TBI Severity & Evaluation Tools

Cherry Junn, MD
March 10th 2017
Learning Objectives

• Define TBI severity using GCS
• Identify cognitive functional level after TBI using Rancho Los Amigos level
• Assess PTA using GOAT and O-Log
• Describe major findings of the amantadine trial
Learning Objectives

• List key parameters of:
  – Glasgow Coma Scale (GCS)
  – Galveston Orientation & Amnesia Test (GOAT)
  – Level of Cognitive Functioning Scale (Rancho)
  – Disability Rating Scale (DRS)
Case

• Mr. TBI is a 25 yo office manager who was in a MVC 2 weeks ago
  – Speed was 45mph
  – LOC 5 minutes
  – Initial head CT with right frontal IPH, left occipital small SDH, diffuse petechial hemorrhage
  – Reports dizziness, headaches, irritability, sleep changes, and cognitive impairment
Case - Common Mechanisms

• Is his mechanism of injury common or uncommon for his age?
  – YES
  – NO
Answer
Clinical Diagnosis of TBI
Diagnose TBI – **clinical diagnosis**

1) Reasonable mechanism of injury

1) LOC / Dazed / Amnesia at the time of injury

1) Objective neuro/psychological abnormalities

→ Differentiate from whiplash
Reasonable Mechanism of Injury

• Blunt Trauma
• Penetrating Trauma
• Acceleration/deceleration
  – MVC
  – Collision (sports, transportation injuries)
• (Blast)
Case

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  - Speed was 45mph
  - LOC 5 minutes
  - Initial head CT with right frontal IPH, left occipital small SDH, diffuse petechial hemorrhage
  - Reports dizziness, headaches, irritability, sleep changes, and cognitive impairment
Case - Diagnosis

• Did Mr. TBI have a TBI?
  – What is his mechanism of injury?
  – What suggests change in consciousness?
  – Where were his neuro/psych/behavioral symptoms and signs?
Determining TBI Severity
## TBI Severity

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Mild</th>
<th>Moderate</th>
<th>Severe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Structural imaging</td>
<td>Normal</td>
<td>Normal or abnormal</td>
<td>Normal or abnormal</td>
</tr>
<tr>
<td>Loss of consciousness</td>
<td>&lt;30 minutes</td>
<td>30 minutes to 24 hours</td>
<td>&gt;24 hours</td>
</tr>
<tr>
<td>Post traumatic amnesia</td>
<td>0-1 day</td>
<td>&gt;1 and &lt;7 days</td>
<td>&gt;7 days</td>
</tr>
<tr>
<td>Glasgow Coma Scale score (best available score in 24 hours)</td>
<td>13-15</td>
<td>9-12</td>
<td>3-8</td>
</tr>
<tr>
<td>Abbreviated Injury Scale score: Head</td>
<td>1-2</td>
<td>3</td>
<td>4-6</td>
</tr>
</tbody>
</table>

Source: Brasure et al., 2012

** TBI Severity Using GCS **

• **Mild: 13-15**
  – Mild-complicated: 13-15 with CT or MRI findings

• **Moderate: 9-12**

• **Severe: 3-8 = Coma**
  • Intubate
### Glasgow Coma Scale and Pediatric Glasgow Coma Scale

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye opening</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
<td>4</td>
</tr>
<tr>
<td>To command</td>
<td>To sound</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>To pain</td>
<td>To pain</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Verbal response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oriented</td>
<td>Age-appropriate localization, smile, or orientation to sound, interests (e.g., babbling), follows objects</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Confused, disoriented</td>
<td>Cries, irritable</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Inappropriate words</td>
<td>Cries to pain</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Incomprehensible sounds</td>
<td>Means to pain</td>
<td></td>
<td>2</td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Motor response</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obeys commands</td>
<td>Spontaneous movements (obeys verbal command)</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Localizes pain</td>
<td>Withdraws to touch (localizes pain)</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Withdraws</td>
<td>Withdraws to pain</td>
<td></td>
<td>4</td>
</tr>
<tr>
<td>Abnormal flexion to pain</td>
<td>Abnormal flexion to pain (decorticate posture)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Abnormal extension to pain</td>
<td>Abnormal extension to pain (decrebrate posture)</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>None</td>
<td>None</td>
<td></td>
<td>1</td>
</tr>
</tbody>
</table>

**Best total score**

15

The Glasgow coma scale (GCS) is scored between 3 and 15, 3 being the worst, and 15 the best. It is composed of three parameters: best eye response (E), best verbal response (V), and best motor response (M). The components of the GCS should be recorded individually; for example, E2V3M4 results in a GCS of 9. A score of 13 or higher correlates with mild brain injury; a score of 9 to 12 correlates with moderate injury; and a score of 8 or less represents severe brain injury. The pediatric Glasgow coma scale (PGCS) was validated in children 2 years of age or younger.

Data from:
GCS

• Predictive: **best motor response** is the most valuable/predictive acutely, especially if overt decorticate/decerbrate posturing is seen.

Case - Severity

After resuscitation he:

– Opens eyes to pain

– He is able to use exclamatory articulated speech, but no conversational exchange. Speaks words but no sentences

– Withdraws from pain

• What is his GCS score?

A. 10
B. 9
C. 8
D. 7
Case question

• What is his injury severity based on his GCS?
  A. Mild
  B. Mild-complicated
  C. Moderate
  D. Severe
Post-traumatic amnesia

• Most commonly used predictors of functional outcome and is associated with DAI\(^1\)

• What correlates with resolution of PTA clinically?

# TBI Severity Using PTA

<table>
<thead>
<tr>
<th>Duration of PTA</th>
<th>Severity</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 5 minutes</td>
<td>Very mild</td>
</tr>
<tr>
<td>5-60 minutes</td>
<td>Mild</td>
</tr>
<tr>
<td>1-24 hours</td>
<td>Moderate</td>
</tr>
<tr>
<td>1—7 days</td>
<td>Severe</td>
</tr>
<tr>
<td>1-4 weeks</td>
<td>Very severe</td>
</tr>
<tr>
<td>&gt; 4 weeks</td>
<td>Extremely severe</td>
</tr>
</tbody>
</table>
GOAT

• Assess both remote memories, time of injury memories, and post-injury memories
• Score ranging from -3 to 100
• PTA ends when GOAT scores are greater than 75 for two consecutive trials, 24 hours apart beginning at the end of the coma
# TABLE 78-3. The Galveston Orientation and Amnesia Test

| Name ___________________________ | Date of test ___________________________
| Age __________ | Sex M F | Day of the week S M T W T F S |
| Date of birth ___________________________ | Time __________ | A.M. P.M. |
| Diagnosis ___________________________ | Date of injury ___________________________ |

1. What is your name? (2) ___________________________ Error points ______
   When were you born? (4) ___________________________
   Where do you live? (4) ___________________________

2. Where are you now? (5) (City) ___________________________
   Hospital (5) (unnecessary to state name of hospital) ___________________________

3. On what date were you admitted to this hospital? (5) ___________________________
   How did you get here? (5) ___________________________

4. What is the first event you can remember after the injury? (5) ___________________________
   Can you describe in detail (e.g., date, time, companions) the first event you can recall after the injury? (5) ___________________________

5. Can you describe the last event you recall before the accident? (5) ___________________________
   Can you describe in detail (e.g., date, time, companions) the first event you can recall before the injury? (5) ___________________________

6. What time is it now? (1 point for each half hour removed from current time to a maximum of 5 points) ___________________________

7. What day of the week is it? (1 point for each day removed from the correct day) ___________________________

8. What day of the month is it? (1 point for each day removed from the correct day to a maximum of 5 points) ___________________________

9. What is the month? (5 for each month removed from the correct month to a maximum of 15 points) ___________________________

10. What is the year? (10 for each year removed from the correct year to a maximum of 30 points) ___________________________

Total error points ___________________________
Total score (100 minus total error points) ___________________________
Case - Post-traumatic amnesia

• His GOAT score today is 78, is Mr. TBI out of PTA?
Orientation-Log (O-Log)

- Like the GOAT, also focuses on disorientation and amnestic symptoms
- Puts more equal weight into scored items and reduces difficulty verifying some responses.
- **2 consecutive scores of 25 and higher** indicate resolution of PTA
# O-Log

## The Orientation Log (O-Log)

<table>
<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>City</th>
<th>Kind of Place</th>
<th>Name of Hospital</th>
<th>Month</th>
<th>Date</th>
<th>Year</th>
<th>Day of Week</th>
<th>Clock Time</th>
<th>Etiology/Event</th>
<th>Pathology Deficits</th>
</tr>
</thead>
</table>

**Key:**
- 3 = spontaneous/free recall
- 2 = logical cuing
- 1 = multiple choice, phonemic cuing
- 0 = unable, incorrect, inappropriate

http://www.tbims.org/combi/olog/olograt.html
Question

Which of the following case is unlikely to result in severe disability after TBI?

A. Post-traumatic amnesia (PTA) greater than 3 months
B. Age > 65 years
C. Age < 5 years
D. PTA less than 2 months
E. Impaired doll’s eye sign
Functional Prognosis Mod-Severe TBI

- **Threshold values** $\rightarrow$ what’s *unlikely* to happen

  - **Severe disability** *unlikely*
    - Time to follow commands less than 2 weeks
    - Duration of PTA less than 2 months
  
  - **Good recovery** *unlikely*
    - Time to follow commands more than 4 weeks
    - Duration of PTA more than 3 months
    - 65+ years old and less than 5 years old
TBI Outcome Studies → GOS

• 1 = DEAD
• 2 = VEGETATIVE STATE
  Unable to interact with environment; unresponsive
• 3 = SEVERE DISABILITY
  Able to follow commands/ unable to live independently
• 4 = MODERATE DISABILITY
  Able to live independently; unable to return to work or school
• 5 = GOOD RECOVERY
  Able to return to work or school

http://www.tbims.org/combi/gos/index.html
Mortality / Vegetative

Jennet (1979)
• GCS 3-4: death or vegetative in 87%
• GCS 5-7: death of vegetative in 53%

McMillan (2011) and other cohort studies
• 30% mortality in severe TBI
• Increased mortality 13 years post injury
Mod-Severe TBI: Trends to worse outcome

- Lower GCS
- Longer duration of coma
- Longer PTA
- Older age
- Deeper lesions on imaging
- Fixed pupils

- Associated injuries
- Hypotension
- Hypoxia
- Pyrexia
- Elevated ICP
- Bleeding issues
COAT

- The Children's Orientation and Amnesia Test: relationship to severity of acute head injury and to recovery of memory.
- Ewing-Cobbs L, Levin HS, Fletcher JM, Miner ME, Eisenberg HM.
- Source
  Department of Pediatrics, University of Texas Medical School, Houston.
- Abstract
  The Children's Orientation and Amnesia Test (COAT) was developed to assess cognition serially during the early stage of recovery from traumatic brain injury in children and adolescents. The norms for the COAT, which is composed of 16 items evaluating general orientation, temporal orientation, and memory, were defined from data obtained from 146 children aged 3 to 15 years. In 37 patients with head injuries, the duration of posttraumatic amnesia, as indicated by the number of days COAT scores were in the impaired range, was significantly related to both verbal and nonverbal memory at the baseline and 6 and 12 months after injury. COAT scores were a better predictor of verbal and nonverbal memory performance than the Glasgow Coma Scale score at 6 and 12 months after the injury. This study shows that the COAT has adequate reliability and validity as a measure of the duration of posttraumatic amnesia in children and adolescents.
- PMID2259396
Rancho Los Amigos Level of Cognitive Function Scale

• Scale to help interpret the cognitive behavioral recovery process after a brain injury
• Ranges from I to VIII
• Lower score indicates a more severe impairment of consciousness
## Rancho Los Amigos Scale

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>No response</td>
</tr>
<tr>
<td>II</td>
<td>Generalized response</td>
</tr>
<tr>
<td>III</td>
<td>Localized responses</td>
</tr>
<tr>
<td>IV</td>
<td>Confused – agitated</td>
</tr>
<tr>
<td>V</td>
<td>Confused – inappropriate</td>
</tr>
<tr>
<td>VI</td>
<td>Confused – appropriate</td>
</tr>
<tr>
<td>VII</td>
<td>Automatic – appropriate</td>
</tr>
<tr>
<td>VIII</td>
<td>Purposeful and appropriate</td>
</tr>
</tbody>
</table>

http://www.tbims.org/combi/lcfs/lcfs.pdf
http://www.rancho.org/research_rancholevels.aspx
Level of Cognitive Functioning Scale

I - No response
II - Generalized
III - Localized
IV - Confused-agitated
V - Confused, inappropriate, non-agitated
VI - Confused-appropriate
VII - Automatic-appropriate
VIII - Purposeful-appropriate
Case - Rancho

• Now Mr. TBI shows bizarre, nonpurposeful, incoherent or inappropriate behaviors, has no short-term recall, attention is short and nonselective

• What Rancho level of cognitive functioning would you label him with?
  A. III
  B. IV
  C. V
  D. VI
Identifying Rancho Level

- A different patient who sustained a severe TBI 3 weeks ago gives random, fragmented, and nonpurposeful responses to complex or unstructured stimuli. She is able to follow simple commands consistently though her memory and selective attention are impaired. She cannot retain new information.

- What is her rancho level?
Identifying Rancho Level

• Another patient who sustained severe TBI behaves appropriately in familiar setting and able to perform daily routines automatically.
• She is able to carry-over for new learning at lower than normal rates.
• She initiates social interactions, but judgment remains impaired.
• What is her rancho level?
### Ranchos Levels of Cognitive Functioning Scale

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level I—No Response.</strong></td>
<td>Patient does not respond to external stimuli and appears asleep.</td>
</tr>
<tr>
<td><strong>Level II—Generalized Response.</strong></td>
<td>Patient reacts to external stimuli in nonspecific, inconsistent, and nonpurposeful manner with stereotypic and limited responses.</td>
</tr>
<tr>
<td><strong>Level III—Localized Response.</strong></td>
<td>Patient responds specifically and inconsistently with delays to stimuli, but may follow simple commands for motor action.</td>
</tr>
<tr>
<td><strong>Level IV—Confused, Agitated Response.</strong></td>
<td>Patient exhibits bizarre, nonpurposeful, incoherent, or inappropriate behaviors, has no short-term recall, and attention is short and nonselective.</td>
</tr>
<tr>
<td><strong>Level V—Confused, Inappropriate, Nonagitated Response.</strong></td>
<td>Patient gives random, fragmented, and nonpurposeful responses to complex or unstructured stimuli. Simple commands are followed consistently, memory and selective attention are impaired, and new information is not retained.</td>
</tr>
<tr>
<td><strong>Level VI—Confused, Appropriate Response.</strong></td>
<td>Patient gives context-appropriate, goal-directed responses, dependent on external input for direction. There is carry-over for relearned, but not for new tasks, and recent memory problems persist.</td>
</tr>
<tr>
<td><strong>Level VI—Automatic, Appropriate Response.</strong></td>
<td>Patient behaves appropriately in familiar settings, performs daily routines automatically, and shows carry-over for new learning at lower than normal rates. Patient initiates social interactions, but judgment remains impaired.</td>
</tr>
<tr>
<td><strong>Level VIII—Purposeful, Appropriate Response.</strong></td>
<td>Patient is oriented and responds to the environment but abstract reasoning abilities are decreased relative to premorbid levels.</td>
</tr>
</tbody>
</table>
Quest for Neuro-recovery
Placebo-Controlled Trial of Amantadine for Severe Traumatic Brain Injury

Joseph T. Giacino, Ph.D., John Whyte, M.D., Ph.D., Emilia Bagiella, Ph.D., Kathleen Kalmar, Ph.D., Nancy Childs, M.D., Allen Khademi, M.D., Bernd Eifert, M.D., David Long, M.D., Douglas I. Katz, M.D., Sooja Cho, M.D., Stuart A. Yablon, M.D., Marianne Luther, M.D., Flora M. Hammond, M.D., Annette Nordenbo, M.D., Paul Novak, O.T.R., Walt Mercer, Ph.D., Petra Maurer-Karattup, Dr.Rer.Nat., and Mark Sherer, Ph.D.
Amantadine

- 184 subjects
  - minimally conscious or vegetative
- 4-16 weeks after TBI
- Amantadine or placebo for 4 weeks
  - Followed for another 2 weeks

“Amantadine accelerated the pace of functional recovery during active treatment”
Other Key Scales...

http://www.tbims.org/combi/list.html
Disability Rating Scale (DRS)

• “From coma to community”
  – Less helpful reflecting recovery course in mTBI

• Higher score better
  – Max 30

• 8 categories
  – Eye opening
  – Communication
  – Motor Response
  – Feeding
  – Toileting
  – Grooming
  – Levels of Function
  – Employability

http://www.tbims.org/combi/drs/index.html
Scales for Assessing Disorders of Consciousness

• Coma Near Coma (CNC) Scale:
  – 11 item scale designed to measure small changes in response those functioning at low level after severe brain injury

• JFK Coma Recovery Scale-Revised (CRS-R)
  – 23 item scale assessing auditory, visual, motor, oromotor, communication, and arousal
Questions?
THANK YOU!
References and Readings


Supplement:
Disorders of Consciousness
# Disorders of Consciousness

<table>
<thead>
<tr>
<th></th>
<th>Sleep Cycles</th>
<th>Eye Opening</th>
<th>Follow Commands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vegetative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minimally conscious</td>
<td></td>
<td></td>
<td></td>
</tr>
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</table>
# Disorders of Consciousness

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<td>-</td>
</tr>
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<td>Vegetative</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Minimally conscious</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>