognitive or psychosocial test results within those assessments were invalid.

These findings are in keeping with a vast international body of research on use of symptom validity measures. The authors recommend implementation of symptom validity measures in all cognitive and psychosocial test situations.

There is no reason to consider that unreliable complaints are not presented also to physicians, speech therapy, and other providers.


Bottom Line:
Remote mTBI ≠ SVT Failure

- Passing, perfect and near perfect on 2 major tests.
- Age 9 female, IQ of 50.
- High dose BDZ.
- Chronic seizure.

Remote mTBI ≠ SVT Failure


In Short, Beware of…

- Nonspecific and unreliable complaints.
- Reductionism, proposing injuries invisible to science.
- Expansionism, “a” cause of interest, where multiple or other causes are more likely.
- Models of mTBI treatment or management that are based on moderate to severe TBI.
- Junk science, mixing science with speculation presented as fact.
- Conceptualization of mTBI prevalence based on misapplied literature.
- Failure to account for and address factors that can account for persisting complaints.

Curious but True!
The Invisible Helmet

Creative Ideas That Work.
http://www.hovding.com/en/

Prevention

- Prevention of Injury
- Prevention of Iatrogenics
  - “Diagnosis Threat”
  - Medication effects
  - Unnecessary restrictions
  - “Diagnosis creep”

Everyone Needs to Know

With the Thrills Come Extreme Risks - NYTimes.com

BY JANE E. BRODY

Overconfidence and a lack of training and a habit of not wearing safety gear, especially helmets, help cause more than 40,000 head and neck injuries nationally a year in sports like skateboarding.
Encourage Use of mTBI Screening Guidelines

- Peritrauma data (LOC, GCS at 30 minutes, PTA, RA, Neuro-medical findings, radiology, LOS).
- Acute confounds: Medications, stress, pain, etc.
- History: Medical, habits, psychosocial, educational, recreational, legal, culture and language.
- Collateral injury and chronic medical conditions.
- Gather thorough symptom reports, vetted for diagnostic significance.
- Symptom validity.
- Differential diagnosis.

Use of Standardized and Systematic Protocols

- Acute Concussion Evaluation (ACE).
- Injury characteristics, peritrauma data.
- Organized "review of relevant systems": Physical, cognitive, emotional, sleep.
- Risk factors for recovery: Prior TBI, HA history, developmental, psychiatric.
- Red flags.
- Diagnostic outline.
- Follow-up Action Plan.
- Useful outline for acute and post-acute review.
- Aids in comparison over time.
- Part of the "Heads Up: Brain Injury in Your Practice" developed for CDC.

Intervention

- Provide information — correct misinformation.
- Accurately classify secondary injury (vestibular, cervical, pain-related, sleep).
- Identify and intervene: Signs, risks of somatization.
- Identify other psychological factors.
- Occupational Problem.
- Phase of Life Problem.
- "The M-word."

Intervention: MCHI — Mild Closed Head Injury

- Yes! We made a useful change of diagnosis.
- A head includes a brain, but much more.
- Consider the likely scope of injury.
- Attend to objective information.
- Do not dismiss subjective reports.
- Consider a "moving target" diagnosis.
- Some MCHI injuries are expected to be static vs dynamic.
- Some may be acute-onset > later onset.
- Most have a reasonably expected natural course.

Practical Model for Intervention

- Knowledgeable providers - MCHI
- Accurate and thorough assessment, early on
- Medically and neuropsychological appropriate education and reassurance
- Appropriate early monitoring and mobilization plan
- Avoid: Diagnosis threat, iatrogenics, misinformation
- Identify and address collateral conditions
- Identify/address: Psychosocial stresses, and, deep
- Identify/address: Noncompliance, unreliable Sxs
- GOAL → RECOVERY

Not New, Just Underappreciated

- Brief cognitive behavioral interventions in mild traumatic brain injury.
- Abstract: Postconcussion syndrome is a common and persisting consequence of mild traumatic head injury. The development of treatments for the syndrome has been hampered by a lack of consensus in diagnostic criteria, confusion about the relative contribution of psychological and neurologic etiological factors, and a paucity of controlled treatment outcome studies.
- Studies in adults and children suggest that although symptoms may initially have a neurologic basis, the syndrome persists because of psychological factors. Brief psychological treatment appears to significantly reduce the severity and duration of symptoms following mild head injury. The attribution of persisting symptoms to organic factors conversely appears to be iatrogenic.
What About Speech & Cognitive Therapy For mTBI?

- If effect sizes are at levels well within normal variation, how is Rx planned and outcome measured?
- Problem: Protocols are often based on models for moderate to severe TBI.
- Problem: Rx often is given greater intensity than psychosocial intervention and differential asset.
- Symptom validity is rarely assessed and addressed.
- Overtreatment risks “diagnosis threat” and reinforcement of false perception of impairment.
- Consider an emphasis on education and management.

How About Brain Training Games?

- First, mTBI is a time-limited condition.
- Also, rigorous cognitive tasks is inconsistent with temporary reduction of cognitive stress.
- There is no well-accepted evidence that brain training games produce generalizeable cog benefits.
- Likely short-term, highly specific performance gains without true change in cognitive baseline.
- If these offer an enjoyed diversion and stress relief, great: Lumosity, CogniFit, CogMed, Jungle Memory.

Are our healthcare resources allocated on the basis of science?

- Are we providing patient and provider education?
- Are we allocating sufficient provider time and services to address collateral conditions and to otherwise limit high-risks of inappropriate utilization?
- Are we relying on science vs. myths to understand a complex condition?
- Are we ….

Vestibular Rehab Training

- If medically indicated.
- Subjective complaints may include: Dizziness, impaired balance (particularly in the dark), blurry vision, difficulty focusing, motion discomfort, height phobia, difficulty/discomfort in busy visual environments.
- Important to differentiate from “brain injury”

What About Neuro…psychological Assessment?

- Select the practitioner who can best assess and address the diagnostic and intervention dilemma.
- What is the neuropsychological profile for mTBI?
- Neurocognitive vs psychological profiles?
- When is it too early or too late for NP assessment?
mTBI: Neuropsychological Condition

- Chose the appropriate neuropsychologist specialist.
  - American Board of Professional Neuropsychology
  - American Board of Clinical Neuropsychology
  - American Board of Pediatric Neuropsychology
  - Providers with high quality experience and outcome results
- Chose the appropriate MCHI specialist.
  - Physical Medicine & Rehabilitation
  - Sports Medicine, Others
- Others with specialist services for MCHI

Summary

- MCHI is a complex diagnostic challenge/puzzle.
- mTBI (uncomplicated) has a very positive prognosis in all but rare cases.
- Complicated mTBI may have features of moderate severity injury, usually isolated.
- Accurate early assessment can be critical to limiting risks of diagnosis threat and iatrogenics.
- Baseline neuropsychological functioning, psychosocial factors and secondary gain must be considered.
- Knowledgeable providers and case managers is key.

Resources

- Sports neuropsychology centers and research (e.g., ImPACT).
- Medical research centers.
- CDC.
- Skilled Providers.

Thank You