ASSESSMENT TECHNIQUES FOR INDIVIDUALS WITH DISORDERED CONSCIOUSNESS

Ann Guernon, MS CCC-SLP, CCRC
Clinical Research Coordinator
Marianjoy Rehabilitation Hospital

Julie Fuiith-Costa, MS CCC-SLP
TBI Program Specialist
Rehabilitation Institute of Chicago
OBJECTIVES

- To develop an understanding of the Disorders of Consciousness Scale (DOCS) for evaluation of persons in unconscious states including:
  - Background into the DOCS
  - Response interpretation and scoring
  - Utilization of DOCS for prognostic & clinical application
SEVERE TBI STATISTICS

- Incidence of Severe TBI is approximately 14 cases per 100,000 (E-Medicine.com)

- Average survival for a person in a state of disordered consciousness for one year or more is 10 years. (Ansell, 1989)
SEVERE TBI STATISTICS

- Estimates of lifetime long-term care costs for a non-independent survivor of severe TBI may be close to 9 million dollars (Papstrat, 1992)

- Persons who suffer a severe TBI continue to make gradual improvements in function for at least 10 years post-injury. (Sbordone, 1995)
CONSEQUENCES OF SEVERE BI

Laureys, Scientific American, 2007
www.comasciencegroup.com
COMA

- A state of unarousable neurobehavioral responsiveness
- No evidence of eye opening either spontaneous or in response to stimulation
- Do not follow commands, demonstrate volitional behavior, nor verbalize/mouth words
- Lack of sleep-wake cycles
VEGETATIVE STATE (VS)

- State of arousal without behavioral evidence of awareness of self or capacity to interact with the environment
- Rudimentary arousal/orienting responses and sleep-wake cycles (major distinction from Comatose)
- May have spontaneous eye opening, purposeless eye movements, blinking, and trunk or limb movements when awake

Guernon & Fuith-Costa, ASHA 2009
MINIMALLY CONSCIOUS STATE (MCS)

- A condition in which minimal but definite behavioral evidence of self or environmental awareness is demonstrated
  - Simple command following
  - Gestural or verbal yes/no response (regardless of accuracy)
  - Intelligible verbalization
  - Movement or affective behaviors that occur in relation to environmental stimuli and aren’t reflexive.
- Transition may be subtle
## Behavioral Features of Coma, Vegetative, and Minimally Conscious States

Adapted from: Taylor et al, 2007

<table>
<thead>
<tr>
<th>Behavior</th>
<th>Comatose</th>
<th>VS</th>
<th>MCS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye Opening</td>
<td>None</td>
<td>Spontaneous</td>
<td>Spontaneous</td>
</tr>
<tr>
<td>Spontaneous</td>
<td>None</td>
<td>Reflexive/Patterned</td>
<td>Automatic/Object Manipulation</td>
</tr>
<tr>
<td>Movement</td>
<td>None</td>
<td>Automatic/Object Manipulation</td>
<td></td>
</tr>
<tr>
<td>Response to Pain</td>
<td>Posturing/None</td>
<td>Posturing/Withdrawal</td>
<td>Localization</td>
</tr>
<tr>
<td>Visual Response</td>
<td>None</td>
<td>Startle/Pursuit (rare)</td>
<td>Object Rec./Pursuit</td>
</tr>
<tr>
<td>Affective</td>
<td>None</td>
<td>Random</td>
<td>Contingent</td>
</tr>
<tr>
<td>Response</td>
<td>None</td>
<td>None</td>
<td>Inconsistent</td>
</tr>
<tr>
<td>Commands</td>
<td>None</td>
<td>None</td>
<td>Intelligible Words</td>
</tr>
<tr>
<td>Verbalization</td>
<td>None</td>
<td>Random Vocalization</td>
<td></td>
</tr>
</tbody>
</table>
RECOVERY OF CONSCIOUSNESS

- Research Definition
  - Reliable and consistent demonstration of one of the following:
    - Functional interactive communication
    - Functional use of one or more objects
    - Behavioral manifestation of a sense of self in the environment
RECOVERY OF CONSCIOUSNESS

- Aspen Criteria
  - Reliable and consistent interactive communication
    - Accurate yes/no responses to six of six basic situational questions on 2 consecutive evaluations (can be via speech, writing, yes/no signals, or AAC)
  - OR
  - Functional object use
    - Appropriate use of at least 2 functional objects on 2 consecutive evaluations

Consciousness

Laureys, Trends in Cognitive Sciences, 2005

www.comascience.org
<table>
<thead>
<tr>
<th></th>
<th>Clinical Neuropsychologists</th>
<th>Speech Language Pathologists</th>
<th>Neuropsychologist &amp; SLP Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Currently Working with VS/MCS</td>
<td>32% (n=21)</td>
<td>60% (n=55)</td>
<td></td>
</tr>
<tr>
<td>Use Standardized Assessment Tools for Initial Evaluation</td>
<td>57% (n=8)</td>
<td>30% (n=13)</td>
<td></td>
</tr>
<tr>
<td>Identify 4-5 diagnostic features of VS</td>
<td></td>
<td></td>
<td>3% (n=184)</td>
</tr>
<tr>
<td>Identify 2 or more diagnostic features of MCS</td>
<td></td>
<td></td>
<td>17% (n=184)</td>
</tr>
</tbody>
</table>

PROBLEM

- Inadequate measures of neurobehavioral functioning in low level neurological states
  - Clinical Implications
    - Course and rate of neurological recovery
  - Caregiving Implications
    - Discharge planning, resource planning
  - Research Implications
    - Outcomes: Recovery of consciousness, long-term functional outcomes
    - Intervention Effectiveness/Measure of Treatment Effect

Guernon & Fuith-Costa, ASHA 2009
DISORDERS OF CONSCIOUSNESS SCALE (DOCS)

- Developed to detect subtle changes in observable indicators of neurobehavioral functioning to:
  - Measure Neurobehavioral Functioning at one point in time
  - Measure Changes in Neurobehavioral Functioning
  - Define the course of Neurobehavioral Recovery Following Severe Brain Injury

Guernon & Fuith-Costa, ASHA 2009
DOCS RELIABILITY & VALIDITY

- Inter-rater reliability between disciplines - high level of agreement
- Validity: 23 of 34 test stimuli remain stable over time with no floor or ceiling effect
- DOCS measures obtained within 94 days of injury predicted recovery of consciousness up to 1 year after injury

The administration of test stimuli and interpretation of responses to test stimuli is conducted across disciplines
- Not by disciplines
- Elicit Best Response Profile

Accurate measurement of Neurobehavioral Functioning is essential because Coma, VS, and MCS are each associated with different:
- Prognosis
- Treatment needs (level, intensity)
- Outcomes
DOCS EVALUATION SESSION

- 40 - 60 minute administration time
- Baseline Observation Protocol
- 23 Test Stimuli/Items
  - 3 Point Rating Scale
    - No Response
    - General Response
    - Localized Response

Guernon & Fuith-Costa, ASHA 2009
CREATING AN OPTIMAL TESTING ENVIRONMENT

- Post “Do Not Disturb” sign
- Close the door
- Eliminate unpredictable noises (e.g., TV, radio, intercom, phone)
- Diminish bright lights (e.g., close or partially close blinds if sunlight is exceptionally bright)
- Avoid inadvertent tactile & auditory stimulation
- Re-position throughout the test as needed

Guernon & Fuith-Costa, ASHA 2009
POSITIONING & RE-POSITIONING
GENERAL RULES

- Discrimination between abnormal postural responses (e.g., flexion, extension patterns) and a true response to the test stimuli
- Good positioning breaks up spastic patterns and inhibits extension
- Remove splints and restraints if permitted
- **STOP** and **RE-POSITION** throughout the evaluation; always wait 20-30 seconds before administering test stimuli after re-positioning.
POSITIONING GUIDELINES

- Right angles are best

- At the side of mat or bed:
  - Feet should be flat
  - Knees should be level with hips
  - Trunk should be supported
  - Head should be held upright
  - Arms should be bent/flexed at elbow

Guernon & Fuith-Costa, ASHA 2009
POSITIONING GUIDELINES (CONT...)

- **Sitting in chair:**
  - Feet should be placed in the foot pedestals
  - Head should be upright, at midline and supported,
  - Arms should be on the arm rests
  - Trunk should be at midline and supported to maintain midline position

- **Laying Supine (bed or mat):**
  - Elevate head of bed to between 45 and 90 degrees
  - Keep foot of bed level with angle of hips
  - Head should be upright, at midline and supported
BASELINE OBSERVATIONS

- A behavioral baseline against which subsequent change can be measured
- Determines the level of neurobehavioral functioning associated with each response to the test stimuli
- Critical to accurate measurement
- Double check the testing environment after completing the Baseline Observation
TESTING READINESS

- Test Readiness = a general state of readiness to respond and it is observed and measured behaviorally.
- Answer Four Questions during the baseline observations:
  1. Is a third nerve palsy (i.e., third cranial nerve damage - inability to lift eye lids) suspected?
  2. Is cortical blindness (i.e., optic nerve damage) suspected?
  3. Is a bilateral ptosis (i.e., drooping of the upper eyelid) suspected?
  4. How will Testing Readiness be defined
      * Eye opening unless suspicion of visual impairment
      then:
      * Specify the reliable motoric pattern/movement that will be used to indicate Testing Readiness (e.g., head movement)

Guernon & Fuith-Costa, ASHA 2009
ADMINISTRATION AND SCORING
GENERAL GUIDELINES

- 23 Test Stimuli (other items are research items)
- Scoring Forms
  B = Long Form
  A = Short Form
- Apply each stimulus for 5 seconds
- Observe for 10-15 seconds after administering a test stimuli and wait 30-60 seconds prior to administering the next test stimulus
- Administer stimuli as many times as needed; score best response

Guernon & Fuith-Costa, ASHA 2009
23 TEST STIMULI

- **Social Knowledge**
  - Greet
- **Taste and Swallowing**
  - Juice
  - Massage
- **Olfactory**
  - Odor
- **Proprioceptive/Vestibular**
  - Joint
- **Tactile**
  - Air
  - Feather
  - Hair
  - Toe
  - Hand (Arm Massage)
  - Scrub
  - Swab
  - Cube

- **Auditory**
  - Whistle
  - Clap
  - Name
  - Bell
  - Command

- **Visual**
  - Blink
  - Focus
  - Tracking Objects
  - Tracking Familiar Faces
  - Focus Familiar Face
RATING SCALE OVERVIEW

- **No Response = 0**
  - No active movement or vocalization in response to stimuli; OR no change in response from baseline

- **Generalized Response = 1**
  - Response is not contextually related to test stimuli but is different from baseline behavior

- **Localized Response = 2**
  - Response, not observed at baseline, that is contextually related to test stimuli
NO RESPONSE

- No active movement or vocalization following the presentation of the stimuli

- Response to stimuli does not differ from behavior observed during baseline observation
GENERALIZED RESPONSES

- A general response is NOT predictable
- Is not contextually related to test stimuli, but is different from baseline behavior

Form B contains several examples, but should **NOT** be considered:
  - An all inclusive list
  - A “recipe”
  - Always use your clinical judgment
Cortex

Brain

Stem

Flex Leg

2 = Contextually Related

1 = Not Contextually Related

0 = No Response

Juice on lips

Guernon & Fuith-Costa, ASHA 2009
EXAMPLES OF GENERALIZED RESPONSES

- If different from baseline, then the following could be examples of Generalized Responses:
  - Reflexes differing from reflexes observed at baseline
  - Changes in respiration
  - Changes in Tone (Increase/Decrease)
  - Muscle tensing or other movements unrelated to the area stimulated
EXAMPLES OF GENERALIZED RESPONSES (CONT...)

- If different from baseline, then these could also be examples of GR:
  - Unrelated vocalizations
  - Blinking that deviates from baseline
  - Deviation in blood oxygen levels from baseline range
  - Deviation in heart rate from baseline range
  - Eye opening

Guernon & Fuith-Costa, ASHA 2009
LOCALIZED RESPONSES

- A response, not observed at baseline, that is contextually related to the test stimuli
- The response reflects an ability of the patient to regulate incoming sensory information, that is constantly changing, and to control their motoric responses to the sensory input

Guernon & Fuith-Costa, ASHA 2009
EXAMPLES OF LOCALIZED RESPONSES

- If different from baseline, then the following could be examples of Localized Responses:
  - Orienting or localization movements toward the sound
  - Vocalization or response indicating subjects comprehension of a greeting
GENERALIZED VERSUS LOCALIZED

- If the differentiation between a GR and a LR is unclear, then follow this rule of thumb:
  - A localized response is a response that is contextually related to the stimulus provided.
  - The production of a localized response requires ongoing regulation of incoming stimulation and an ability to voluntarily control the response to the stimulation.
  - Localized responses occur in relationship to the area stimulated and these responses are not attributable to reflexic activity.
VIDEO EXAMPLES

Video clips of DOCS items to illustrate different levels of responses
CONVERSION OF RAW SCORE TO DOCUS MEASURE

- Calculation of Raw Score
  - Add scores of 23 items
  - What if items are skipped?
- Conversion of Raw Score to DOCunit
  - Closed Head Injury vs. Other Brain Injury
- What does this mean?

Guernon & Fuith-Costa, ASHA 2009
DOCS Scoring Table for the 23 Reliable and Valid Items Reported in Pape (2005)*

Instructions: Transfer best scores from scoring form to this form and add total DOCS score. Use the appropriate conversion chart to convert Total DOCS Raw Score to DOCS Measure. If items were skipped write skipped in the cell and do not add it in the total. The scores can be converted to a measure if items are skipped and therefore not included in the total score.

<table>
<thead>
<tr>
<th>Item #</th>
<th>DOCS Test Item</th>
<th>1st Evaluation</th>
<th>2nd Evaluation</th>
<th>3rd Evaluation</th>
<th>4th Evaluation</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1</td>
<td>1. GREET</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S1</td>
<td>2. JUICE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>S2</td>
<td>3. MASSAGE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1</td>
<td>4. ODOR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PV1</td>
<td>5. JOINT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T1</td>
<td>6. AIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T2</td>
<td>7. FEATHER</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T3</td>
<td>8. HAIR</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T4</td>
<td>9. TOE (Vibration)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T5</td>
<td>10. HAND (Massage)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T6</td>
<td>11. SCRUB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T7</td>
<td>12. SWAB</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>T8</td>
<td>13. CUBE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A1</td>
<td>14. WHISTLE</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A2</td>
<td>15. CLAP</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A3</td>
<td>16. NAME</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A5</td>
<td>17. BELL</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A6</td>
<td>18. COMMAND</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V3</td>
<td>19. BLINK</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V4</td>
<td>20. FOCUS (On Objects)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V5</td>
<td>21. TRACKING (Objects)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V7</td>
<td>22. TRACKING (Familiar Face)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>V8</td>
<td>23. FOCUSFA (Familiar Face)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TOTAL DOCS RAW SCORE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

DOCS Measure (Obtained from Appropriate Conversion Chart)

---


** Item numbers correspond with numbers in Table 2. Page 10 of Pape (2007)
<table>
<thead>
<tr>
<th>DOCS Raw Score</th>
<th>DOCunit</th>
<th>Standard Error</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>5.0</td>
<td>18.2</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>16.8</td>
<td>9.9</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>23.5</td>
<td>6.9</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>27.4</td>
<td>5.7</td>
<td>4</td>
</tr>
<tr>
<td>4</td>
<td>30.2</td>
<td>4.9</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>32.4</td>
<td>4.4</td>
<td>7</td>
</tr>
<tr>
<td>6</td>
<td>34.1</td>
<td>4.1</td>
<td>9</td>
</tr>
<tr>
<td>7</td>
<td>35.7</td>
<td>3.8</td>
<td>12</td>
</tr>
<tr>
<td>8</td>
<td>37.0</td>
<td>3.6</td>
<td>13</td>
</tr>
<tr>
<td>9</td>
<td>38.3</td>
<td>3.4</td>
<td>15</td>
</tr>
<tr>
<td>10</td>
<td>39.4</td>
<td>3.3</td>
<td>16</td>
</tr>
<tr>
<td>11</td>
<td>40.4</td>
<td>3.2</td>
<td>19</td>
</tr>
<tr>
<td>12</td>
<td>41.4</td>
<td>3.1</td>
<td>21</td>
</tr>
<tr>
<td>13</td>
<td>42.3</td>
<td>3.0</td>
<td>22</td>
</tr>
<tr>
<td>14</td>
<td>43.2</td>
<td>2.9</td>
<td>25</td>
</tr>
<tr>
<td>15</td>
<td>44.0</td>
<td>2.9</td>
<td>28</td>
</tr>
<tr>
<td>16</td>
<td>44.8</td>
<td>2.8</td>
<td>30</td>
</tr>
<tr>
<td>17</td>
<td>45.6</td>
<td>2.8</td>
<td>33</td>
</tr>
<tr>
<td>18</td>
<td>46.3</td>
<td>2.7</td>
<td>37</td>
</tr>
<tr>
<td>19</td>
<td>47.1</td>
<td>2.7</td>
<td>41</td>
</tr>
<tr>
<td>20</td>
<td>47.8</td>
<td>2.7</td>
<td>43</td>
</tr>
</tbody>
</table>

Guernon & Fuith-Costa, ASHA 2009

<table>
<thead>
<tr>
<th>DOCS Raw Score</th>
<th>DOCunit</th>
<th>Standard Error</th>
<th>Percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>48.6</td>
<td>2.7</td>
<td>44</td>
</tr>
<tr>
<td>22</td>
<td>49.3</td>
<td>2.7</td>
<td>47</td>
</tr>
<tr>
<td>23</td>
<td>50.0</td>
<td>2.7</td>
<td>49</td>
</tr>
<tr>
<td>24</td>
<td>50.7</td>
<td>2.7</td>
<td>51</td>
</tr>
<tr>
<td>25</td>
<td>51.4</td>
<td>2.7</td>
<td>54</td>
</tr>
<tr>
<td>26</td>
<td>52.2</td>
<td>2.7</td>
<td>56</td>
</tr>
<tr>
<td>27</td>
<td>52.9</td>
<td>2.7</td>
<td>59</td>
</tr>
<tr>
<td>28</td>
<td>53.7</td>
<td>2.7</td>
<td>62</td>
</tr>
<tr>
<td>29</td>
<td>54.4</td>
<td>2.8</td>
<td>66</td>
</tr>
<tr>
<td>30</td>
<td>55.2</td>
<td>2.8</td>
<td>70</td>
</tr>
<tr>
<td>31</td>
<td>55.9</td>
<td>2.9</td>
<td>72</td>
</tr>
<tr>
<td>32</td>
<td>56.8</td>
<td>2.9</td>
<td>73</td>
</tr>
<tr>
<td>33</td>
<td>57.7</td>
<td>3.0</td>
<td>76</td>
</tr>
<tr>
<td>34</td>
<td>58.6</td>
<td>3.1</td>
<td>79</td>
</tr>
<tr>
<td>35</td>
<td>59.6</td>
<td>3.2</td>
<td>81</td>
</tr>
<tr>
<td>36</td>
<td>60.6</td>
<td>3.3</td>
<td>83</td>
</tr>
<tr>
<td>37</td>
<td>61.8</td>
<td>3.4</td>
<td>84</td>
</tr>
<tr>
<td>38</td>
<td>63.0</td>
<td>3.6</td>
<td>85</td>
</tr>
<tr>
<td>39</td>
<td>64.3</td>
<td>3.8</td>
<td>87</td>
</tr>
<tr>
<td>40</td>
<td>65.9</td>
<td>4.1</td>
<td>90</td>
</tr>
<tr>
<td>41</td>
<td>67.6</td>
<td>4.4</td>
<td>92</td>
</tr>
<tr>
<td>42</td>
<td>69.8</td>
<td>4.9</td>
<td>93</td>
</tr>
<tr>
<td>43</td>
<td>72.6</td>
<td>5.7</td>
<td>95</td>
</tr>
<tr>
<td>44</td>
<td>76.5</td>
<td>6.9</td>
<td>97</td>
</tr>
<tr>
<td>45</td>
<td>83.1</td>
<td>9.9</td>
<td>98</td>
</tr>
<tr>
<td>46</td>
<td>95.0</td>
<td>18.2</td>
<td>99</td>
</tr>
</tbody>
</table>
CLINICAL APPLICATION OF DOCS RESULTS

- Overall Performance Over Time
- Interpretation by Modality
- Evaluation of Pharmacologic Intervention
- Predictive Utility for Recovery of Consciousness and Functional Skills One-Year after injury
MONITORING RECOVERY OVER TIME

Average DOCS Measures Every 2 Weeks
(N = 91 Persons & 141 DOCS)

- Total Sample
- CHI/MVA
- "GSW"

DOCUnits

Days after Injury

Guernon & Fuiith-Costa, ASHA 2009
INTERPRETATION OF DOCS BY MODALITY

DOCS Results For One Subject By Modality

[Graph showing DOCS results over days after injury for auditory, tactile, visual, and total DOCS]

Days After Injury

DOCunits

Auditory DOCS

Tactile DOCS

Visual DOCS

Total DOCS

Guernon & Fuith-Costa, ASHA 2009
CLINICAL APPLICATION OF MODALITY PLOTTING

- Objectively document progress by modality
- Develop interdisciplinary and uniform communication system
- Identify strengths and weaknesses by modality
- Diagnosis of sensory deficits (i.e. blind or deaf)
EVALUATION OF PHARMACOLOGIC INTERVENTION

Days After Injury

DOCS Neurobehavioral Measure (DOCunits)

Baseline
Methylphenidate
2 Times Daily
Methylphenidate Withdrawn

Guernon & Fuith-Costa, ASHA 2009
PREDICTIVE UTILITY

- Predicting Time to Consciousness within First Year of Injury
  - Four Months
  - Eight Months
  - Twelve Months

- Predicting Recovery of Functional Skills 1-Year After Injury
PREDICTING TIME TO CONSCIOUSNESS

- **Goal:** Predict Recovery and Lack of Recovery of Consciousness at multiple time points within the first year of injury with
  - Equal accuracy (Balanced Predictions)
  - Accuracy higher than .73

- **Sensitivity (Se)** = Predict recovery of consciousness when consciousness really *does* occur

- **Specificity (Sp)** = Predict lack of recovery of consciousness when it really does *not* occur

Guernon & Fuith-Costa, ASHA 2009
## TIME TO CONSCIOUSNESS MOST BALANCED PREDICTIONS

### DOCS Baseline and DOCS Change: TBI (n = 83)

<table>
<thead>
<tr>
<th></th>
<th>4 Months</th>
<th></th>
<th>8 Months</th>
<th></th>
<th>12 Months</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AUC</td>
<td>Se</td>
<td>Sp</td>
<td>AUC</td>
<td>Se</td>
<td>Sp</td>
</tr>
<tr>
<td>Baseline DOCS &lt; or ≥ 48</td>
<td>.82</td>
<td>.78</td>
<td>.76</td>
<td>.83</td>
<td>.80</td>
<td>.80</td>
</tr>
<tr>
<td>DOCS Change 1st - 5th</td>
<td>.87</td>
<td>.86</td>
<td>.83</td>
<td>.81</td>
<td>.75</td>
<td>.75</td>
</tr>
<tr>
<td>DOCS Change 1st - 2nd</td>
<td>.91</td>
<td>.84</td>
<td>.87</td>
<td>.88</td>
<td>.83</td>
<td>.83</td>
</tr>
</tbody>
</table>


Guernon & Fuith-Costa, ASHA 2009
TIME TO CONSCIOUSNESS:
INTERPRETATION OF SE AND SP

Example: DOCS Change measured from 1st and 5th DOCS when predicting recovery of consciousness 4 months after injury

- This measure of change predicted recovery when it actually occurred 86% (Se) of the time and when it actually did not occur 83% (Sp) of the time
- Yielding a False Negative rate of 14% and a False Positive rate of 17%.
- Each prediction will be accurate 88% of the time

Guernon & Fuith-Costa, ASHA 2009
### Time to Consciousness: Influence of Magnitude of Change

Table 4. Predicted Probabilities for Recovering Consciousness in One-Year Given Increments of 7, 8 or 9 Units of Change

<table>
<thead>
<tr>
<th>Change in DOCS (in DOCountts)</th>
<th>Decline</th>
<th>Plateau</th>
<th>Improve</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>-27</td>
<td>-24</td>
<td>-21</td>
</tr>
<tr>
<td></td>
<td>-18</td>
<td>-16</td>
<td>-14</td>
</tr>
<tr>
<td></td>
<td>-9</td>
<td>-8</td>
<td>-7</td>
</tr>
<tr>
<td></td>
<td>0</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>14</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>18</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>27</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If Baseline DOCS score is...</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>344</td>
<td>0.016</td>
<td>0.021</td>
<td>0.029</td>
</tr>
<tr>
<td>433</td>
<td>0.039</td>
<td>0.047</td>
<td>0.057</td>
</tr>
<tr>
<td>483</td>
<td>0.091</td>
<td>0.139</td>
<td>0.166</td>
</tr>
<tr>
<td>533</td>
<td>0.161</td>
<td>0.204</td>
<td>0.259</td>
</tr>
<tr>
<td>593</td>
<td>0.296</td>
<td>0.372</td>
<td>0.421</td>
</tr>
</tbody>
</table>
| Absolute Probability of Regaining Consciousness in Year 1 of Injury

- Decline: 
- Plateau: 
- Improve:
TIMEFRAME FOR 7 TO 9 UNITS OF DOCS CHANGE

- Baseline acquired within 94 days of injury
- Average # of days during which 7, 8 and 9 units of DOCS change occurred
  - Ranges from 18 to 22 days suggesting that DOCS evaluations do not have to be conducted every 7 days to sufficiently capture/detect this amount of change.
PREDICTING RECOVERY OF FUNCTIONAL SKILLS 1-YEAR AFTER INJURY

- N = 63
  - Average Age at Injury = 35 years
  - 84% Males (53/63)
  - 81% CHI (51/63)
  - 63% recovered consciousness within 1-year of injury (40/63)
    - Average Time to Consciousness = 161 days
    - Range = 24 to 365 days
  - 13% living at or below poverty 1-year after injury
    - Mean Disposable Income = $51,183.00

<table>
<thead>
<tr>
<th>Functional Outcome</th>
<th>Definition</th>
<th>Example of Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Out of Bed</td>
<td>Out of bed $\leq 8$ hours or $&gt; 8$ hours per day</td>
<td>No UTI during acute phase of recovery; more likely to be out of bed more than 8 hours per day.</td>
</tr>
<tr>
<td>Physical Assistance</td>
<td>Requires physical assistance for ADL $&lt; 12$ hours or $\geq 12$ hours per day</td>
<td>Less time between injury and admit to rehab; more likely to require less than 12 hours per day of assistance.</td>
</tr>
<tr>
<td>Cognitive Assistance at Home</td>
<td>Someone is always around to provide cognitive assistance at home or person is left alone for parts of day</td>
<td>Less time between injury and admit to rehab; more likely to be left alone for parts of the day.</td>
</tr>
<tr>
<td>Memory Help</td>
<td>Always or sometimes needs assistance for remembering important things</td>
<td>Married at time of injury; more likely to need help sometimes with memory instead of always</td>
</tr>
</tbody>
</table>
PROGNOSTIC INFORMATION BASED ON MODALITY SPECIFIC INFORMATION

- Recovery of Functional Skills 1-Year after Injury
- Additional Independent Variables
  - DOCS Auditory Measure
  - DOCS Tactile Measure
  - DOCS Visual Measure

Guernon & Fuith-Costa, ASHA 2009
<table>
<thead>
<tr>
<th>Models</th>
<th>Dependent Variables</th>
<th>Significant Predictor Variables</th>
<th>P Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tactile Average + pneum + HTN+ seiz + UTI</td>
<td>Time out of Bed</td>
<td>UTI</td>
<td>.058*</td>
</tr>
<tr>
<td>Visual Average + pneum + seiz + UTI</td>
<td>Cognitive Assistance</td>
<td>Seizure</td>
<td>.021*</td>
</tr>
<tr>
<td>Visual Average + pneum + seiz + UTI</td>
<td>Recovery of Consciousness</td>
<td>Visual Average</td>
<td>.076</td>
</tr>
<tr>
<td>Auditory Average + pneum + seiz + UTI + HTN</td>
<td>Recovery of Consciousness</td>
<td>Auditory Average</td>
<td>.082</td>
</tr>
<tr>
<td>Auditory Average + pneum + seiz + UTI + HTN</td>
<td>Communication Assistance</td>
<td>Auditory Average</td>
<td>.023*</td>
</tr>
<tr>
<td>Auditory Average + pneum + seiz + UTI + HTN</td>
<td>Cognitive Assistance</td>
<td>Auditory Average</td>
<td>.020*</td>
</tr>
<tr>
<td>Auditory Average + pneum + seiz + UTI + HTN</td>
<td>Social Contact</td>
<td>Auditory Average</td>
<td>.066</td>
</tr>
</tbody>
</table>

TRANSLATION OF EVIDENCE TO CLINICAL PRACTICE

- DOCS useful for Rehabilitation Goal Setting and for Monitoring Neurobehavioral Recovery
- Evidence Based Prognoses after Severe TBI for Individual Patients IS Possible:
  - Functional skill recovery: Not ready for implementation
  - Recovery of Consciousness: Ready for use in Clinical Practice
  - Understand the Accuracy (Error) associated with each prediction/probability
- Determining Short Term Medication Effects
RECOVERED CONSCIOUSNESS - NOW WHAT?

- No formal assessment tool - Informal assessment:
  - Auditory Comprehension
    - Establish consistent means of yes/no
    - Following simple commands
  - Expression
    - Vocalization to imitation; command; spontaneous
    - Imitate sounds, words, etc
  - AAC
    - Low tech options
  - Attention
    - Visual tracking
  - Swallowing
    - Consistency of swallow to thermal-tactile stimulation
    - Is a swallow study appropriate?
WHERE DO WE GO FROM HERE?

- Can Neural Adaptation after Severe Brain Injury be Facilitated?
  - Clinical trial to determine if high dose familiar voice stimulation improves neurobehavioral outcomes in patients in VS or MCS after severe TBI
  - Uses DOCS, Coma Near Coma Scale and fMRI

- Transcranial Magnetic Stimulation during Coma Recovery
  - Safety trial to examine safety and therapeutic efficacy of repetitive transcranial magnetic stimulation in persons with severe TBI in VS or MCS
  - Uses DOCS, EEG and fMRI
CONTACT INFORMATION

- Ann Guernon, MS CCC-SLP, CCRC
  - Marianjoy Rehabilitation Hospital/Hines VA
  - Ann.guernon@va.gov

- Julie Fuith-Costa, MS CCC-SLP
  - Rehabilitation Institute of Chicago
  - jfuith@ric.org
ACKNOWLEDGEMENTS

- US Department of Veterans Affairs, Office of Research & Development, Rehabilitation
  - Health Services Research & Development (CCN07-133-1)
  - Rehabilitation Research & Development (B2632-V, B3302K & B4949N)

- Therapists and Clinicians at Participating Hospitals:
  - Marianjoy Rehabilitation Hospital
  - Minneapolis VAMC
  - The Rehabilitation Institute of Chicago
  - RML Specialty Hospital
  - Tampa VAMC
  - Hines VAMC

- Northwestern University’s Feinberg School of Medicine
- Nick Kot Charity (www.nickkotcharitynfp.com)
- The patients and their families/loved ones
VETERANS AND SOLDIERS