Administration Manual

Disorders of Consciousness Scale

(DOCS)

Theresa Louse-Bender Pape, Dr.PH., MA., CCC-SLP
Department of Veterans Affairs
Edward Hines, Jr. Hospital
Hines, IL 60141
Manual

Sandra Lundgren PhD, ABPP
Ann M. Guernon, MS, CCC-SLP
James P. Kelly, MD
Allen W. Heinemann, PhD, ABPP

October 2011

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Prologue

ABOUT THE PRIMARY AUTHOR OF THE DOCS

Dr. Theresa Louise-Bender Pape is a Clinical Neuroscientist with the Veterans Administration (VA) Rehabilitation Research and Development (RR&D) Service and a Research Associate Professor at Northwestern University's Feinberg School of Medicine in the Department of Physical Medicine and Rehabilitation. Dr. Pape is also a clinical research associate with Marianjoy Rehabilitation Hospital.

Dr. Pape earned her master's of arts (MA) degree in speech-language pathology from Western Michigan University in 1986. She provided speech-language services to persons with traumatic brain injury (TBI) for several years. Dr. Pape then completed a pre-doctoral fellowship with the VA Health Services Research and Development Service in 1999 as well as earning her doctorate of public health (Dr. PH) from the University of Illinois at Chicago in 1999. Dr. Pape completed a post-doctoral fellowship in 2001 at Northwestern's Institute for Health Services Research and Policy Studies (IHSRPS), which is an Advanced Rehabilitation Research Training Program co-sponsored by the National Institute on Disability and Rehabilitation Research (NIDRR) and the National Research Service Awards (NRSA). Dr. Pape was also awarded a Merit Switzer fellowship through NIDRR. After completing this fellowship in 2001 Dr. Pape went on to receive three consecutive career development awards with the VA RR&D service. First she received a Research Career Development Award to study rehabilitation measurement and outcomes post severe TBI. She subsequently received an Advanced Research Career Development Award to study advanced neurosciences and neural plasticity. Dr. Pape received the third award, a Career Development Transition Award, to study neural plasticity in neurorehabilitation after TBI.

Dr. Pape's pre- and post-doctoral training cut across the traditional boundaries of medical rehabilitation research and this training builds on her clinical experiences in traumatic brain injury (TBI). Dr. Pape applies and synthesizes her clinical experiences and advanced training in neurosciences, neural plasticity, CNS repair mechanisms, measurement/psychometrics, outcomes, statistical analyses and research design to enable the conduct of research within the theme of neural plasticity in neurorehabilitation of TBI. Within this research tract Dr. Pape's foci are rehabilitation measurement, effectiveness and outcomes.

Dr. Pape's first research project focused on rehabilitation measurement and outcomes and the Disorders of Consciousness Scale (DOCS) is a product of this effort. While developing the DOCS Dr. Pape's perspective has been that the DOCS measures must be useful clinically for predicting outcomes and useful for conducting clinical trials during coma recovery. The first outcome Dr. Pape chose to examine is recovery of consciousness. Additional outcomes that will be examined relate to recovery of long term function. While standardized tests in general are routinely used to develop prognosis, standardized test results are also used to diagnose patients. For the severe TBI population Dr. Pape decided that prognostication, rather than diagnostics, was the first priority when developing the DOCS. Dr. Pape chose to first enhance the prognostic utility of the DOCS because (a) there is very little evidence supporting the existence of multiple sub-syndromes of altered states of consciousness, (b) existing evidence only supports clinical consensus criteria to make distinctions between altered states of consciousness (e.g., vegetative versus minimally conscious), and (c) families need information about what to expect in order to respond to and cope with the common logistical, financial, personal, and ethical issues associated with a lifetime of severe impairments.

While Dr. Pape chose to focus first on prognostication, diagnosing distinct sub-syndromes of altered state of consciousness is equally important. The diagnostic utility of a test is important because an accurate diagnosis enables development of a prognosis and a treatment plan. A diagnosis of a minimally conscious state certainly implies a better prognosis relative to the diagnosis of a vegetative state. Waiting to examine the diagnostic utility of the DOCS has allowed the state of science in this arena

to mature. In 2002, for example, clinical criteria defining the minimally conscious state were published in *Neurology*. Behavioral evidence regarding emergence into consciousness has also evolved in the past five years. Evidence of volitional control not observable behaviorally, for example, was detected during functional imaging. These findings advanced our knowledge of accuracy in defining recovery of consciousness behaviorally. Dr. Pape will work closely with psychometricians in 2011 to evaluate the diagnostic utility of the DOCS relative to (a) clinical reference standards defining the comatose, vegetative and minimally conscious states, (b) psychometric data indicating clusters or sub-groups within the continuum of altered consciousness, and (c) clinical and neurophysiological data distinguishing consciousness from minimal consciousness. These analyses will determine the extent to which the DOCS can identify and distinguish between altered states of consciousness as well as recovery of consciousness.

Dr. Pape's research career started in rehabilitation measurement and outcomes because of the need to develop accurate measures of neurobehavioral functioning that can be obtained at the bedside. Dr. Pape determined that development of these measures was critical for the conduct of effectiveness research to examine therapeutic effectiveness at the behavioral level. Dr. Pape developed the DOCS as one step toward her career of developing medical rehabilitation interventions to shape and guide CNS repair to ultimately lead to functional recovery after severe TBI.

ACKNOWLEDGEMENTS

Study Participants:

We want to acknowledge and thank the individuals who participated in this research project as study participants, their family members, and loved ones. Without their involvement, it would not have been possible to advance scientific and clinical knowledge in this area of recovery.

Advisors & Collaborative Partners:

Ghada Ahmed, MD
Melanie Blahnik, PsyD, LP
Nenad Brkic MD
Laura Chalcraft MS
David Demarest, PhD
Nelson Escobar MD
Collins Fitzpatrick MD
Anita Giobbie Hurder, MS
Allen W. Heinemann, PhD, ABPP
Dr. Gwendolyn Kartj, MD, PhD
James P. Kelly, MA, MD
Katherine Kieffer, MS
Sandra Lundgren, PhD, LP, ABPP
Trudy Mallison, PhD
Vijaya Patil, MD
Linda Picon MA
Melanie Querubin, MD
Steve Scott MD
Ricardo G. Senno, MD
Ileana Soneru MD
Phil Davis, MS, CNIS
Charlene Tang, PhD, MPH, MD
Yongliang Wei, MS

Research Team Members:

The development of the DOCS involved contributions from several research team members including: Dave Anders, Catherine Burress, Megan Darragh, Kathleen Froehlich, Julie Fuith-Costa, Anita Giobbie-Hurder, Ann Guernon, Brett Harton, Cheryl Odle, Michelle Peterson, Heidi Roth, Sarah Schettler, Laura Veltman, Jia Wang, and Vanessa Williams.

Current and/or Past Subject Recruitment Sites:

We would also like to recognize the contributions of the participating hospitals whose cooperation, collaboration, and support facilitated implementation of this research. Additionally, we wish to acknowledge the allied health associates at each hospital, including the speech-language pathologists, physical therapists, occupational therapists, respiratory therapists, and nurses whose ongoing pursuit of excellence contributed to the quality of data collection. These hospitals include:

- Edward Hines Jr. VA Hospital, Hines, Illinois
- On With Life, Brain Injury Rehabilitation, Ankeny, Iowa
- Marianjoy Rehabilitation Hospital, Wheaton, Illinois
- Northwestern Memorial Hospital, Chicago, Illinois

- Minneapolis Veterans Affairs (VA) Medical Center, Minneapolis, MN
- RML Specialty Hospital, Hinsdale, Illinois
- Tampa VA Medical Center, Tampa, Florida
- The Rehabilitation Institute of Chicago. Chicago, Illinois

Funding:

Funding was provided by the Department of Veterans Affairs (VA), Veterans Health Affairs, Rehabilitation Research and Development Services through career development grants to Dr. Theresa Pape (B2632-V, B3302K) and VA HSR& D CCn07-1331-1. Funding was also provided by the U.S. Department of Education, National Institute on Disability and Rehabilitation Research, through Advanced Rehabilitation Research Training Program grant CFDA 84.133P and a Merit Switzer Award to Dr. Pape (CFDA 84.133f). A grant from the Nick Kot Charity (not for profit) and in-kind contributions from Marianjoy Rehabilitation Hospital, Wheaton, Illinois and the Minneapolis VA Medical Center (VAMC) were also received to support this work.

Abbreviations Used in Manual:

BI – Brain Injury
CHART - Craig Handicap Assessment and Reporting Technique
CNS - Central Nervous System
CRS – Coma Recovery Scale
DIF - Differential Item Functioning
DOCS – Disorders of Consciousness Scale
GCS - Glasgow Coma Scale
GR – Generalized Response
IP - Inpatient
LR – Localized Response
MCS - Minimally conscious state
NPV– Negative predictive Value
NR – No Response
PCA - Principal Component Analyses
PPV - Positive Predictive Value
SE - Standard Error
SMART - Sensory Modality Assessment and Rehabilitation Technique
TBI – Traumatic Brain Injury
UTI – Urinary Tract Infection
VS - Vegetative state
WHO – World Health Organization
WNSSP – Western Neuro Sensory Stimulation Profile

Chapter 1: Introduction to the Concepts of the DOCS

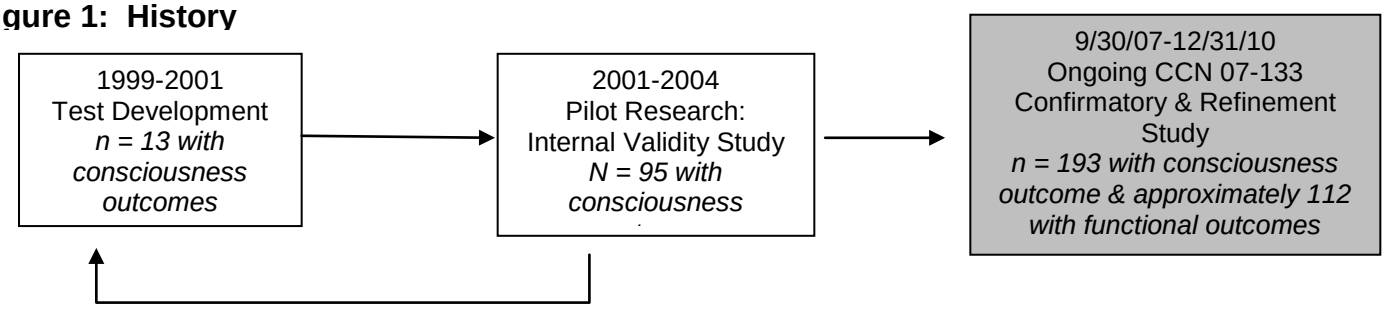
Description of Measure:

The Disorders of Consciousness Scale (DOCS) is a bedside test measuring neurobehavioral functioning during coma recovery**.** This bedside neurobehavioral evaluation was designed to allow the clinician to examine the unconsciousness as a continuum of fluctuating levels of neurobehavioral integrity while detecting and distinguishing between true changes and random fluctuation. The DOCS is different from other assessment tools in that the rating scale of the DOCS provides a description of neurobehavioral recovery. This rating scale describes levels of neurobehavioral integrity and a level is assigned to responses to test stimuli. The DOCS was developed to detect subtle changes in observable indicators of neurobehavioral functioning.

History & Development of the DOCS:

Originally the DOCS was developed from 1991-1992 and was formerly titled "Standardized Assessment of Consciousness". The title was changed to the DOCS in 1995. The development of the DOCS has been an iterative process, with the pilot findings from 1992 through 1999 serving as the basis for revisions, including changes to the rating scale and test stimuli. The theory of the DOCS is further discussed in **Chapter 2**. The DOCS in its current version was developed from 1999-2001 (Figure 1). The 2001 version has been examined (2001-2004) for reliability, construct validity and predictive validity.[1-3] The sample (n = 95) of largely young (mean = 36 years) males (85%) with closed head injuries (72%) were examined with the DOCS by forty-four allied health clinicians. This large group of raters was chosen to enhance generalizability. That is, real world rehabilitation involves multiple allied health disciplines testing unconscious patients to determine level of functioning. Other study samples are summarized in **Chapter 3**.

Figure 1: History



Purpose:

One of the most crucial and challenging tasks for health care practitioners caring for survivors of severe brain injury (BI) is establishing a prognosis for long-term functional recovery, early after injury or while the patient is still unconscious. Clinicians need an assessment tool that (1) can be completed at bedside, (2) is sensitive to subtle changes in neurobehavioral functioning, (3) produces a reliable and valid measure of neurobehavioral functioning in unconscious persons over time, (4) and can identify the factors that influence and predict recovery. Additionally, prognostication during coma recovery can help with early counseling and adjustment of the patient and family, as well as guide and evaluate the effectiveness of present and future medical and rehabilitation interventions. The DOCS was designed to address these clinical and scientific needs.

Persons incurring severe brain injury (BI) who are rendered unconscious demonstrate two dimensions of recovery; recovery of consciousness and function. Severe BI survivors demonstrate a wide range of durations of unconsciousness and short and long-term (> 6 months) functional outcomes.[4,5] Currently there is no universally accepted definition of consciousness[6]; however, lack of recovery of consciousness is described clinically by three sub-syndromes (i.e., the comatose, vegetative

and the minimally conscious states.[7] There is no gold standard for diagnosing these sub-syndromes[8-10] but there are published clinical consensus/reference standards to define these sub-syndromes.[8,11]

In brief, emergence from coma is signaled by eye-opening and the vegetative state indicates wakefulness without internal or external awareness (i.e., self and environment). Even though there is no "official" definition of vegetative state (VS), it has been defined as the return of arousal (e.g. sleep-wake cycles) without signs of awareness.[12] The diagnosis of VS usually requires several clinical examinations of interpreting behavioral responses as individuals with disordered level of consciousness are usually limited in the frequency and complexity of their responses.[13] Minimal consciousness reflects the ability to demonstrate limited but clear evidence of awareness of self, but lack of functional communication. Minimally conscious state (MCS) has been defined as the presence of behaviors associated with conscious awareness that may occur intermittently but is reproducible and is differentiated from a reflexive behavior.[11] The distinguishing characteristic between VS and MCS is the requirement that the person demonstrate at least one clear-cut behavioral sign of consciousnesses.[13] The difficulty with this definition is that it is not clear what type of evidence is sufficient to clearly demonstrate that a specific behavior is instilled with purpose of meaning or awareness.[14] However, in the absence of any "hard" neurophysiologic markers, the burden of proof for determining the appropriate level of consciousness remains with the behavioral assessment.[15]

The first step in the clinical management of persons with disordered consciousness is the accurate differential diagnosis between VS and MCS.[13] It is a challenge to determine which behaviors are reflexive or automatic and reliant on spinal or subcortical pathways from behaviors that are purposeful and reflect some level of awareness and are cortically mediated.[15] The differential diagnosis of the various levels of disordered consciousness can be challenging and often times require clinical judgment of the examiner based upon inferences of the observed behavior.[16] Variations in levels of arousal and motor responsiveness commonly occur in persons with disordered level of consciousness and may impact the diagnostic instability.[17,18] To further complicate an accurate diagnosis for the level of consciousness, a person may exhibit behavioral signs of awareness during one examination and fail to do so at another examination.[14] Finally, the examiner may have difficulty with distinguishing between reflexive or involuntary movement from a purposeful behavioral response.[15]

Accurately diagnosing the level of consciousness is extremely important as the prognosis for MCS is generally more favorable as compared to VS and may impact the patient's long-term rehabilitation placement.[13,19] Evidence indicates that about 35% of persons remaining in a VS for 3-months will recover consciousness by 12-months.[12] Recent evidence specifies further that 65% [20] to 80% [21] of persons unconscious 28 or more days consecutively recovered consciousness by 12-months.[20,21] Preliminary functional outcomes data for persons recovering consciousness by year one, 85 of 137; 54%, indicates that the majority of these persons have a FIM Cognitive score < 25 (72%) and a FIM motor score < 60 (68%)(unpublished data derived from ongoing study VA HSR&D Merit Grant # CCN 07-133). These scores mean that these persons require assistance 25% to 100% of the time to engage in physical (e.g., transferring from bed and chair, toileting) and/or cognitively mediated activities such as expression of basic to complex needs/ideas or social interaction 1-year after severe BI. While we have sufficient evidence to describe long-term functional outcomes for the study population as heterogeneous,[4] the factors influencing recovery of function are not well understood.

Even though behavior assessment remains the "gold standard" for evaluating levels of consciousness[22], it is possible that sensory and/or motor deficits may result in an underestimation of the person's cognitive level of functioning.[11] Additional issues that may also interfere with the accurate assessment of the person's level of consciousness include persons who are not positioned properly, are uncomfortable, and who may be blind or aphasic.[23] Because a behavior response may represent an indirect indicator of consciousness, the dependence on behavioral assessment may lead to misdiagnosis.[15] Previous studies have revealed a misdiagnosis rate for VS that ranged from 15% to

43%.[24-26] Misdiagnosis of the level of consciousness may also potentially lead to some grave consequences, particularly when situations where end of life decisions are being made.[27]

Components of the DOCS:

The DOCS is administered by allied health clinicians. Two rating forms, the short version and long version, as well as the research version form may be used (see Appendix for forms). There are 23 test items for clinical use and six research items requiring higher levels of cognitive processing. The six research items are currently being examined in the ongoing CCN 07-133 study.

Baseline observations are completed first and then test items are administered. Clinicians administer the items (e.g., sensations, commands) and rate behavioral responses to the items (i.e., responses deviating from baseline) according to a 3-point rating scale (0 = No response, 1 = Generalized Response, 2 = Localized Response).

Timeframe to Administer the DOCS:

The administration of test stimuli and interpretation of responses is conducted across disciplines and uses a best response profile. The administration of the 23 test stimuli / items requires approximately 40-60 minutes.

Who Should Administer the DOCS:

The DOCS may be administered by allied health clinicians (eg, nurses, occupational therapists, physical therapists, and speech language pathologists) after completing the administration and scoring training protocol.

Administration & Scoring Protocol Training Requirements:

The training requirements for administering the DOCS in the clinical setting include reviewing this manual and viewing a 2 hour training DVD. To administer the DOCS for research purposes, additional training beyond this manual and the 2 hour DVD training is required and includes observing an experienced DOCS examiner administer the exam and scoring the DOCS in tandem with an experienced rater. If you are interested in participating in research with the DOCS, please contact Dr. Pape.

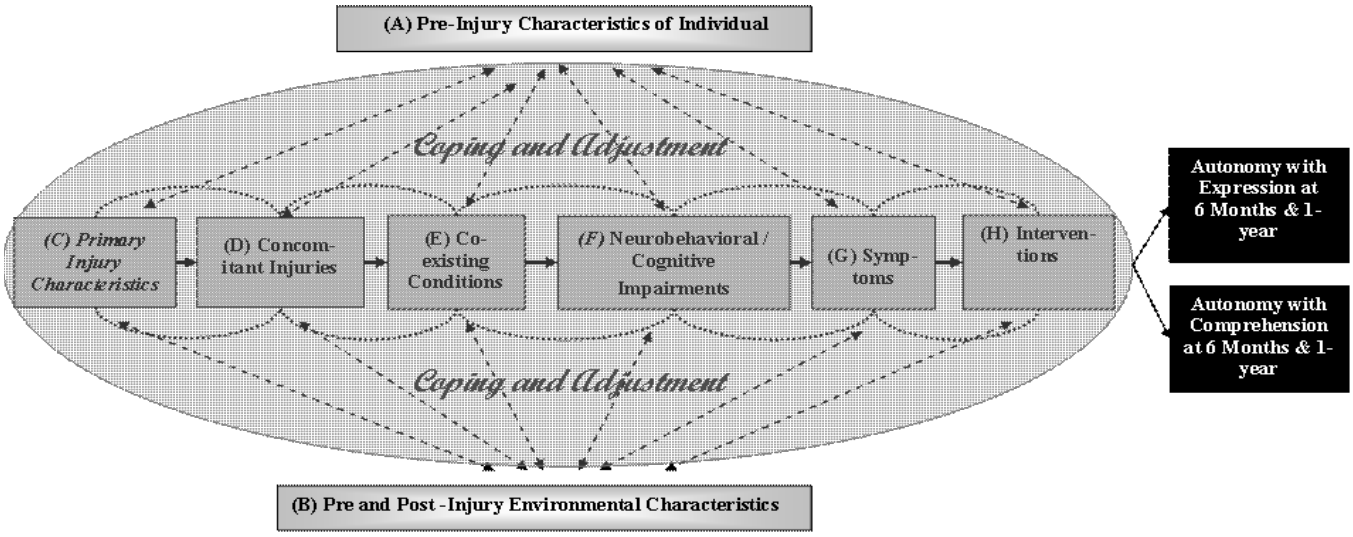
Chapter 2: Theoretical Basis of DOCS

Conceptual Framework:

The current state of evidence regarding factors known or thought to influence recovery of function is summarized in this section according to the WHO framework of influential linkages with explanatory or mitigating factors in relationship to the primary and secondary functional outcomes; autonomy with expression and comprehension. The unidirectional arrows with solid lines in Figure 2 represent influential linkages between injury related factors, which are known or thought to influence recovery of function. The synergistic, interactive and/or reciprocal nature of the linkages between factors and subsequent influence on autonomy is depicted by arcing dotted lines. The uniformity of the gray rectangles is not meant to imply that each factor influences autonomy in the same manner or same amount over time. The manner and amount of each factor's influence will fluctuate over time in accordance with the survivor learning to cope with and adjust to life with acquired disabilities.[28]

The injury related factors depicted in the horizontally aligned gray rectangles are, to varying degrees, influenced by individual (Factor A) and environmental (Factor B) characteristics. These reciprocal influences are depicted via bi-directional arrows with dashed lines. Individual characteristics refer to pre-injury educational achievement and employment status as well as age and gender. Individual characteristics known to influence recovery include the pre-injury condition of the brain reflected by indices such as age.[12] Age is known to be predictive of fewer functional gains for older (i.e., > 64 years) persons.[29] Age at injury is well established as being predictive of magnitude of recovery, but our study population is homogeneous in regards to age because we are studying severe BI due to traumatic incident. That is, the majority of persons in the DOCS sample is younger than 64 years. Our current study (CCN 07-133), for example, has a mean age 37 ± 17 years (Range: 18 to 65 years; n = 147). This suggests that age is not likely to mitigate or influence the recovery of autonomy with expression and comprehension in this population.

Figure 2. Conceptual Framework



Environmental characteristics refer to pre and post -injury social networks, social support, and finances. Socio-economic status of children with severe traumatic BI, for example, was the most significant predictor for recovery of vocabulary skills.[30] Time from injury to rehab admission was categorized as an environmental characteristic because in the private sector advocacy and finances might influence lengths of stay after transfer from intensive care. Time from injury to rehabilitation admission is important because it is associated with recovery 16 weeks after severe BI.[31-32] The influence of pre-injury employment on recovery is unknown. The horizontally aligned gray rectangles in Figure 2 depict injury related factors corresponding with severe BI. The first rectangle, "Primary Injury Characteristics" (Factor C), represents injuries directly to the brain. Primary injury indicators linked to recovery are duration of unconsciousness, types of brain lesions, location of lesions and ex*tent of brain* damage.[32] Longer durations of unconsciousness is related to less recovery in terms of magnitude.[33] Lesion location, type and extent[34] are associated with time to command following and/or gains in the Barthel Score 16-weeks after severe TBI or at discharge from inpatient rehabilitation For persons recovering consciousness, it is also well known that recovery of function can be influenced by etiology.[12] Severe BI is due to many etiologies and each etiology differs by (a) demographic groups, (b) recovery rate, (c) magnitude of recovery, (d) duration of recovery phase, and (e) injury and lesion characteristics.

Excluding cerebral vascular etiologies, the most common severe BI etiologies are closed head contra coup trauma, open head trauma such as gunshot wounds, blast trauma and anoxia. A traumatic BI involves a blow or jolt to the head or a penetrating head injury that disrupts the function of the brain. . Blast trauma are the least understood etiology, but the associated demographic group is active duty military personnel.[35] Anoxia is a condition in which there is no oxygen in the bloodstream and it is, unlike other etiologies, not associated with any particular demographic group. Differing demographics groups have different risks for each BI etiology. Blunt trauma BI due to falls in the civilian population, for example, are more likely with older persons whereas younger persons are more likely to incur a contra coup BI from a vehicular crash. The study team has encountered hypoxic events due to choking, suicide, cardiac arrest and drowning and these causes of anoxia can and do occur in multiple demographic groups.

Despite established evidence that etiology influences recovery, (i.e., measured by rate, magnitude and duration of recovery phase) the relationship is not well understood. It is known that traumatic BI has a greater magnitude of recovery and longer recovery phase relative to non-traumatic BI (e.g., anoxia).[12] Regardless of the evidence indicating a poorer functional recovery for persons with severe BI due to anoxia, there is ample contradictory evidence indicating that persons with anoxic BI do make functional gains.[36,37]

The rectangle titled 'Concomitant Injuries' (Factor D) represents injuries co-occurring at time of brain injury. These often include fractures to the spine, extremities, pelvis and/or face as well as trauma to the heart, lung, and abdomen. This is measured via the Injury Severity Scale (ISS), which is a well established predictor of mortality and acute care lengths of stay.[38] The 'Co-existing Conditions' (Factor E) rectangle refers to common conditions co-existing with recovery (e.g., hydrocephalus). Co-existing conditions are collected because they may mitigate recovery of function.[21]

The 'Neurobehavioral/Cognitive Impairments' (Factor F) rectangle represents indices such as post-traumatic amnesia (PTA) and neurobehavioral functioning measures obtained during and after coma. While PTA cannot be established during coma recovery, PTA is a well established indicator of cognitive impairment that is predictive of functional outcomes.[39,40] Neurobehaviorally, published evidence indicates that visual and motor measures influence prediction of total scores for the Western Neuro Sensory Stimulation Profile (WNSSP) and Glasgow Coma Scale (GCS). We also know from this limited evidence that modality specific measures influence function, but the outcomes examined to date are gross indicators of function (e.g., good versus poor outcome; WNSSP/GCS gains) thereby lacking meaning for families and clinicians or have insufficient follow-up durations (e.g., 3-months). Evidence also indicates that recovery rate, measured as change in average Disability Rating Scale (DRS) scores

over two weeks, are predictive of the DRS score 16 weeks after enrollment and time to command following.[41-43] Evidence of the influence of modality specific measures is limited, but does indicate that somatosensory evoked potentials contribute to predicting DRS gains.[44]

The 'Symptoms' (Factor G) rectangle in the conceptual framework depicted in Figure 2 represents the influence of acute and chronic pain and mood disorders (e.g., depression, anger) on functioning. We could find no published evidence regarding the influence of symptoms on functioning after severe TBI, but we think it might be related to autonomy with expression (e.g., less initiation due to depression masked as less autonomy with expression). The 'Interventions' (Factor H) rectangle represents provision of rehabilitation services and medications during inpatient rehabilitation. Specifically, it reflects each subject's length of rehabilitation hospitalization, rehabilitation intensity and prescribed medications by class and dose.

In summary, Figure 2 and the evidence from the literature illustrates the importance of examining multiple factors in the prediction model to address the complexity of the relationships between explanatory factors and autonomy with expression and comprehension at 6 months and 1-year post injury. Predicting function requires combining the variables known or thought to be associated with recovery of function.[41,44-46]

Why is the DOCS Different?

Table 1 summarizes the comparison of the measurement properties of the DOCS with CRS, WNSSP, and SMART as reported in the literature. What distinguishes the DOCS from other tools is that it was designed to measure neurobehavioral integrity from the following perspectives:

(1) The state of altered consciousness is a continuum.
(2) The finite set of prescribed or expected responses does not serve as an exhaustive index of neurobehavioral functioning.
(3) The ability to monitor neurobehavioral recovery or change after a severe brain injury is related to the ability to measure the amount or level of neurobehavioral functioning within the continuum of altered consciousness.
(4) A sensitive, reliable, and valid measure of neurobehavioral functioning must maintain its meaning over time.

The DOCS is different from other tools, such as the Coma Recovery Scale (CRS)[46] and the Western Neuro Sensory Stimulation Profile (WNSSP)[47] in that the rating scale of the DOCS provides a description of neurobehavioral recovery. With the CRS, if the specific behavioral response is not demonstrated in response to the given test stimulus, then the patient is assigned a lower score indicating less or no neurobehavioral functioning. The dichotomous data obtained from the CRS reflect either the presence or absence of a specific behavior rather than the level of neurobehavioral functioning.

The WNSSP was one of the first assessment tools designed to detect subtle changes in neurobehavioral functioning in low-level neurological states and was used as a starting point for the development of the DOCS test stimuli but was expanded and further refined because the WNSSP test stimuli did not target lower functioning patients. Even though the WNSSP and the DOCS are similar, the test stimuli administration and scoring procedures are different. The WNSSP allows for cues and indicates that lower scores should be assigned if a patient responds to a test stimulus when provided with a cue and if a response is delayed. It is well accepted that cueing techniques do facilitate behavioral responses and functioning, but the use of cues makes determining the amount of neurobehavioral functioning without priming impossible. With the DOCS, the timeliness of the responses to test stimuli is also different as the patient is allowed 10 to 30 seconds (depending on the test stimuli) to respond. This was implemented with the DOCS to discriminate responses to test stimuli from random responses.

The Sensory Modality Assessment and Rehabilitation Technique (SMART) is an assessment tool that distinguishes five levels of neurobehavioral functioning by consistency of behavioral responses.[48]

Table 1: Comparison of Psychometric Properties of DOCS Relative to Published Findings of Other Instruments

Variable	DOCS	CRS	SMART	WNSSP
Study Sample	385 DOCS evaluations completed across 95 unconscious persons who had an initial GCS score ≤ 8 (before the administration of neuroparalytic agents)	23 minimally responsive patients as defined by inpatient rehabilitation admission DRS score between 17-29 and RLA II-IV; 18 persons presenting at RLA I-IV; 80 patients who were vegetative or minimally conscious.	30 persons in a vegetative state	57 persons with inpatient rehabilitation admission RLA III-V
Content	Baseline Observational Protocol: 34 test items organized by difficulty into 8 subscales: 1. Social Knowledge 2. Taste & Swallowing 3. Olfactory 4. Proprioceptive & Vestibular 5. Auditory 6. Visual 7. Tactile 8. Test Readiness	5 test items organized into 6 subscales: 1. Arousal 2. Auditory 3. Visual 4. Motor 5. Verbal 6. Communication CRS items were revised in 2004	8 subscales: 1. Visual 2. Auditory 3. Tactile 4. Olfactory 5. Gustatory 6. Gustatory 7. Motor 8. Level of "wakefulness"	33 test items organized into 6 subscales: 1. Arousal 2. Auditory Comprehension 3. Visual Comprehension 4. Visual Tracking 5. Object Manipulation 6. Expressive Communication
Scales of Measurement / Scale Properties	Rating Scale: 0=No response 1=General response 2=Localized response Logits: Equal interval measures derived from ordinal raw score Step thresholds: 76% of step thresholds for each item (26/34) maintain stability over time	Dichotomous Scale indicating: • Expected behavior is demonstrated or • Expected behavior is not demonstrated Ordinal raw score Histogram reflects symmetrical distribution of CRS-revised total scores	For 7/8 scales, a Dichotomous Scale is used indicating: •Expected behavior is demonstrated or • Expected behavior in not demonstrated For level of wakefulness, a scale of 1-5 is used Ordinal raw score range from 7-35 points Scale Properties: Not reported	Multiple rating scales mixed within each subscale. Scores are determined according to accuracy, response latency, and provision of cueing. Nominal & ordinal raw scores Scale Properties: Not reported
Reliability Indices	Interrater for over 40 different raters: • % of exact agreement (54%) is greater than predicted (43%) • Ratings between rater pairs are not significantly different ($\chi^2=8_{5df;}$ p=0.15) • Adjusted averages across 6 discipline groups indicate that he DOCS measure is impacted by only 0.18 points • Pearson separation reliability of 2.38 for CHI and 1.8 for Other BI indicates that items detect 3 levels of functioning within the continuum of altered consciousness. Cronbach's alpha =0.77	Interrater findings for 2 raters: k = 0.83 Spearman r = 0.60-0.96 Spearman's rank order r = 0.84 Test-retest Spearman r=0.94 (1 day separated between test)	Not reported	Interrater: r=0.70

Variable	DOCS	CRS	SMART	WNSSP
Construct Validity	PCA Items: 34 DOCS items explain majority (61%; 53.5/87) of total variance in observations. First factor explained 4% of total unexplained variance. Fit Statistics: 23 of 34 items have infit mean square statistics > 0.7 ≤ 1.3 and calibration (difficulty) remains stable over time (fall within 0.95 CI).	Not reported. Items misfitting in CRS were revised in CRS-revised	Not reported	Not reported
Concurrent Validity	• One published case study comparing DOCS and fMRI. • One published case study comparing DOCS, fMRI, and QEEG	GCS: r = 0.90 DRS: r = -0.93 CNC: r = 0.48 (p< 0.10) WNSSP: r=0.36 (NS) CRS-Revised: r=0.97 CRS-Revised & DRS: r=0.90	7 emerged WNSSP SMART	WNSSP $\times^2 = 7_{2df}$ p≤0.05 SMART $\times^2 = 13_{2df}$ p≤0.05 RLA: r=0.73
Predictive Validity	Outcome predicted: Recovery of consciousness within 365 days of injury. Significant predictor variables: • Dichotomized DOCS-1 • DOCS-Average • LOS dichotomized at 28 days • Presence of CHI Predictive values for DOCS-1: •True Positive = 0.71 •True Negative = 0.68	Outcome predicted: DRS score at time of hospital discharge. Significant predictor variable: • Difference of CRS admission and discharge raw scores (r=-0.78, p<0.01)	None reported	None reported
Targeting of Test to Population	Average person measures for CHI and other BI samples are closely aligned with average item calibrations. •No floor •No Ceiling	Not reported	Not reported	Not reported by authors. Floor effect noted by O'Dell et al., 2004

DOCS Authors Conclusions: Comparison of Psychometric Properties of DOCS Relative to Published Findings of Other Instruments:

DOCS:

- DOCS rating scale reflects progressively improving levels of neurobehavioral functioning throughout the continuum of altered consciousness.
- Allied health professionals can reliably administer the DOCS given 2 hours of training.
- The DOCS produces a sensitive, reliable, and valid measure of neurobehavioral functioning for patients emerging from a coma.
- Detecting differences between those persons who did recover consciousness versus those who did not improved if first DOCS was obtained within 94 days of injury.
- First DOCS measure when dichotomized to reflect high and low performers predicts recovery and lack of recovery of consciousness 1 year after injury.

- Predicting recovery and lack of recovery of consciousness 1 year after injury is improved further with use of a multivariate model composed of DOCS-Average length of IP rehabilitation stay, and an etiological variable.

CRS:

- Rate of improvement, as measured by change from admission CRS to discharge CRS, predicts DRS hospital discharge score.
- CRS-revised reliably and accurately distinguishes between vegetative and minimally conscious states.
- Scale is administered reliably by trained neurophysiologists.
- CRS-revised total score is stable when repeated assessment is done within 24 hours of initial assessment.

SMART:

- Emergence from vegetative state may be able to be determined with use of rate of change score; a larger confirmatory study is indicated.

WNSSP:

- Specific items capable of predicting rehabilitation readiness and recovery rate.

The DOCS is also different from other bed-side assessments because the DOCS is useful for predicting recovery of consciousness.[20,49] This salient difference is thought to be related to administration and scoring procedures as well as the rating scale. Test item administration procedures include, for example, providing multiple stimuli to elicit behavioral responses (e.g., tracking picture of self or tracking self in mirror).[50] Test stimuli administration procedures also provide multiple response modes (e.g., 'Is your name Jane?' and 'Tell me your name.'). These procedures as well as other procedures optimize opportunities for eliciting best responses. The multiple stimuli and response modes also enable differentiation between diminished responsiveness due to language impairments and impairments of arousal, wakefulness or awareness thereby avoiding an underestimation of the patient's level of consciousness. A patient, for example, may not respond to a language cue, but this does not necessarily mean the patient is at a lower level of consciousness.[51]

Summary: Why the DOCS is Different?

In summary, evidence indicates that the value added by the DOCS is (a) the prognostic utility, (b) sensitivity to detecting subtle changes in neurobehavioral functioning indicative of arousal, awareness and attention, (c) composite modality measures that can be used to identify individual strengths and weaknesses, (d) that total DOCS and DOCS composite measures can be used to monitor recovery, which enables ongoing refinement of rehabilitation goals and communication systems, (e) enables writing of measurable rehabilitation goals, and (f) enables examination of immediate medication efficacy on arousal, wakefulness and awareness.[20] The DOCS test stimuli, administration procedures, and scoring procedures were designed to allow the clinician to examine unconsciousness as a continuum of fluctuating levels of neurobehavioral integrity while detecting and distinguishing between actual true changes and random variation.

Theory of the DOCS:

The DOCS was designed as a transdisciplinary tool based on the theoretical concept that transdisciplinary intervention increases responsivity and it is one component of an evaluation environment that provides the patient with optimal opportunities to demonstrate responsiveness. Therefore, the DOCS, because of its transdisciplinary design, consist of a comprehensive set of test items and it elicits the patients "best responses." The administration guidelines also specify that optimal conditions are to be created so as to allow the patient to demonstrate responsiveness. The subsequent

profile of “best responses” helps rehabilitation professionals determine the patients’ level of cognitive performance.

Rating Scale Development:

The original DOCS rating scale distinguished five levels (0-1-2-3-4) of neurobehavioral integrity but was collapsed in 1999 to a three-category scale because not all rating scale points were used. The rating scale points are as follows: 0=No Response, 1=Generalized Response, 2=Localized Response. The rating scale defines transitions from low to middle to high neurobehavioral functioning within the continuum of altered consciousness.

Test Scoring & Scoring Forms:

The DOCS comprises of two scoring forms known as Form A (short version) and Form B (see appendix for forms). Form B was developed in 1992 and includes the baseline observation protocol, test stimuli administration procedures, and behavioral response interpretation guidelines. In 1999, Test B was expanded to also include examples within each subscale of behaviors that represent general and localized responses. Form A (short version) was also developed in 1999 and includes the baseline observation protocol and scoring grids. When administering the DOCS, the examiner may choose either Form A or Form B, however, novice examiners are encouraged to use Form B. The clinician scores the best behavioral response to the test stimuli on a 3 point scale (0=No Response, 1=Generalized Response, 2=Localized Response). Please refer to **Chapter 4** for additional information on DOCS test scoring.

Test Administration Procedure Development

Three concepts guided the development of the administration procedures and the selection of test stimuli for the DOCS. First, a method for discriminating between true and random responses of the test stimuli was required. To address this, the baseline observation protocol, which involves a systematic checklist, was developed. The baseline observational protocol is complete by the examiner observing the patient at rest for 2 to 5 minutes. Test stimuli can only be administered after the completion of the baseline observation protocol.

The second concept for the development of the DOCS was that the administration procedure should reflect allied health clinical judgment. The DOCS procedure state, for example, that easier items can be omitted if the examiner determines that a patient’s ability exceeds the challenge presented by a given test item.

The third concept was that potential confounders to distinguishing between true and random responses should be controlled before the examiner administers the first test item and during the entire testing process. The procedure for controlling these confounding variables include environmental (e.g. avoidance of extreme insults to the sensory system such as bright lights and unpredicted noises), position, and testing-readiness controls. Testing with the DOCS does not begin until environmental controls are in place. General positioning guidelines are followed throughout the DOCS evaluation along with some additional specifications for some of the test items.

The predictive value of the DOCS is thought to be related to testing procedures as well as the rating scale. Testing procedures allow for administration of multiple types of stimuli per test item (e.g., item = tracking familiar face where familiar face = involved in patient’s daily life at least one year prior to injury; test stimuli can include tracking picture of self, tracking self in mirror, tracking picture of wife, tracking wife). Similarly, testing procedures allow for multiple response modes (e.g., ‘Is your name Jane?’ and ‘Tell me your name’ yes/no responses can be provided via gestures, verbally or via eye gaze). The multiple stimuli and response modes optimize opportunities for eliciting best behavioral responses while enabling differentiation between diminished responsiveness due to language impairments and impairments of arousal, wakefulness or awareness. A patient, for example, may not respond to a

language cue, but this does not necessarily mean the patient is at a lower level of consciousness. These testing procedures minimize the possibility of underestimating a patient's level of consciousness.

Subscales Selection:

The test stimuli of the DOCS are organized into eight subscales: Social Knowledge, Taste & Swallowing, Proprioceptive, Auditory, Visual, Tactile, and Testing-Readiness. The test items in each subscale are ordered in a hierarchy from easy to difficult and this ordering was determined from pilot data. Below includes a summary of the subscales and theoretical basis for inclusion into the DOCS:

***Social Knowledge*:** The purpose of this subscale is to evaluate higher level cognitive functioning involving the frontal lobes during a social greeting. The level of cognitive responsiveness is determined by the patient's response to the social greeting which may be visual, verbal, gestural, or mouthing a word.

***Taste & Swallowing*:** The purpose for this sub-scale is to determine the patient's level of volitional control over salivation and swallowing. The level of cognitive responsiveness (e.g., LR versus GR) is determined by being aware of the patient's spontaneous salivation and swallowing behavior prior to stimulation. This sub-scale may shed light on the prognosis for the intake of nutrition orally. The stimuli include taste and tactile stimulation to the oral motor musculature associated with salivation and swallowing. Taste is one of the means of increasing salivation, which is a precursor to swallowing. Introduction of a foreign substance into the oral cavity increases salivation, which in turn also facilitates swallowing.[52-55]

Olfactory: The olfactory system functions to protect one self, assist digestion, facilitate recollection and give emotional substance to the environment, in conjunction with other sensory systems. Its connection areas incorporate the limbic system and its origin as one of the oldest parts of the brain, phylogenetically, implies significant input in behavior and emotion. Additionally, the loss of the sense of smell, either temporarily or permanently, occurs frequently after a TBI.[56] Therefore, researchers are further interested in investigating the relationship of olfactory sensation or lack thereof to functional outcome. While administering this sub-scale, it is important to not assume which stimuli are noxious and which are pleasant because smells can evoke memories for people, places or events that are unknown to the tester.

Proprioceptive: Proprioception refers to the joint receptors capacity to receive stimuli. The stimuli include the motion and position of the body with respect to the supporting surface and the motion and position of the body segments with respect to each other.[57-59]

Visual: Visual function is difficult to assess with the minimally conscious population, but visual responses to stimulation are frequently used to draw conclusions regarding the patient's overall level of cognitive responsiveness and whether or not they are re-emerging into consciousness.[60] The visual sub-scale reveals not only a possible mode for communication, but it could also yield information regarding a possible visual impairment (ie, cortical blindness). That is, a complete absence of visual orientation could be indicative of either a vegetative state or visual impairment (ie, cortical blindness). Whereas some degree of visual discrimination could be indicative of a minimally conscious state.[59-63] Visual tracking is defined as a patient following a moving object for a sustained period of time.[64] A sustained movement is defined as lasting 2-3 seconds in duration and it is a movement that is continuous and not random nor roving. There are two components to tracking: 1) fixation/focusing and 2) eyes following the object. Roving or non-random specific eye movements may be mistaken for tracking. In these instances, the patient may appear to "look through" the object or not focus on it. Tracking may occur spontaneously during the evaluation, rather than during the formal testing of it, and this should be considered when scoring the visual tracking and focusing responses.[60]

***Tactile*:** Heightened awareness of tactile sensation and/or tactile defensiveness, which was first defined by Ayres in 1964[65] are often observed following a severe TBI. These aberrant responses to tactile sensation are disorders of either sensory registration and/or integration. It has been theorized that firm touch, in these circumstances, is more soothing to the patient (i.e., as compared to light touch). Research, however, in this area is in its infancy. Therefore, the DOCS incorporates some of the principles of sensory integration so as to shed further light on their usefulness in facilitating functional recovery. The section that incorporates light tactile stimulation is included so as to evaluate sensory registration.[66] Pain has been excluded from the tactile sub-scale, since pain and temperature are subserved by the same tracts within the Central Nervous System (CNS). A pain stimulus can by elicited by prolonged icing of the skin.[58,59]

Auditory: The evaluation of auditory responsiveness is based on a developmental continuum, ranging from reflexive responses to noise, to general awareness of sound, to ability to localize sound sources, and finally, to associate sound with increasingly complex meaning. The auditory sub-scale is administered towards the end of the exam so that the clinicians can pre-determine a range of motor abilities. Then the patient is asked to follow commands that are tailored to his/her physical abilities.[67] The patients startle response is tested so as to evaluate the integrity of the cochlea, auditory nerve and brain stem mechanisms (ie, particularly if there is a history of basilar skull fracture or severe brain stem injury). Command following is a key element for assessing level of cognitive responsivity. That is, it provides evidence that language is perceived and that the patient has control over the execution.

Test Item Selection & Corresponding Neuroanatomical Level

Table 2 summarizes the relationship between the various subscales, the specific test item on the DOCS, and the highest level of central nervous system processing. Some DOCS test items are associated with more than one corresponding neuroanatomical level.

Table 2: Test Item Selection & Corresponding Neuroanatomical Level:

Subscale	Item Name	Highest Level of Central Nervous System Processing
Social Knowledge	Greet	Bilateral Hemispheric Function
Taste & Swallowing	Taste (Juice)	Upper brain stem and possibly dicencephalon
Taste & Swallowing	Taste (Contrasting Sweet & Sour)	Upper brain stem; possibly dicencephalon; and/or Thalamus
Taste & Swallowing	Massage	Upper brain stem and possibly dicencephalon
Olfactory	Odor (orange, peppermint, or vanilla extract)	Swallowing motor sequence; Medulla, Nucleus tractus solatarius, Nucleus ambiguous and pre-central gyrus for programming and uncus of temporal lobe
Proprioceptive & Vestibular	Joint: Passive Range of Limb	Parietal Lobe
Tactile	Light Tactile: Air	Parietal Lobe
Tactile	Light Tactile: Feather	Parietal Lobe
Tactile	Light Tactile: Hair	Parietal Lobe
Tactile	Light Tactile: Vibration to Toe	Parietal Lobe
Tactile	Firm Tactile: Hand Pressure	Parietal Lobe
Tactile	Firm Tactile: Scrub	Parietal Lobe
Tactile	Temperature: Swab	Parietal Lobe
Tactile	Temperature: Ice Cube	Parietal Lobe
Auditory	Startle: Clap	Pons (Lateral Lemniscus)
Auditory	Localization: Bell	Thalamus (Medial Geniculate)
Auditory	Comprehension: Command	Frontal Cortex, Pre-Central Gyrus
Visual	Blink	Midbrain (Superior Colliculus); Medulla & Pons Connection
Visual	Focus: Object	Bilateral Occipital Lobe Thalamus (Lateral Geniculate Nucleus)
Visual	Tracking: Object	Cortex (Parieto-Occiptal Lobe) & possibly sub-cortical structures
Visual	Tracking: Familiar Face	Bilateral Temporal-Occipital Lobe & Right Inferior-Occipital Lobe mesial surface
Visual	Focus: Familiar Face	Right greater than left Occipital Lobe

Chapter 3: Measurement & Technical Properties of the DOCS

This chapter describes the psychometric properties of the DOCS including a summary description of the evidence of reliability, accuracy and precision and the DOCS test. This chapter and the cited peer reviewed publications should be reviewed to facilitate a comprehensive understanding of the psychometric properties of the DOCS.

The data presented in this chapter was derived from five separate analyses. While the samples used for these analyses and the data collection procedures are summarized in this chapter, comprehensive details for two of the analyses are provided in peer reviewed articles.[20, 21, 49] If research methods are not available in peer-reviewed manuscripts, then we provide them in this chapter to augment the peer reviewed publications. First the samples for each of the five analyses are described. Data collection procedures, operational definitions (e.g., consciousness) and data preparation techniques used in each analysis is then described.

After describing the study methods for each of the five analyses, the psychometric properties of DOCS test including the rating scale are then described according to the results derived from each of the five analyses. The meaning of the rating scale is first described followed by reliability and validity. Results derived from the five analyses regarding predictive validity are then summarized.

STUDY METHODS

Samples:

The initial study sample was used for the first large scale analysis of the reliability, construct validity and predictive validity of the DOCS. The subjects for this initial study sample were recruited at time of acute rehabilitation admission in the United States. Persons 18 years of age and older at time of study enrollment with a severe brain injury (BI) as measured by an emergency room Glasgow Coma Scale-GCS ≤ 8 were eligible for study enrollment. If an emergency room GCS was not available, then the GCS at time of rehabilitation admission was computed. Patients who were comatose, vegetative and/or minimally conscious at time of study enrollment were eligible for inclusion. Patients who had recovered consciousness at time of enrollment were excluded. Persons with closed and open-head injuries and anoxia were eligible for inclusion. Patients with a history of neurological and/or psychological disorders were excluded.

The initial study sample (N = 95) included largely young (mean age at injury = 36 ± 15 years), men (85%) with closed head injuries (72%). Table 3 summarizes additional demographics at the time of injury for the initial study sample.

Table 3: Demographics of Initial Study Sample (N=95)

Variable	All BI (N=95)	CHI (n=68)	Other BI (n=27)	Sample Sizes
Age (Mean ± SD)	36 ± 15	35 ± 16	40 ± 14	---
Race (N=95)				
White	69 (73%)	56 (82%)	13 (48%)	69
Black	16 (17%)	7 (10%)	9 (33%)	46
Other	10 (10%)	5 (8%)	5 (19%)	10
Gender (N=95)				
Male	81 (85%)	59 (87%)	22 (81%)	81
Female	14 (15%)	9 (13%)	5 (19%)	14
Marital Status* (N=94)				
Married	42 (45%)	27 (40%)	15 (55%)	42
Single	42 (45%)	34 (51%)	8 (30%)	42
Divorced or Separated	9 (10%)	5 (8%)	4 (15%)	9
Widowed	1(<1%)	1 (1%)	0 (0%)	1
Education* (N=86)				
≤Grade 11	9 (10%)	6 (9%)	3 (14%)	9
High School or GED	21 (24%)	18 (28%)	3 (14%)	21
Some College (no degree)	29 (34%)	21 (33%)	8 (36%)	29
Community College or Trade School Degree	11 (13%)	6 (9%)	5 (22%)	11
Bachelors and/or Graduate Degree	16 (19%)	13 (21%)	3 (14%)	16
Employment* (N=87)				
Unemployed	20 (23%)	14 (22%)	6 (28%)	20
Full-Time	46 (53%)	36 (55%)	10 (45%)	46
Part-Time	13 (15%)	9 (14%)	4 (18%)	13
Full-time Student	8 (9%)	6 (9%)	2 (9%)	8
Insurance* (N=81)				
Uninsured	6 (7%)	6 (10%)	0 (0%)	6
HMO	13 (16%)	9 (16%)	4 (17%)	13
PPO	32 (40%)	21 (36%)	11 (48%)	32
Private Pay	13 (16%)	10 (17%)	3 (13%)	13
Other	17 (21%)	12 (21%)	5 (22%)	17
Household Income* (N=75)				
≤$14,999	11 (15%)	9 (16%)	2 (11%)	11
$15,000 to $49,999	19 (25%)	14 (25%)	5 (26%)	19
≥$50,000	45 (60%)	33 (59%)	12 (63%)	45

* Sums do not reach total sample size because of missing data

Four additional study samples have been analyzed since this initial analysis. Study eligibility criteria for these subsequent study samples were identical to inclusion and exclusion criteria for the initial study sample, but the definition of severe BI was refined to include only persons in a state of prolonged disordered consciousness. That is, persons in either a comatose, vegetative and/or minimally conscious state for at least 28 days consecutively were eligible.

The second study sample (N = 63) was used to examine/explore whether or not it is possible to predict activity and participation outcomes 1 year after severe brain injury. [21] This study was conducted because one of the most challenging tasks for clinicians is establishing a prognosis for long-term functional outcome while the patient is unconscious. This second study sample (N = 63) includes largely young (median age at injury = 35 years), white (81%), males (84%) with CHI (84%) who at the time of injury, were not married (63%), had received formal education beyond high-school (12th grade) (63%), were employed full or part time (64%) and had health insurance in the US (49%). The mean length of rehabilitation hospitalization was 53 days. Eighteen percent of the participants had not recovered consciousness 1–year after injury. For participants who did recover consciousness, the median number of days of unconsciousness was 122 days (range = 24-365) with 75% recovering consciousness within 221 days.

The third study sample (N=113) was used to examine the predictive validity of measures of DOCS neurobehavioral change for predicting return to consciousness 4, 8, and 12 months after a severe BI.[20] This third study sample (N = 113) includes mostly men (67%) with a mean age of 38 (±17.8 years) at time of incurring a traumatic BI (73%) or a non-traumatic BI (27%). The mean length of rehabilitation hospitalization was 59 (± 36.38 days). Sixty-five percent of the total sample recovered consciousness within the first 12 month of injury and 35% did not. Of those patients who recovered consciousness, median duration of unconsciousness was 85 days, ranging from 24 to 485 days.

The fourth study sample (N = 70) was used to examine whether or not it is possible to predict the level of autonomy with expression of basic needs and ideas 1 year after severe BI. The study sample includes mostly men (64 %) with an average age of 36 years. The majority recovered consciousness (72%) within 12 months of injury and, for these participants, the average duration of unconsciousness was 126 days. The DOCS Moderately-Complex average of 52 significantly (p value = .01) contributes to predicting more or less autonomy with expression one year after injury when controlling for time between injury and rehabilitation admission.

The fifth study sample (N = 25) was used to describe satisfaction with life one year after severe BI. The sample was abstracted from an ongoing longitudinal study where all participants incurred severe Traumatic BI, which is defined as a Glasgow Coma Scale (GCS) score $\leq$ 8 at time of study enrollment. Each participant was enrolled at time of admission to acute rehabilitation and followed for 12-months after date of injury. The abstracted sample includes twenty five persons $\geq$ 18 years of age rendered unconscious for more than 28 days consecutively. The sample of mostly (72%) young men (mean age of 35 years) were unconscious, for an average of 111 days.

DOCS Test Items used in Each of the Five Analyses:

The initial analysis examined the value of 34 DOCS items. This analysis demonstrated that 23 of the 34 items were valuable for prediction and were reliable and valid. The next analysis examining/exploring whether or not it is possible to predict activity and participation outcomes 1 year after severe brain injury, used these 23 DOCS items. The third analysis, examining the predictive value of different DOCS change measures when predicting time to consciousness, used these 23 items as well as six new or experimental test items. These 29 items were subsequently used in the fourth analysis examining the feasibility of predicting ability to express basic to complex ideas 1 year after severe traumatic BI. The fifth analysis used the 23 DOCS test items to examine satisfaction with life one year after severe traumatic BI.

Data Collection Procedures:

This section summarizes the data collection procedures generally used for all of the analyses. However, procedures for each analysis are provided in the respective peer reviewed publication. Data collection was conducted at different times during and after acute rehabilitation. Data sources included medical records (i.e., this includes billing records for non-VA sites), bed-side tests, monthly follow-up and 1-year outcome interviews.

As patients were admitted to each recruitment site, researchers screened for eligibility. If eligible, then the surrogate/legal representative was approached for consent. After obtaining consent, co-investigators repeated the GCS as a confirmation of study eligibility and injury severity. If the subject was enrolled, then emergency room, ICU and acute care records were obtained to determine days of unconsciousness, which is an additional confirmation of injury severity. All images acquired as part of routine medical care were obtained (e.g., MRI). Corresponding radiological reports were collected.

All data derived from the above medical records were coded according to a data coding manual provided to each site. To collect data not in the records, a surrogate interview after reviewing records was conducted. For data elements requiring direct testing, the bed-side tests were completed during acute rehabilitation. All study participants were evaluated weekly with the DOCS during rehabilitation

hospitalization up to 6 weeks. If during the six weeks the subject recovered consciousness, then DOCS evaluations were discontinued. Indices of DOCS change were derived from the repeated DOCS tests, which were repeated approximately every 7 days. The indices of change reflected the days between evaluations, but not the time after injury.

During rehabilitation hospitalization, each subject was also evaluated for indications of consciousness. After rehabilitation discharge, follow-up was performed monthly to evaluate consciousness and the outcome interview was performed at 1-year. Both the follow-up and the outcome interview were performed with the surrogate and/or primary caregiver via telephone. If the subject was conscious and able to participate in the telephone interviews, then questions were directed to the subject and caregiver. If there was a discrepancy between respondents, then all responses were recorded but the caregiver's response was considered accurate. If the subject was not conscious, then some of the outcome measures (e.g., quality of life) were not collected. Data collected during the outcome interview included, at a minimum, symptom data (i.e., Depression and Pain), paid and unpaid care giving hours, and levels of autonomy with expression and comprehension and activities. A portion of all DOCS evaluations, consciousness evaluations, monthly follow-up and outcome interviews, for each study, were randomly selected for repetition by an independent researcher. If discrepancies were identified, then they were discussed and resolved during project meetings.

Consciousness: Definition & Measurement:

During acute rehabilitation, consciousness evaluations were conducted 1-2 times per week at the subject's bedside by allied health clinicians. After acute rehabilitation, consciousness evaluations are conducted monthly via telephone interview. Given the lack of a well-established standard for measuring time to consciousness, we operationally defined return to consciousness according to the cross-discipline consensus knowledge that existed at the time of study start-up.[11,49] Consciousness required external and internal awareness demonstrated behaviorally by consistent manifestation of at least one of three criteria: (1) functional interactive communication, (2) functional use of an object or (3) a behavioral manifestation of sense of self in an environment. We then developed a consciousness algorithm (see appendix) according to consensus knowledge available at time of study start up. We also developed probes/questions and a scoring form so that post acute rehabilitation follow-up interviews regarding return to consciousness could be conducted in a uniform/standard manner and so that the clinician has sufficient guidance to use reported information to attribute consciousness to a given behavior. During the monthly follow-up evaluations, the clinician attributes consciousness and not the interviewee, but the clinician is using reported behaviors to make this attribution. The clinician uses the probes to acquire a thorough report of observed behaviors. The data obtained during acute rehabilitation and post rehabilitation discharge is used to specify a date of consciousness recovery. Return to consciousness can then be measured as time to consciousness or as a dichotomy of yes or no.

Data Preparation: Transformation of Raw Behavioral Data

When administering the DOCS, the clinician scores the best behavioral response to the test stimuli, which is different from baseline behaviors, on a 3 point scale (0=No Response, 1=Generalized Response, 2=Localized Response) (See **Chapter 4 Scoring Procedures** for more details). These raw scores for each of the five analyses were then converted to equal-interval measures with the use of the rating scale (i.e., partial credit) model and facets model.[20, 21, 49] These models are conjoint (additive) probability models that estimate person measures and item difficulties with the use of the maximum likelihood estimation for each element identified in the models. The rating scale model includes a person's ability and test item difficulty whereas the facets model includes rater severity as well as person ability and test item difficulty.

Based on findings from the initial analyses of the DOCS psychometric properties, the DOCS measure can be converted to a 0 to 100 scale while remaining an equal interval measure. Results from the initial analysis indicated that the range of the DOCS instrument based on a baseline measure (DOCS-1) is approximately 8 logits (-4.0 to 4.0 logits). Using this range, then the logit scale can be

transformed into a scale that is more easily understood for clinical applications (DOCunit=50 + (logit x 12). This convenient transformation is referred to as the "DOCunit" (DOCS Measure) and gives the DOCS a range of 0 to 100. After this transformation, the standard error of the DOCS for a participant with all items administered is approximately 4 DOCunits. With this precision, decimal places are uninformative at the individual level and are therefore not reported. The conversion of raw scores to logit and then to the DOCunit (DOCS measures) allows it to be easily understood and used in parametric statistics. This conversion was completed each of time an analysis was conducted. **Table 4** summarizes the average item calibrations in DOCunits (DOCS measure) and outfit mean squares by difficulty and samples for the remaining 23 items:

Table 4 - Average Item Calibration in DOCunits (DOCS Measure)

CHI Sample					Other BI Sample				
Item No.	Item Name	Description	Item Calibration	Outfit Mean Square	Item No.	Item Name	Description	Item Calibration	Outfit Mean Square
T3	HAIR	Hard	61.3	0.97	T3	HAIR	Hard	60.9	0.07
C1	GREET		56.7	1.28	V5	TRACKING		59.3	0.99
T7	SWAB		56.1	1.20	T7	SWAB		58.1	0.79
T6	SCRUB		55.3	1.08	V7	TRACK FACE		57.2	0.90
T1	AIR		53.2	1.02	V4	FOCUS		56.7	0.85
V5	TRACKING		53.1	0.74	V8	FOCUS FACE		51.9	0.14
V7	TRACK FACE		52.5	0.73	C1	GREET		51.7	0.85
A5	BELL		52.1	0.81	A6	COMMAND		51.7	0.11
T5	HAND		51.7	0.80	A5	BELL		51.2	0.72
A3	NAME		50.7	0.60	T6	SCRUB		50.6	0.76
A6	COMMAND		50.2	0.77	T5	HAND		50.5	0.20
A1	WHISTLE		49.5	1.07	PV1	JOINT		49.8	0.10
T2	FEATHER		48.6	0.87	A3	NAME		48.4	0.73
S2	MASSAGE		47.6	1.71	T8	CUBE		47.9	0.15
A2	CLAP		47.4	0.99	V3	BLINK		47.8	0.06
V4	FOCUS		47.3	0.84	O1	ODOR		47.6	0.26
T8	CUBE		47.2	1.01	T2	FEATHER		46.8	0.67
V8	FOCUS FACE		47.0	0.79	S2	MASSAGE		46.6	0.13
O1	ODOR		46.8	1.02	T4	TOE		46.3	0.35
T4	TOE		46.3	1.24	A1	WHISTLE		44.9	0.15
PV1	JOINT		45.3	0.94	T1	AIR		43.6	0.97
V3	BLINK		44.2	1.51	A2	CLAP		41.9	0.00
S1	JUICE	Easy	40.0	1.40	S1	JUICE	Easy	38.6	0.10
		MEANS	50.0	1.0			MEANS	50.0	0.40

PSYCHOMETRIC PROPERTIES OF DOCS TEST:

DOCS Rating Scale:

The initial analysis (N = 95) indicates that for all participants the DOCS rating scale reflects progressively improving levels of functioning as demonstrated by the monotonic ordering of the average DOCS measures for each category of the rating scale (0= -8.0, 1=0.10, 2=8.5). This indicates that lower-rating categories were more probable for persons with lower levels of neurobehavioral functioning and the higher-rating categories was more probable for persons with higher levels of neurobehavioral functioning. The transition points between categories of the rating scale, step threshold measures, are also monotonically ordered (-15.71, 15.71), indicating that each of the three-rating categories is most likely to be used according to improving neurobehavioral status. Scale stability is also evidenced by the observation that the majority of the items (75%, 26/34) and the corresponding average measures for each of the 34 items, according to each category of the rating scale, maintain monotonic ordering. **Table 5** provides additional information regarding the average measure in DOCunit (DOCS measure) by item and rating category.

Table 5: Average Measures in DOCunit (DOCS Measure) by Item & Rating Categories

Item Name	Rating Category	Sample Size	Average Measure	Standard Error
GREET	0	81	43.61	0.93
	1	41	51.26	1.52
	2	33	57.41	1.39
JUICE	0	28	42.32	1.92
	1	79	47.05	0.85
	2	132	55.18	0.99
MASSAGE	0	54	45.41	1.21
	1	85	49.27	1.00
	2	75	55.76	1.32
SPOONW	0	35	42.40	1.23
	1	36	48.85	1.46
	2	69	54.29	1.03
SPOONC	0	17	43.92	2.42
	1	47	43.99	1.07
	2	76	54.74	0.94
TAP	0	15	41.29	1.70
	1	47	44.61	1.17
	2	104	55.75	1.12
STROKE	0	18	41.98	1.97
	1	45	44.52	1.26
	2	102	56.07	1.11
GUMS	0	36	41.90	1.46
	1	58	47.95	1.07
	2	109	53.62	0.97
ICING	0	77	46.07	0.97
	1	55	49.43	1.37
	2	71	56.24	1.28
SMELL	0	85	44.33	1.01
	1	58	51.13	1.06
	2	69	58.56	1.46
ODOR	0	67	42.38	1.13
	1	65	49.83	0.91
	2	92	57.74	1.17
JOINT	0	54	42.53	1.20
	1	79	49.35	0.94
	2	84	58.02	1.23
AMBIENT	0	95	46.02	0.91
	1	28	54.28	1.14
	2	35	63.76	2.21
BLINK	0	74	43.23	1.03
	1	11	49.83	1.61
	2	124	57.46	0.93
FOCUS	0	93	43.30	0.78
	1	20	52.73	1.48
	2	96	59.60	1.06
CONVERGE	0	127	47.35	0.89
	1	49	57.20	1.12
	2	16	68.67	3.49
TRACKING	0	111	44.49	0.75
	1	32	54.01	1.04
	2	70	61.70	1.19
DILATION	0	42	41.35	1.71
	1	36	47.32	1.28
	2	151	54.00	0.88

Item Name	Rating Category	Sample Size	Average Measure	Standard Error
TRACKFACE	0	78	43.61	0.88
	1	17	51.68	1.51
	2	44	59.54	1.09
FOCUSFACE	0	64	42.58	0.97
	1	12	47.44	2.00
	2	63	57.43	0.91
AIR	0	75	44.51	1.11
	1	79	50.06	0.87
	2	67	57.77	1.38
FEATHER	0	62	43.38	1.29
	1	94	48.31	0.79
	2	72	58.74	1.27
HAIR	0	129	46.22	0.87
	1	56	53.15	1.05
	2	24	64.64	3.24
TOE	0	77	43.11	1.12
	1	45	51.52	0.93
	2	108	55.46	1.09
HAND	0	78	44.28	1.08
	1	93	49.87	0.87
	2	56	60.28	1.56
SCRUB	0	99	44.85	1.01
	1	87	50.38	0.77
	2	48	61.16	1.77
SWAB	0	111	44.52	0.85
	1	52	53.64	1.01
	2	38	59.08	1.89
CUBE	0	82	42.79	0.97
	1	48	50.70	1.09
	2	97	56.40	1.16
CLAP	0	58	43.02	1.24
	1	82	47.91	0.88
	2	97	56.97	1.15
WHISTLE	0	57	43.52	1.24
	1	64	49.66	1.09
	2	68	56.33	1.40
NAME	0	88	41.93	0.83
	1	64	50.93	0.74
	2	88	59.78	1.08
BELL	0	88	43.06	0.95
	1	75	51.20	0.90
	2	61	59.58	1.39
TV	0	73	44.72	0.99
	1	31	52.97	1.31
	2	27	62.39	2.06
COMMAND	0	100	43.19	0.80
	1	48	51.53	0.90
	2	92	59.78	1.18

Reliability & Validity:

In the initial analysis, the facets model was used to analyze inter-rater reliability and rater severity, because each person, item, and rater is individually parameterized in the model. The allied health professional who conducted the DOCS for which the inter-rater reliability analyses were conducted comprised of 12 speech-language pathologists, 12 physical therapists, 14 occupational therapists, 2 registered nurses, 2 neuropsychology doctoral candidates, and 2 respiratory therapists. This large group of raters was chosen to enhance generalizability. That is, real world rehabilitation involves multiple allied health disciplines testing unconscious patients to determine level of functioning.

To examine construct validity, the stability of the rating scale over time was examined. It was examined for (a) the fit of each test item relative to the underlying construct of neurobehavioral functioning, (b) the fit of each participant to the response sets of the entire sample, and (c) the stability of item calibration over time.

To examine predictive validity we evaluated the performance characteristics of the DOCS that would be most useful and accurate for predicting recovery of consciousness within the first year of injury. We also evaluated the predictive validity of the DOCS for activity and participation and satisfaction with life at 1 year post injury.

Inter-rater Reliability: Agreement & Severity

Inter-rater reliability was examined using the initial study sample pair-wise across all raters to compute the percent-observed agreement versus percent-predicted agreement using the facets model. Over the entire data set, 33,003 exact agreement opportunities were present. The percentage of actual exact agreement under identical conditions (54.4%) is slightly greater than the percent agreement predicted by the facets model (43.8%). This ratio is analogous to a Kappa of .95.[1] Strong rater agreement is also evidenced by findings indicating that ratings between all pairs are not significantly different ($\chi^2 = 8_{5df}$ $p = .15$) indicating that the raters are acting as independent experts and are unlikely to be rating by consensus.

The DOCS was also examined by individual raters according to allied health disciplinary groups. Since failure to assign appropriate scores can be driven by factors related to the rater (e.g., discipline, experience), all sets of ratings were examined for the presence of systematic rater errors (i.e., severity or leniency, halo, central tendency, and restriction of range) by using “rater by discipline” as a covariate in the Facets measurement model.[1] Results indicate that the DOCS measure, by discipline groups, impacted rater drift by only .18 raw score points. Neuropsychologists tended to score lower (more severe) than other disciplines by an average of .18 points, but this trend did not bias the DOCS measure. Collectively, these findings indicate that ratings were done in the same manner across raters with negligible impact on DOCS measures.

Construct Validity:

Evidence of construct validity is provided by how well the DOCS measures what it purports to measure (neurobehavioral functioning). If the behavioral responses to test stimuli describe neurobehavioral functioning meaningfully, MCS participants should manifest more localized responses while VS participants should demonstrate a more generalized response to the difficult items. Demonstrating localized responses to each incrementally more difficult task should translate to more intact central nervous system processing. Construct validity was evaluated with the principal component analyses (PCA) of residuals and with the examination of fit indices and item calibration for each time point.

The PCA of item residuals was conducted to determine whether a secondary dimension is in the test item or whether the unexplained residual variance can be attributed to random fluctuations in the

[1] Kappa = (.544 - .438) / (100 - .438) = .001; Conventionally "expected agreement %" is level of chance agreement based on the marginal frequencies of contingency tables. Kappa values > 0 are desired, but, under model conditions, "expected agreement %" is the model prediction; so expected value of Kappa is 0.0.

observations. PCA detected correlations among the item residuals. Results indicated that the DOCS measure (eigenvalue = 53.5) explained the majority (53.5/87.5, 61%) of the total variance in the observations; the first factor of the residuals accounted for only 4% of the residual variance (eigenvalue = 3.5/34.0). Comparing the strength or power of the 34 DOCS items to the power of the first factor allowed for a determination of whether 4% was or was not a meaningful secondary dimension. Eigenvalue for the 34 DOCS items was 15 times stronger that the eigenvalue for the first factor, suggesting that the structure to the unexplained variance in the item residuals was negligible. An additional examination of the factor contrasts confirmed that no meaningful substructure exists. Together, this evidence indicated that the first factor in the residuals was dominated by noise, and there was no practical impact on the measurement of neurobehavioral functioning with the DOCS test items.

Validity on 23 of the 34 test stimuli remained stable over time with no floor or ceiling effects. DOCS measures obtained within 94 days of injury predicted recovery of consciousness up to 1 year after injury. The DOCS has not been published for diagnostic validity. Construct validity was evaluated to determine how well the DOCS test actually measures neurobehavioral functioning was examined with fit indices and item calibrations for each of six time points. Evidence indicates that unexplained residual variance from test items is due to random fluctuations with no impact on measurement of neurobehavioral functioning. Fit statistics indicated that items do not over-fit (not < .70) and are not overly predictable (not > 1.3). Outfit statistics for the 23 items indicate that all items fall within the acceptable range (.70 - 1.30; a conservative range) and provide independent information about neurobehavioral functioning.

Predictive Validity:

The predictive value of the DOCS is thought to be related to testing procedures as well as the rating scale. Testing procedures allow for administration of multiple types of stimuli per test item (e.g., item = tracking familiar face where familiar face where familiar = involved in patient's daily life at least one year prior to injury; test stimuli can include tracking picture of self, tracking self in mirror, tracking picture of wife, tracking wife). Similarly, testing procedures allow for multiple response modes (e.g., 'Is your name Jane?' and 'Tell me your name', yes/no responses can be provided via gestures, verbally or via eye gaze). The multiple stimuli and response modes optimize opportunities for eliciting best behavioral responses while enabling differentiation between diminished responsiveness due to language impairments and impairments of arousal, wakefulness or awareness. A patient, for example, may not respond to a language cue, but this does not necessarily mean the patient is at a lower level of consciousness. These testing procedures minimize the possibility of underestimating a patient's level of consciousness.

Predictive Validity: Recovery of Consciousness

The DOCS was evaluated to identify the performance characteristics that are more useful and accurate for predicting recovery of consciousness. The baseline DOCS was examined for predictive value in the initial study sample (N = 95) where recovery of consciousness at one year was dichotomized as yes or no. Another sample (N = 113) was used to examine the predictive value of the DOCS in predicting recovery of consciousnesses at 4, 8, and 12 months after injury. For this follow-up analysis we examined the predictive value of (1) indices of DOCS change, (2) number of DOCS tests used to compute change, (3) magnitude of change, and (4) magnitude of change over time.

Predictive Value of Baseline DOCS

When examining the predictive value of the baseline DOCS for predicting recovery of consciousness at 1 year, we examined with bivariate analyses, mixed random effects, regression analyses, a comparison of four logistic regression model, and a comparison of actual versus predicted outcomes. Thirteen predictor variables (**Table 6**) were examined. DOCS measures derived from the refined set of 23 DOCS test items were the primary predictor variables of interest and were used as point-estimates in the validity analyses. The dichotomous outcome was whether or not a participant recovered consciousness within 1 year of injury.

Table 6 - Predictor Variables Defined for Baseline DOCS Analyses

Predictor Variable	Definition
Age	Age at time of injury
Male	Being male or not being male
HS	Had a high school diploma or equivalent or more than high school education at time of injury
Marital Status	Being married or not being married at time of injury
Employed	Being employed full-time or not being employed full time at time of injury
Insurance	Having PPO or HMO insurance, insurance other than PPO or HMO, or no insurance
CHI	Incurred a closed-head injury or other type of brain injury
LOSIPR	Length of stay for inpatient rehabilitation hospitalization, up to three separate admissions summed in days
DOCS-Average	The sum of each participant DOCS measures divided by the total number of DOCS evaluations [∑(DOCS-1 + ...+DOCS-6)/No. DOCS evaluations]; average DOCS measure
DOCS-1	Initial DOCS neurobehavioral measure; DOCS measure from first DOCS evaluation; baseline DOCS
DOCS-1 Days	Number of days after injury that DOCS-1 was obtained
DOCS-Slope	DOCS Neurobehavioral Recovery Slope (β_1) as derived from mixed random effects regression analyses of 95 participants (68 CHI; 27 other types of brain injuries)
DOCS-Intercept	DOCS initial severity level (β_o) as derived from mixed random effects regression analyses of 95 participants (68 CHI; 27 other types of brain injuries)
PPO=preferred provider option, HMO=health maintenance organization, HS=high school	

Initial Severity & Recovery Rates by Individuals & Groups: For the mixed random effects regression model, the individual participants and time served as the random effects. The fixed effects were the etiological groups (N=95; CHI=68; other BI=27) and time by group interaction (Time x Group). Results indicated that the CHI and other BI group did not significantly differ according to initial severity (mean DOCS = 43.04 DOCunits). Both groups exhibited an overall improvement of 51.08 DOC measures every 3 weeks (21 days). This finding means that a statistically significant change takes place at approximately 6 month, but a clinically significant change of 50 DOCS measures take about 4 months. The rate of improvement between the two groups was not significantly different, but a significant variation was found in individual participant's initial severity (p=0.001) and rate of improvement between individual participants (p=0.04). No significant covariance was found between these two terms (p=0.07).

Bivariate Results & Multivariate Model Development: Follow-up data were collected for 72 of the 95 participants. The bivariate and multivariate analyses included all DOCS-1 assessment regarding of when the first DOCS assessment was completed. Bivariate and multivariate analyses were then repeated on a subsample of 55 participants (55/72) who received the DOCS-1 assessment within 94 days of injury. Data analyses included chi-square tests, t-tests, and Pearson correlation coefficients for bivariate analyses evaluating the association between predictor variables and the recovery of consciousness at 1 year post injury. The results indicated that persons who recovered consciousness within 1 year had a significantly higher percentage of CHIs, had significantly better DOCS-Intercept and DOCS-Average, were seen for their first DOCS assessment significantly earlier after injury, and had significantly longer length of stay for IP rehabilitation. DOCS-1 measures were better (higher) but only at the trend level for those recovering consciousness 1 year after injury. Bivariate analyses of the subsample of 55 participants who had a DOCS-1 administered within 94 days of injury indicate that persons who recovered consciousness had significantly higher (better) DOCS-Average, DOCS-Slope, and DOCS-Intercept. The DOCS-Slope, which is an indicator of recovery rate, was significantly different between those who recover and those who do not recover consciousness within 1 year of injury when obtained from a DOCS measure obtained before 94 days post injury. **Table 7** summarizes additional details of these analyses.

Table 7 - Bivariate Analyses According to Entire Sample & Subsample

	Total Sample (DOCS-1= 8-424 days after injury; n=72)			Subsample (DOCS1= 8-94 days after injury; n=55)		
Predictor Variable	**Recovered Consciousness within 365 days (n=46)**	**Did NOT Recover Consciousness within 365 days (n=26)**	***p*-Values**	**Recovered Consciousness within 365 days (n=46)**	**Did NOT Recover Consciousness within 365 days (n=26)**	**p-Values**
Age	**34.5 ± 15.1**	**34.6 ± 12.5**	**0.97**	**33.4 ± 15.9**	**36.9 ± 13.3**	**0.43**
Male	**89.1%**	**76.9%**	**0.19**	**89.5%**	**76.5%**	**0.24**
HS	**31.8%**	**40.9%**	**0.59**	**30.6%**	**33.3%**	**0.99**
Marital Status	**39.1%**	**48.0%**	**0.62**	**36.8%**	**52.9%**	**0.38**
Employed	**54.6%**	**52.0%**	**0.99**	**50.0%**	**58.8%**	**0.57**
Insurance	**59.5%**	**60.0%**	**0.99**	**57.1%**	**76.9%**	**0.32**
CHI	**80.4%**	**53.9%**	**0.03***	**84.2%**	**58.8%**	**0.08**
LOSIPR	**65.7 ± 36.0**	**39.7 ± 38.4**	**0.01***	**67.2 ± 35.5**	**45.5 ± 45.6**	**0.08**
DOCS-Average	**0.97 ± 1.1**	**0.04 ± 1.3**	**0.002***	**0.96 ± 1.1**	**-0.24 ± 1.1**	**0.0004***
DOCS-1	**0.18 ± 1.3**	**-0.53 ± 1.2**	**0.06**	**0.18 ± 1.3**	**-0.53 ± 1.3**	**0.06**
DOCS-1 Days	**66 ± 56**	**106 ± 92**	**0.05***	**47 ± 22**	**54 ± 1.3**	**0.24**
DOCS-Slope	**0.07 ± 0.12**	**0.11 ± 0.14**	**0.19**	**0.06 ± 0.13**	**0.14 ± 0.13**	**0.04***
DOCS-Intercept	**-0.27 ± 1.0**	**-0.91 ± 1.1**	**0.002***	**-0.19 ± 0.9**	**-1.06 ±1.0**	**0.002***

Predictive Values Positive & Negative & Multivariate Model Development: A receiver-operating characteristic curve (ROC) was constructed for the subsample of 55 persons first evaluated with the DOCS within 94 days on injury. The 10, 25, 50, 75, and 90 percent quintiles of the DOCS-1 were used as the cut points to compare the predicted recovery with the actual recovery. The corresponding true positive and false positive rates are summarized in **Table 8**. The median DOCS-1 cut point (48.08) was the most balance with initial DOCS accurately predicting the recovery of consciousness 71 percent of the time and the lack of recovery 68 percent of the time. The area under the ROC curve is 0.73, indicating that the DOCS-1 can discriminate between persons who did and did not recover consciousness within 1 year 73 percent of the time.

Table 8 - Predictive Values Positive & Negative

DOCS-1 Cut Point (DOCunits)	True Positive (%)	True Negative (%)	False Positive (%)	False Negative (%)	Correctly Classified (%)
30.32	18	95	5	82	71
42.2	41	84	16	59	71
48.08	71	68	32	29	69
53.84	82	37	63	18	51
63.92	88	13	87	12	36

Predictive Value of DOCS Change:

When examining predictive validity of indices of DOCS change we controlled for possible etiological bias by estimating DOCS measures three different times and each time we used the rating scale (partial credit) model. That is DOCS measures were estimated for each of three groups: (a) total sample (N=113), (b) Traumatic BI (83/113), and (c) Non-traumatic BI (30/113). The Traumatic BI group (n=83) included closed head injuries, blunt TBI, blast TBI, and non-brain-penetrating gunshot wounds to the face or neck. Participants with severe brain injury caused by anoxia, cancer, cerebral infarctions, hemorrhages, aneurysms, and arteriovenous malformations formed the non-traumatic BI group (n=30).

Baseline DOCS, subsequent DOCS measures (DOCS2, DOCS3, DOCS4, DOCS5, DOCS6) and the average number of days post injury that each DOCS was completed are presented in **Table 9**. The TBI and Non-traumatic groups did not differ in baseline DOCS, indicating that both groups were comparable according to neurobehavioral functioning at time of study enrollment. Baseline DOCS was

obtained significantly earlier for the Traumatic BI groups. The Traumatic BI and Non-traumatic BI groups did not differ in number of days between evaluations, except for DOCS 4, where the Non-traumatic BI group was evaluated significantly later.

Table 9 – Average DOCS Measures & Days After Injury DOCS Completed

	Groups	n	Mean DOCS ± SD	*P* Value	Mean Day after Injury ± SD	*P* Value
Baseline DOCS	Total Sample	113	47.4 ± 11.0		48.2 ± 20.6	
	TBI	83	47.9 ± 12.0	.703	45.9 ± 20.9	.036
	OBI	30	47.1 ± 7.6		55.1 ± 18.4	
DOCS2	Total Sample	92	50.4 ± 11.6		61.6 ± 33.9	
	TBI	64	50.5 ± 12.3	.710	61.6 ± 39.0	.971
	OBI	27	49.7 ± 10.0		61.9 ± 18.6	
DOCS3	Total Sample	63	51.0 ± 11.8		67.7 ± 27.2	
	TBI	45	52.0 ± 13.1	.102	64.9 ± 29.5	.209
	OBI	18	47.7 ± 7.1		74.6 ± 20.1	
DOCS4	Total Sample	45	51.4 ± 10.3		77.4 ± 29.3	
	TBI	30	52.3 ± 11.2	.372	70.1 ± 25.4	.017
	OBI	15	49.6 ± 8.3		91.8 ± 32.0	
DOCS5	Total Sample	44	53.7 ± 13.3		89.2 ± 32.4	
	TBI	32	55.3 ± 15.6	.325	80.8 ± 27.7	.057
	OBI	12	51.1 ± 7.9		103.1 ± 36.0	
DOCS6	Total Sample	22	50.3 ± 9.2		113.5 ± 40.1	
	TBI	20	52.2 ± 10.7	.209	106.1 ± 35.8	.345
	OBI	9	47.9 ± 6.0		123.3 ± 45.5	

DOCS=Disorders of Consciousness Scale, SD=standard deviation, TBI=traumatic brain injury, OBI=other brain injury

The average amount of DOCS change from baseline and each subsequent DOCS (**Table 10)** increased for the total sample from 4 units to 10 units at the time of the fifth DOCS evaluation (DOCS5) and then declined to 6 units at the time of DOCS6. The groups did not significantly differ in magnitude of change except from baseline DOCS to DOCS3, where the Traumatic BI group made significantly more improvements. This finding corresponds with later time in the recovery trajectory for DOCS4 for the Non-traumatic BI group.

Table 10 – Mean Change Between DOCS1 & Subsequent DOCS

Baseline DOCS Through	Groups	n	Mean	SD	*P* Value
DOCS2	Total Sample	92	4.24	10.37	
	TBI	64	5.00	11.20	.262
	OBI	27	3.00	8.24	
DOCS3	Total Sample	63	5.94	9.80	
	TBI	45	7.50	10.15	.027
	OBI	18	2.02	7.81	
DOCS4	Total Sample	45	6.94	11.32	
	TBI	30	8.84	11.89	.088
	OBI	15	3.16	9.31	
DOCS5	Total Sample	32	10.10	14.50	
	TBI	20	12.76	16.20	.131
	OBI	12	5.55	10.04	
DOCS6	Total Sample	22	6.20	10.40	
	TBI	13	9.22	11.23	.076
	OBI	9	1.74	7.53	

How and whether DOCS change accurately predicted the recovery of consciousness at 4, 8, and 12 months after injury was assessed via an examination of difference between sensitivity and specificity, by comparing positive and negative predictive (PPV/NPV) values and by inspecting predicted probabilities. An examination of sensitivity, specificity, PPV, NPV for each index of DOCS change (**Table 11**) was conducted by dichotomizing magnitude of change based on the median change (cut-off points) from baseline to each subsequent DOCS assessment (e.g., 4 change units between baseline DOCS and DOCS2 was cut-off point for variable DOCSchg1-2). Baseline DOCS was dichotomized by the median (48 units). The value above cut-off points were considered as positive tests and the values below the cut-off points were considered as negative tests.

Both sensitivity and specificity were used to identify the most balanced measures of DOCS change. The values set in bold within **Table 11** indicate DOCS change measures with maximum balance (i.e., minimum difference) between sensitivity and specificity for each of the 3 time points (4,8, and 12 months after injury).

Table 11 – Predictive Values Positive & Negative by 4, 8, and 12 Months After Injury

Group	Indices of Change	4 Months					8 Months					12 months				
		AUC	Se	Sp	PPV	NPV	AUC	Se	Sp	PPV	NPV	AUC	Se	Sp	PPV	NPV
Total Sample	Baseline DOCS	.87	.81	.81	.90	.66	.88	.82	.81	.88	.73	.79	.72	.71	.69	.74
	DOCStotalchg	.86	.81	.77	.89	.65	.84	.80	.70	.82	.68	.77	.72	.71	.69	.74
	DOCSchg1-2	.89	.75	.75	.84	.62	.87	.74	.73	.79	.67	.81	.73	.72	.65	.79
	DOCSchg1-3	.88	.71	.73	.81	.62	.87	.74	.73	.77	.70	.87	.78	.79	.72	.84
	DOCSchg1-4	.85	.72	.71	.78	.63	.85	.76	.76	.76	.76	.87	.80	.78	.67	.88
	DOCSchg1-5	.87	.82	.85	.88	.79	.87	.79	.81	.79	.81	.91	.78	.81	.64	.90
	DOCSchg1-6	.93	.83	.88	.91	.78	.80	.70	.70	.70	.70	NC	NC	NC	NC	NC
	DOCSavg	.84	.81	.81	.90	.66	.84	.79	.78	.86	.69	.75	.67	.67	.65	.70
TBI	Baseline DOCS	.82	.78	.76	.91	.52	.83	.80	.80	.91	.62	.73	.67	.66	.70	.62
	DOCStotalchg	.84	.78	.77	.91	.52	.81	.75	.75	.88	.54	.76	.74	.75	.78	.71
	DOCSchg1-2	.91	.84	.87	.94	.68	**.88**	**.83**	**.83**	**.91**	**.70**	.80	.69	.70	.69	.70
	DOCSchg1-3	.87	.74	.75	.87	.56	.83	.80	.79	.87	.69	.83	.74	.75	.74	.75
	DOCSchg1-4	.84	.70	.67	.82	.50	.81	.78	.82	.88	.69	.83	.77	.75	.71	.80
	DOCSchg1-5	**.87**	**.86**	**.83**	**.92**	**.71**	.81	.75	.75	.82	.67	**.88**	**.88**	**.92**	**.88**	**.92**
	DOCSchg1-6	.88	.75	.75	.86	.60	.83	.86	.57	.86	.80	NC	NC	NC	NC	NC
	DOCSavg	.82	.78	.76	.91	.52	.81	.80	.80	.91	.62	.71	.64	.63	.68	.59
OBI	Baseline DOCS	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	.89	.86	.80	.60	.94
	DOCStotalchg	NC	NC	NC	NC	NC	.98	.90	.88	.82	.94	**.83**	**.71**	**.70**	**.46**	**.88**
	DOCSchg1-2	NC	NC	NC	NC	NC	**.97**	**.88**	**.87**	**.78**	**.93**	.84	.60	.67	.33	.86
	DOCSchg1-3	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
	DOCSchg1-4	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
	DOCSchg1-5	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
	DOCSchg1-6	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC	NC
	DOCSavg	NC	NC	NC	NC	NC	.77	.80	.76	.67	.87	.89	.71	.65	.42	.87

Baseline DOCS is ≤ 48 or > 48; DOCStotalchg = DOCS Change from 1st to the last DOCS ≤ 3 OR > 3; DOCSSchg1-2 = DOCS change from 1st to 2nd DOCS is ≤ 4 OR > 4; DOCSchg 1-3 = DOCS change from 1st to 3rd DOCS is ≤ 5 OR > 5; DOCSchg 1-4 = DOCS change from 1st to 4th DOCS is ≤ 6 OR > 6; DOCSchg 1-5 = DOCS change from 1st to 5th DOCS is ≤ 8 OR > 8; DOCSchg 1-6 = DOCS change from 1st to 6th DOCS is ≤ 6 OR > 6; DOCSavg = DOCS average for each participant ≤ 51 OR > 51

Values set in bold indicates DOCS change measure with maximum balance (ie, minimum difference) between sensitivity and specificity for each of the 3 times points (4,8, and 12 months after injury).

AUC= area under the receiver operating characteristics curve; PPV=positive predictive value; NPV= negative predictive value; Se=sensitivity; Sp=specificity; NC=not computed because of small sample size

The Influence of DOCS change on outcome prediction was examined by comparing predicted probabilities according to 7- 8- and 9-minimally clinically important units of DOCS gains/declines (Table 8). Quintiles represents baseline DOCS neurobehavioral functioning. **Table 12** indicates that for baseline DOCS measures obtained within 94 days of injury and if subsequent DOCS measures used to define change are obtained at least 7 days and at most 18 days of the baseline DOCS, then the difference can be used to determine each patient's probability for recovering consciousness. We know further that these probabilities for recovery and lack of recovery will be accurate 88% (AUC = .88) of the time.

Table 12 – Predicted Probabilities for Recovery of Consciousness in 1 Year Given Increments of 7, 8, or 9 Units of Change

Change in DOCS (in DOCS units)

If Baseline DOCS Score is…..	Decline									Plateau				Improve					
	-27	**-24**	**-21**	**-18**	**-16**	**-14**	**-9**	**-8**	**-7**	**0**	**7**	**8**	**9**	**14**	**16**	**18**	**21**	**24**	**27**
34.4	.016	.021	.029	.039	.047	.057	.091	.100	.110	.202	.340	.364	.388	.514	.564	.614	.683	.746	.799
43.3	.050	.067	.088	.116	.139	.166	.249	.268	.289	.453	.629	.653	.675	.776	.810	.839	.876	.906	.929
48.3	.092	.122	.158	.204	.239	.278	.391	.415	.440	.617	.767	.785	.801	.871	.892	.910	.932	.949	.962
53.0	.161	.207	.262	.325	.372	.421	.547	.573	.597	.752	.861	.873	.884	.927	.940	.950	.963	.972	.980
59.2	.306	.374	.448	.525	.575	.624	.735	.754	.773	.874	.934	.940	.946	.967	.973	.978	.983	.988	.991

Predictive Validity: Activity & Participation

The following information is based upon a follow-up study of 63 individuals whose information was abstracted from the study database to examine the predictability of 42 independent variables and 16 dichotomous outcomes of functional outcomes 1-year after surviving a severe BI. The 16 dichotomous outcomes examined for this study were based upon the data obtained from the 32 CHART questions asked during the 1-year outcome interviews. **Table 13** provides the definitions of functional outcomes according to the WHO ICF classification in relationship to CHART rest items**.** Twelve of the 16 dichotomous functional outcomes evaluated in this follow-up study were found to be significantly predictable ($p < .0.5$). These functional outcomes were represented in all three of the WHO ICF categories of activity, participation & environment, and quality of life outcomes. The dichotomous outcomes that were predictable were as follows: the amount of assistance needed for memory, cognition, communication, daily living, community participation, and the likelihood of having returned to recreational activities and/or employment.

Table 13 – Definitions of Functional Outcomes

WHO ICF	Outcome	Operational Definition	CHART
Activities	1. Bedout	Participant is out of bed ≤ 8 hours or > 8 hours per day	9
	2. Cogashom	Someone is always around to provide cognitive assistance in the home or the participant is left alone for portions of the day	4
	3. Memhelp	Participant always or sometimes needed assistance for remembering to do important things to do	7
	4. Money	Someone makes all money decisions for the participant or the participant makes at least some independent decisions about financial matters	8
	5. Paidassi	Participant receives physical assistance to perform activities of daily living from a paid caregiver > 8 hours or ≤ 8 hours per day	1a
	6. Phyassi	Participant requires physical assistance to perform activities of daily living by a paid or unpaid caregiver <12 hours or 12 or more per day	1
Participation & Environment	7. Commhelp	In general, participant always needs help or sometimes needs help for communication with other people	6
	8. Empact	Participant spends 4 or more hours per week or < 4 hours per week doing activities related to gainful employment or obtaining skills towards gainful employment including work, school, and volunteerism	18, 19, 22
	9. Houseout	Participant spends ≤3 days or > 3 days per week out of the house going somewhere	10
	10. Ngtaway	Other than hospitalization, participant spend 0 or 1 or more nights per month sleeping somewhere other than his or her current place or residence. This could be friends, relatives, or hotels.	11
	11. Recact	Participant is engaged in recreational and/or leisure activities inside or outside the home > 2 hours per week. Time spent watching television and listening to the radio are not included.	23, 24
	12. Socontac	Participant made ≥ 1 or < 1 social contact/visit outside the home in a month. This may be with relatives, business, or organizational associates and/or friends.	27, 28, 29
	13. Transind	Participant is or is not able to use transportation without assistance from another person.	14
	14. Transnot	Participant does or does not have transportation available with little advance notice; allowing the participant to go places that come up on a last-minute basis.	17
	15. Transwhen	Participant does or does not have access to transportation to get out whenever he or she would like.	16
Quality of Life	16. Poverty	Participant's disposable income is or is not ≤ the poverty threshold. Disposable income is combined annual income of all persons in the household who were residing with the participant at the time of injury minus all out-of-pocket medical expenses related to the injury.	31, 32

There were 42 potential predictor variables exported from the study's longitudinal database and 25 of these met the criteria for statistical analysis. **Table 14** provides the operational definitions for the 25 predictor variables examined in this follow-up study. Ten of these predictor variables examined in this study were found to be significant for prediction of at least one of the outcomes and included the following: etiology (CHI vs. Other BI), presence of UTI, seizure, hypertension during IP rehabilitation, veteran benefit eligibility, health insurance, marital status at injury, whether or not recovery of consciousness occurred within 1 year, number of days between injury and admission to IP rehabilitation, and average length of IP rehabilitation stay. Eight of these 10 variables are available early after injury or when the patient is unconscious. **Table 15** provides a compendium of the significant predictors for each model.

Table 14 – Predictor Variables Examined

Variables	Operational Definitions
1. AGE	Age, in years, at time of injury
2. CHI	Had a closed head injury or another type of injury
3. DOCS-1	DOCS neurobehavioral measure from 1st evaluation, in DOCSunits
4. DOCS-1 Dys	Number of days after injury the 1st DOCS evaluation was completed
5. DOCS Avg	Sum of each participant's DOCS measure divided by the total number of DOCS evaluations
6. DOCS-Incpt	DOCS neurobehavioral level at time of study enrolment, from mixed random effects regression analyses of 63 participants
7. DOCS-Slope	DOCS Neurobehavioral Recovery Slope/Trajectory, from mixed random effects regression analyses of 63 participants
8. Dysinjrx	Number of days between injury and receiving rehabilitation
9. Gender	Being a male or a female
10. HS	Had high school diploma, equivalent to high school diploma, less than high school education or more than high school education at time of injury
11. HTN	Was or was not diagnosed with hypertension during acute IP rehabilitation; not HTN that also was present pre-injury
12. HYDRO	Was or was not diagnosed with hydrocephalus during acute IP rehabilitation
13. HYPERTON	Was or was not diagnosed by a physical or occupational therapist as having hypertonia during IP rehabilitation
14. INS	Category 1: has PPO/HMO insurance; Category 2: has insurance other than PPO/HMO or no insurance
15. INSCM	Insurance company did or did not assign a case manager
16. LOSIPRX	Average duration (days) of acute rehabilitation
17. MARITAL	Being married or not married at time of injury
18. NSTIM	Did or did not receive central nervous system stimulants during acute IP rehabilitation
19. PNEUM	Was or was not diagnosed with pneumonia (via x-ray) during acute IP rehabilitation
20. RENAL	Was or was not diagnosed with renal failure at some time after injury (e.g. ICU, IP rehabilitation)
21. RXINTENS	Average hours of IP rehabilitation services per day over a 7 day week
22. SEIZ	Was or was not diagnosed with seizure disorder during IP rehabilitation and was still managed via seizure prophylaxis at time of IP rehabilitation discharge
23. SHUNT	Did or did not have a shunt placed
24. UTI	Did or did not have a UTI during IP rehabilitation
25. VET	Is or is not eligible for veteran benefits

Table 15: Final Multivariate Logistic Regression Models

WHO ICF	Outcomes	Significant Predictors	*p*-value	95% CI	Odds Ratio	1 –year after Injury Interpretations
Activities	Bedout[3]	CHI	0.0067	(2.26, 158.9)	18.94	Person with CHI was at least 18 times more likely to be out of bed for more than 8 hours as compared to persons with other BI
		UTI	0.0018	(2.65, 72.09)	13.83	Person who did *not* have a UTI during IP rehabilitation was at least 13 times more likely to be out of bed for more than 8 hours
	Cogashom[3]	Vet	0.0319	(1.17, 32.16)	6.13	Compared to persons who are *not* eligible for veterans benefits, eligible persons were 6.13 times more likely to be considered safe to be left alone for portions of the day, rather than requiring 24-hour care for cognitive assistance
		Dysinjrx	0.0182	(1.10, 1.19)	1.39	Every 5 day decrement in time between injury and receiving IP rehabilitation indicated that the person was 1.39 times more likely to be left alone for portions of the day rather than requiring 24-hour care due to cognitive issues
	Memhelp[3]	Marital	0.0354	(1.12, 22.79)	5.05	Persons who were married at time of injury were at least 5 times more likely to sometimes need help with memory rather than always needing help with memory
	Physassi[1]	Dysinjrx	0.0340	(1.01, 1.19)	1.10	Every 1 day decrement between injury and receiving IP rehabilitation indicated that a person was 1.1 times more likely to require < 12 hours/day physical assistance
Participation & Environment	Empact[1]	Losiprx	0.0380	(1.00, 1.08)	1.04	Every 1 day increase in length of IP rehabilitation stay indicated that a person was 1.04 times more likely to participate in activities related to gainful employment for 4 or more hours/week 1-year after injury
	Sonontac[3]	CHI	0.0187	(1.56, 131.1)	14.28	Persons with CHI, compared to other BI, were 3.78 times more likely to have 1 or more than 1 social contact each month outside of the home rather than none.
	Transind[3]	Vet	0.0276	(1.33, 133.6)	13.33	Persons not eligible for veterans benefits, compared to eligible persons, were 13 times more likely to be able to use transportation independently rather than requiring assistance
	Transwen[3]	Marital	0.0249	(1.24, 24.36)	5.50	Estimated odds of having access to transportation instead of not having access to transportation for patients being married at time of injury was 5.50 times the estimated odds for those not married.
		Vet	0.0487	(1.01, 29.06)	5.42	Compared to persons who are not eligible for veterans' benefits, eligible persons were 5.42 times more likely to have access to transportation when he or she wanted it.

1=Logistic Regression Analyses included DOCS-AVG, Dysinjrx-continuous, bun not DOCS-1, DOCS-Intcpt, DOCS-Slope and DOCS-1 Dys; 2=Logistic Regression Analyses included DOCS-Slope, Dysinjrx-continuous but not DOCS-Avg, DOCS-Intcp, DOCS-1 Dys; 3=Logistic Regression Analyses included DOCS-1, Dysinjrx-categorical, but not DOCS-Avg, DOCS-Intept, DOCS-Slope and DOCS-1 Dys; CHI=Closed Head Injury; OBI=Other type of brain injury.

Predictive Validity: Autonomy with Expression of Needs and Ideas:

To examine the feasibility of predicting autonomy with expressing basic to complex needs and ideas, we derived a DOCS measure referred to as the DOCS Moderately-Complex measure. This measure is derived from seven of the 29 DOCS test items (23 test items plus the six research items). Each of the 29 DOCS test items require processing at the brain-stem, sub-cortical and/or cortical levels. Some items (e.g., whistle) require a minimal amount of processing in the central nervous system (CNS) (e.g., brain stem only) to receive the highest score possible while others (e.g., tracking familiar face) require more complex CNS processing (e.g., brainstem, fusiform face area, temporal lobe) to receive the highest possible score. These differences are categorized according to minimal, moderate or maximal CNS processing. When using all 29 DOCS items three composite measures reflecting the complexity of CNS processing required to manifest a localized behavioral response can be derived and these are: (a) Minimally-Complex, (b) Moderately-Complex, and (c) Maximally Complex. We examined the value of the Moderately-Complex measure in predicting ability to express basic to complex needs and ideas one year after injury.

The DOCS Moderately-Complex measures were estimated using the seven items that require a moderate amount of complex CNS processing (e.g., sweet and sour contrast, name called aloud). Evidence-based prognostication for the magnitude of autonomy with expression is possible when using

the DOCS Moderately-Complex average in concordance with time between injury and rehabilitaiton admission.

We conducted analyses to examine our hypothesis that the DOCS Moderately-Complex measure would significantly contribute to predicting the magnitude of autonomy with expression one year after injury. The evidence summarized in this section indicates that magnitude of recovery one year after injury in terms of autonomy of expression is predictable for persons who experience prolonged states of disordered consciousness of 28 days or more consecutively from traumatic and non-traumatic etiologies and who are admitted to acute rehabilitation. The evidence indicates further that the DOCS Moderately-Complex average, when controlling for time between injury and rehabilitation, significantly predicts more or less autonomy with expressing basic needs and complex ideas one year after injury.

The fourth study analysis of 70 participants examined whether or not it was possible to predict the level of autonomy with expression of basic needs and ideas 1 year after severe brain injury. The dependent variable for this study was dichotomized as “Less” or “More” autonomy and was measured with the FIM item # 15. The majority of the study sample recovered consciousness (72%) within 12 months of injury. For the persons recovering consciousness, the average days of unconsciousness was 126 $\pm$ 97.15 days. For the total sample, the baseline DOCS (DOCS1) was obtained on average 50 days (median) after injury with a DOCS1 average of 47.40 $\pm$ 11.43 (median = 49.60). This DOCS1 average indicates that the majority of the sample was in the vegetative state (VS) at baseline (i.e., DOCS range of 40 to 49 corresponds with VS). The average DOCS Moderately-Complex measure for the total sample was 52. 23 ± 14.93. The average FIM Expression for the total sample was 2.89 $\pm$ 2.11 (median = 2.00) indicating that the majority of the sample (69%) required moderate to maximal (Less Autonomy) assistance to express basic ideas one-year after injury. Expressing basic to complex ideas for the remaining participants (31%) ranged from minimal to no assistance (More Autonomy).

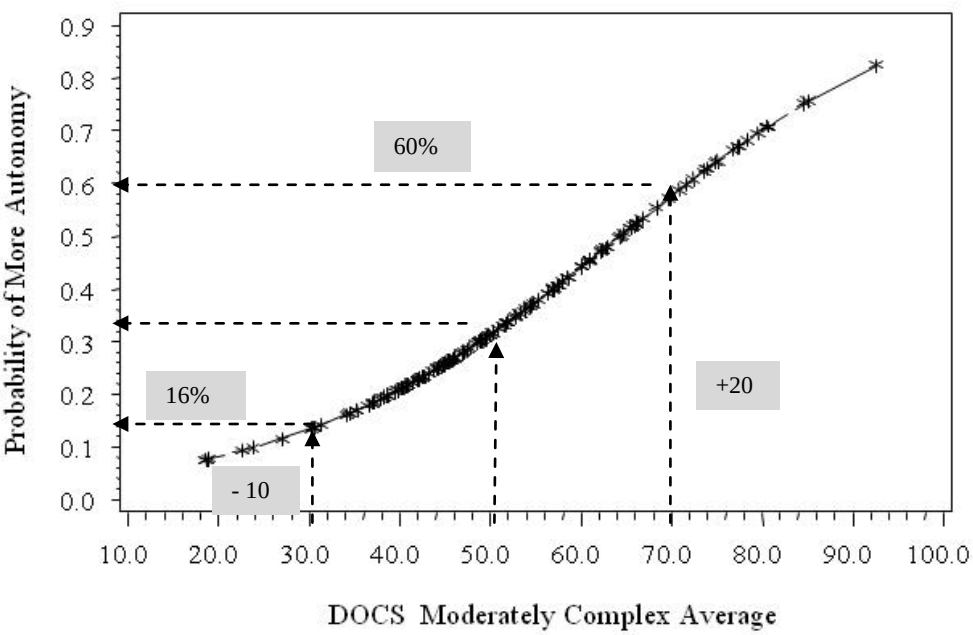
For persons experiencing prolonged unconsciousness, the odds for more autonomy with expression one year after injury increase with incremental gains in the DOCS Moderately-Complex average and with fewer days between injury and rehabilitation. During acute rehabilitation clinicians can establish an evidence based prognosis regarding odds of having more or less autonomy with expression one year after severe BI. The DOCS Moderately-Complex average of 52 significantly (p value = .01) contributed to predicting more or less autonomy with expression one year after injury when controlling for time between injury and rehabilitation admission. During acute rehabilitation, a person with a DOCS Moderately-Complex average 10 units lower than the sample average of 52 indicates that a person is likely to require moderate to maximal caregiver assistance (Less Autonomy) to express needs and ideas one year after severe BI. This corresponds with the FIM ratings indicating that this person will require caregiver support 50% to 100% of the time to express needs and ideas. A person with higher odds of more autonomy is more likely to require minimal to no assistance to express needs and ideas one year after injury. This corresponds with the FIM ratings indicating that this person will require caregiver support 0% to 25% of the time to express needs and ideas.

For persons incurring a severe BI from traumatic and non-traumatic etiologies who remain unconscious for longer than 28 days, the findings indicate that evidence-based prognostication for the magnitude of autonomy with expression is possible when using the DOCS Moderately-Complex average in concordance with time between injury and rehabilitaiton admission. The evidence indicates that during acute rehabilitation physicians and therapists together can (a) establish an evidence based prognoses regarding odds of having more or less autonomy with expression one year after severe BI, (b) identify persons at risk for low levels of autonomy with expressing needs and ideas one year after injury, (c) facilitate adjustment to expected levels of autonomy, (d) educate families about expectations for care giving needs, and (e) target rehabilitation interventions toward expected autonomy levels.

To illustrate the odds of more autonomy increasing with incremental gains in DOCS Moderately-Complex average, we first plotted the odds (Figure 3) without controlling for time between injury and

rehabilitation (i.e., univariate plot). Figure 3 illustrates how for 10 units above the DOCS Moderately-Complex average of 52, the odds of having more autonomy increase two-fold (i.e. two times better). A person with an average DOCS Moderately-Complex measure of 72 has a 60% chance of requiring minimal to no assistance (i.e., more autonomy) with expressing needs and ideas one year after injury. A person with a DOCS Moderately-Complex average 10 units below the sample average of 52 (i.e., 42) has a 16% chance of minimal to no assistance and a 84% chance of requiring moderate to max assistance (less autonomy) with expressing needs and ideas one year after injury.

To illustrate how the findings should be translated into daily clinical practice we plotted the odds of autonomy according to how they vary with shorter and longer time between injury and admission to acute rehabilitation (Figure 4). In other words, we plotted the predicted probabilities adjusted for time between injury and rehabilitation admission. For those participants who had 30 days (25th percentile of total sample) between injury and rehabilitation admission, the trend of their odds for more autonomy with expression one year after injury against the DOCS Moderately-Complex Average is the top red line in Figure 3. Given that the DOCS Moderately-Complex average is 52, the evidence indicates that the person with 30 days between injury and rehabilitation has a 50% chance of only requiring minimal to no assistance (More Autonomy) with expression of needs and ideas one year after injury. If the DOCS Moderately-Complex Average is 10 points higher than the sample average of 52 for a person with 30 days between injury and rehabilitation, then their odds for having more autonomy with expression increases to almost 60%. Similarly, the blue line in Figure 4 represents those participants admitted to rehabilitation 44 days (median of total sample) after injury and the green line represents those participants admitted to acute rehabilitation 75 days (75th percentile for total sample) after injury. Figure 4 illustrates the finding that as time between injury and rehabilitation admission increases, the odds for more autonomy with expression decreases if the DOCS Moderately-Complex Average is not higher than the sample average of 52.



Gains in DOCS Moderately-Complex Average	Odds Ratios
+ 1.0000	1.06
+ 5.0000	1.31
+ 8.0000	1.55
+ 10.0000	1.73
+ 15.0000	2.30

Figure 3. Probability of More Autonomy with Expression at 1-Year by Incremental Gains in DOCS Moderately-Complex

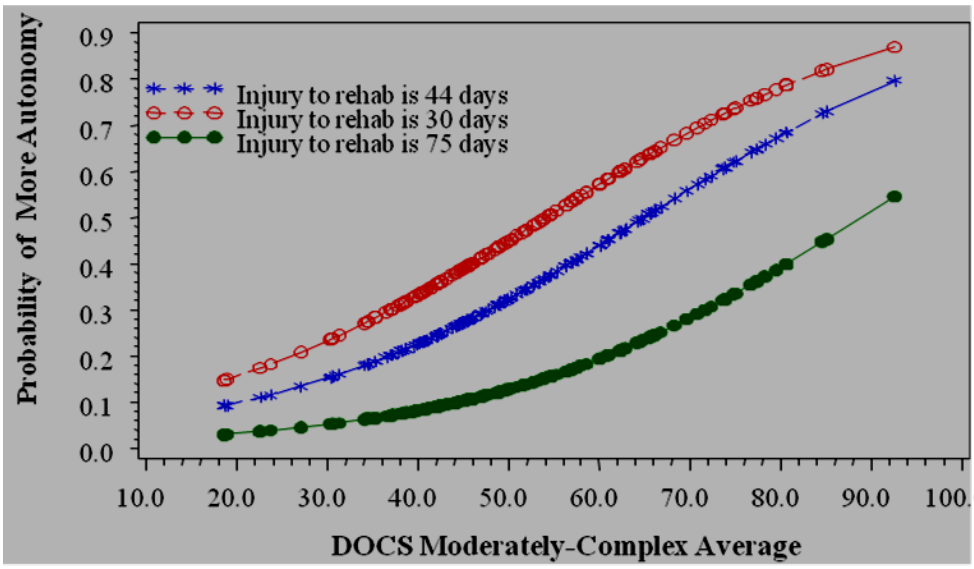


Figure 4. Probability of More Autonomy with Expression at 1-Year by Incremental Gains in DOCS Moderately-Complex average according to time between injury and rehabilitation admission

Predictive Validity: Autonomy with Expression: Closed Head versus Other Type of Brain Injury

Given well-established evidence demonstrating that the recovery trajectory for persons with anoxia is different compared to persons with traumatic etiologies[12] we also compared persons with closed head injuries and persons with other types of brain injury according to the outcome and the other potential explanatory variables (**Tables 16 & 17)**. A little more than two-thirds of participants from the total sample (55/70; 79%) incurred a severe closed head injury (e.g., from motor vehicle and blast related causes). A smaller proportion of persons (15/70; 21%) incurred severe BI from other types of injuries including anoxia (8/70; 11%), vascular (i.e., hemorrhage or aneurysm) (4/70; 6%) and penetrating (3/70; 4%) injuries.

Persons experiencing closed head BI (n = 55), did not significantly ($p > 0.05$) differ from persons with other types of BI (n = 15) according to: baseline DOCS measures, average DOCS measures, DOCS change measures (DOCS1), age, time between injury and acute rehabilitation, average days of unconsciousness, average hours of total daily therapy, average hours of speech and occupational therapy **(Table 16)** having hydrocephalus, hypertension after injury, requiring seizure prophylaxis during acute rehabilitation, being married at time of injury, being employed outside of the home at time of injury, occupation type, education at time of injury and being male or female **(Table 17).**

Table 16. Description of Total Sample by Means ± Standard Deviation and by Etiology

	Total Sample (n = 70)	Closed Head BI (n = 55)	Other BI (n = 15)	P Values
Baseline DOCS Moderately-Complex (DOCSModCom1)	52.23 ± 14.93	47.41 ± 18.40	50.11 ± 11.80	0.50
DOCS Moderately-Complex Change 1_2 (DOCSModComChg1_2)	6.40 ± 18.80	7.70 ± 20.03	1.10 ± 11.60	0.17
DOCS Moderately-Complex Average (DOCSModComAvg)	52.96 ± 13.91	53.62 ± 14.70	50.40 ± 10.30	0.35
Baseline DOCS Auditory (DOCSAud1)	44.62 ± 16.10	44.57 ± 17.02	44.80 ± 12.30	0.96
DOCS Auditory Average (DOCSAudAvg)	45.10 ± 15.70	45.33 ± 19.20	44.20 ±10.00	0.76
DOCS Auditory Change 1_2 (DOCSAudChg1_2)	4.54 ± 17.37	6.60 ± 16.44	-2.23 ± 19.30	0.15

	Total Sample (n = 70)	Closed Head BI (n = 55)	Other BI (n = 15)	P Values
Baseline Total DOCS	47.41 ± 11.43	46.96 ±12.34	49.00 ± 7.60	0.44
Average Hours of Daily Therapy (TOTrxIntens)	2.26 ±2.77	2.43 ± 3.36	1.93 ± 0.79	0.24
Average hours of daily speech therapy (SLPIntens)	0.66±0.81	0.72 ± 0.98	0.54 ± 0.26	0.13
Average hours of daily occupational therapy (OTIntens)	0.75±0.83	0.80 ± 1.00	0.65 ± 0.30	0.27
Days of Hospitalization (rxLOS)	62.80 ± 30.51	36.00 ± 17.53	35.87 ± 15.01	0.98
Days btw. Injury & Hospital Admit (TIMEDOIrx)	57.34 ± 41.98	47.00 ± 29.40	92.80 ± 58.30	0.01
Days of Unconsciousness (Durcons)	142.80 ± 116.11	133.79 ± 113.26	184.89 ± 126.86	0.47
Age at Injury (Age)	35.96 ± 16.91	35.98 ± 17.53	35.87 ± 15.06	0.64
FIM Expression at 1 Year (Express1)	2.89 ± 2.11	3.22 ± 2.13	1.67 ± 1.54	0.00

Table 17. Description of Total Sample by Proportions and Etiology

	Total Sample (n = 70)	Closed Head BI (n = 55)	Other BI (n = 16)	P Values
Hydrocephalus Required Shunt (SHUNT)				
Yes	34 %	38%	20%	0.23
No	66%	62%	80%	
Hydrocephalus No Shunt (HYDRO)				
Yes	37%	42%	20%	0.14
No	63%	58%	80%	
Hypertension Post Injury (HTN)				
Yes	51%	55%	36%	0.24
No	49%	45%	64%	
Required Seizure Prophylaxis (SEIZ)				
Yes	41%	41%	40%	1.00
No	59%	59%	60%	
Methylphenidate during rehabilitation				
Yes	33%	36%	20%	0.39
No	17%	16%	20%	
Marital Status at Injury				
Single	47%	60%	60%	1.00
Married	53%	40%	40%	
Occupation Type				
Managerial and/Professional	29%	31%	20%	0.17
Technical/Sales/Administrative	17%	13%	30%	
Services/operator/laborer	54%	56%	50%	
Employment				
Full or Part Time Employment	54%	54%	64%	0.56
Not Employed Outside of Home	46%	46%	36%	
Education				
HS Diploma	37%	38%	33%	1.00
Post High School	63%	62%	67%	
Gender				
Male	64%	67%	53%	0.37
Female	36%	33%	47%	

Persons with closed head BI and other types of BI do differ significantly ($p \leq 0.05$) according to average lengths of stay in acute rehabilitation and average FIM expression scores one year after injury. Persons with closed head BI, relative to other types of BI, had significantly more days of acute rehabilitation and more autonomy with expression of ideas one year after injury.

Univariate analyses were conducted to eliminate variables for the next step of model selection. A univariate or simple regression model was run for each explanatory variable in **Table 18** with the dependent variable in **Table 19**. Eleven variables met criteria (p-value ≤ .25) for inclusion in the next step of model selection, which involves multiple regression modeling.

Table 18. ***Potential Explanatory Variables***

Explanatory Variables Defined	*Variable Names*
Neurobehavioral Functioning measured with Disorders of Consciousness Scale (DOCS)	
1. DOCS Moderately-Complex change score from 1st to 2nd DOCS	DOCSModComChg1_2
2. DOCS Moderately-Complex change score from 1st to 5th DOCS	DOCSModComChg1_5
3. DOCS Moderately-Complex average = ∑ (DOCS Part-Cog Measures/# of DOCS Tests]	DOCSModComAvg
4. DOCS Auditory change score from 1st to 2nd DOCS	DOCSAudChg1_2
5. DOCS Auditory average = ∑ (DOCS Auditory Measures/# of DOCS Tests]	DOCSAudAverage
6. Change in Total DOCS score between 1st to 2nd DOCS	DOCStotChg1_2
Co-existing Conditions	
7. Presence of hydrocephalus where effective management requires shunt	SHUNT
8. Shunt not required for effective management of hydrocephalus	HYDRO
9. Hypertension that was not present prior to injury	HTN
10. Required seizure prophylaxis (anticonvulsants) during acute rehabilitation	SEIZ
Acute Rehabilitation Interventions	
11. Average hours of daily therapy = [∑(PT, OT, SLP & Psychology Hours) / rxLOS]	TOTrxIntens
12. Average hours of daily speech therapy = [∑(SLP Hours) / rxLOS]	SLPIntens
13. Average hours of daily occupational therapy = [∑(OT Hours) / rxLOS]	OTIntens
14. Days of acute rehabilitation where days of admission and discharge are included	rxLOS
15. Did or did not receive Methylphenidate during acute rehabilitation	Meth
Clinical Indices of Injury	
16. Closed Head Brain Injury versus Other Type of Brain Injury	Etiology
17. Time between injury and rehabilitation admission	TIMEDOIrx
18. Number of days of unconsciousness	Durcons
Pre and Post Injury Environmental Characteristics	
19. Marital status at injury	MARITAL1
20. Type of pre-injury occupation by required levels of communication	EMPL_OC
21. Employment status at time of injury	EMPLSTAT
Pre-Injury Characteristics of Individual	
22. Age at time of injury	AGE
23. Pre-Injury level of educational attainment	EDUC
24. Being Male or Female	GENDER

Table 19. Dichotomous Outcome using the Functional Independence Measure ™

Outcome	Rating	Burden of Care/Level of Autonomy Corresponding to FIM Rating
Less Autonomy	1	Total Assistance; completes < 25% of work, caregiver completing 75% or greater
	2	Maximal Prompting; completes 25-49% of work, caregiver provides 51-75% assistance
	3	Moderate Prompting;; completes 50-74% of work, caregiver provides 26-50% assistance
More Autonomy	4	Minimal Prompting;; completes 75-90% of work, caregiver provides 10-25% assistance
	5	Standby Prompting;; completes work > 90% of time, caregiver assists with < 10%
	6	Modified Independence; may require additional time or equipment
	7	Complete Independence

DOCS Auditory Average and Duration of Unconsciousness were not significant in the univariate modeling, but the p-values for these Univariate models (p-values 0.34 and 0.27, respectively) were very close to the cut-point criteria (p-value ≤ .25) for inclusion in multiple regression modeling. Therefore, these variables and all two-term interactions were also included in the multiple regression modeling. All other non-significant explanatory variables were not included in multiple regression modeling.

The 11 variables meeting inclusion criteria, DOCS Auditory Average and Duration of Unconsciousness and all two-term interactions were included in multiple regression modeling. A variable with a p-value >.05 was dropped from multiple regression models. **Table 20** demonstrates that etiology was not significant in multiple regression modeling (p > .05), but since there is overwhelming evidence indicating the influence of etiology and seizures on recovery, these variables were forced into the model **(Table 20**) but these two variables remained non-significant (p > .05). This finding indicates that the predictive value of the DOCS Moderately-Complex Average does not significantly co-vary according to seizure or etiology or any of the other non-significant independent variables.

Table 20 Final Predictor Models for Autonomy with Expression 1-Year after Injury

	Explanatory Variables	Wald X^2	P Values	Odds Ratios	95% CI
1. Model with Seizure	Intercept	3.85	0.05		
	DOCSModComAvg	6.00	0.01	1.07	1.01, 1.132
	SEIZ	3.06	0.08	0.26	0.06, 1.17
	TIMEDOIrx	4.68	0.03	0.96	0.93, 0.99
2. Model with Etiology Forced	Intercept	6.21	0.01		
	DOCSModComAvg	5.74	0.02	1.08	1.01, 1.15
	Etiology	1.22	0.27	0.27	0.03, 2.73
	SEIZ	2.52	0.11	3.56	0.74, 17.10
	TIMEDOIrx	4.32	0.04	0.96	0.92, 0.99
3. Final Model	Intercept	1.65	0.19		
	DOCSModComAvg	6.13	0.01	1.05	1.01, 1.09
	TIMEDOIrx	7.14	0.01	0.96	0.94, 0.99

The final model indicates that autonomy with expression one year after injury is significantly influenced by the DOCS Moderately-Complex average when controlling for time between injury and admission to acute rehabilitation. That is, each one unit increase in the DOCS Moderately-Complex average, relates to a one-fold increase in odds of having more autonomy with expressing ideas one year after injury.

Clinicians can also use the findings to estimate the amount and type of care giving that will be needed to enable the patient to communicate needs and ideas. Amount of care giving can be estimated by using the FIM estimates of percentage of support needed for persons with low expressive autonomy (FIM Ratings 1 - 3; support 50% to 100% of the time) and persons with more expressive autonomy (FIM ratings 4 - 7; support 0% to 25% of the time) (**Table 19**).

Predictive Validity: Satisfaction With Life at 1 Year

A fifth study sample (N = 25) was used to describe satisfaction with life one year after severe brain injury. The purpose of these analyses was to describe self reported life satisfaction one year after severe TBI for persons incurring prolonged unconsciousness and yet recovering consciousness within the first year of injury. Life satisfaction was measured with the Satisfaction with Life Scale (SWLS) that reflects a person's judgment of their life situation relative to their own expectations. The prospective data collection included medical record reviews, clinical assessments, and follow-up interviews at 1 year post injury. While describing self-reported life satisfaction for this population was the primary purpose of this

analysis, a secondary purpose was to examine associations between life satisfaction and individual subject characteristics, environmental characteristics and four health-related outcomes.

Other questionnaires completed during the one year outcomes interview included the Craig Handicap Assessment and Reporting Technique (CHART) and the Functional Independence Measure (FIM). The CHART measures the degree to which impairments and disabilities result in handicaps in the years following initial rehabilitation via an interview about physical independence, mobility, occupation, social integration and economic self-sufficiency. The original CHART has a weighted scoring system where higher scores do not always indicate more functioning. Therefore, the CHART was rescaled so that increasing scores indicate more functioning making the CHART rating scale similar to the other instruments, thereby facilitating data interpretation. The FIM is an 18-item scale used to determine the amount of assistance required by a person with a disability to perform basic life activities safely and effectively. The FIM rating scale of one to seven reflects increasing independence with increasing score and the Total FIM raw score can range from 18 to 126. The 18 items have been shown to define two different indicators of disability; motor and cognitive function. All 18 FIM items were used to estimate, for each research participant, the amount of assistance required to safely and effectively perform basic life activities one year after severe TBI. Total FIM scores were derived by summing the FIM motor and FIM cognitive scores. The DOCS neurobehavioral measures for each participant were estimated using the 23 test stimuli demonstrated to remain stable throughout the recovery trajectory.

The Total DOCS, DOCS change measures, Total SWLS, Total CHART, Total FIM, FIM Cognitive and FIM Motor measures were estimated from the raw scores using the rating scale model. Since the range of the DOCS, SWLS, revised CHART and FIM were symmetrical, the estimated measures were re-scaled to a more user friendly zero to one hundred scale. The re-scaling made the findings easier to understand, but the rescaled estimates remain equal interval because the underlying mathematical properties of each measure were not altered.

The results of the rating scale analyses indicated (a) strong reliability (i.e., person separation reliability = .83), (b) that the study sample falls into two groups of functioning-low and high (CHART person separation index = 2.21), and (c) that 25 of the 32 CHART items reflect the degree to which impairments and disabilities result in handicaps in the community where the participant resides. CHART items specified on **Table 21** are used to construct study variables (e.g. CogINd), but total CHART measures were estimated only using only those items meeting infit criteria. The seven CHART items <u>not</u> meeting infit criteria are:

(1) Transportation is sufficient for access to desired places (Infit Mean Square-IMS = 1.37)
(2) At home assistance needed for memory, decision making, judgment (IMS = .65)
(3) Hours/week spent in homemaking activities (IMS = .63)
(4) Involvement in a romantic relationship (IMS =.60)
(5) Entering and exiting home without assistance (IMS =.60)
(6) Who directs and supervises attendant (IMS =.55)
(7) Away from home, assistance needed for memory, decision making, judgment (IMS =.50)

Table 21 Study Variables: Variables Possibly Influencing Life Satisfaction

Variables	Definitions
Individual Characteristics: Demographic Variables	
Age at time of Injury	Age at time of injury
Gender	Male or Female
Education Achieved at time of Injury	Pre-injury Level of Educational Attainment
Employment Status at Time of Injury	Employment status at time of injury; Employed outside of home or not employed outside of home;
Occupation of Employed Persons	Employment type/Occupation at time of injury; 1 = Managerial, 2 = Technical, Sales or Administration or Services or Operator/Laborer
Environment: Social Support and Social Interaction Variables	
Marital	Marital status at time of injury
Social Support	Amount of social support as measured by number of relatives residing with, romantic involvement, number of relatives in contact with monthly CHART Item 25, 26 and 27
Amount of Interaction	Amount of social interaction outside of house as measured by hours spent out of the house and nights away from house weekly, hours spent each week in employment, school volunteer and/or recreational activities and monthly visits to associates and/or friends and number of times initiate conversations with strangers; CHART Items 10, 11, 18, 19, 22, 23, 28. 29 and 30
Social Independence	Independence with social interactions; FIM Item 16
Household Income at Injury	Income category in household where subject resides at time of Injury
Household Income 1-Year after Injury	Income category in household where subject resides 1-year after Injury; CHART Item 31
Disposable Income 1-Year after Injury	Disposable income 1-year after injury (Household Income – Out-of-Pocket Medical Expenses for past year)
Environment: Réhabilitation and Insurance Variables	
Rehab Length of Stay	Inpatient rehabilitation length of stay in days
Insurance Type	Type of Insurance (PPO or HMO) of Lack of Insurance
Veteran Benefits	Subject is or is not eligible for Veteran Benefits
Concomitant Injuries	
Myocardial Infarction	Presence or absence of myocardial infarction subsequent to traumatic brain injury
Spinal Cord Injury	Presence or absence of a spinal cord injury
Paralysis	Presence or absence of a hemiparesis
Facial Fractures	Incurred or did not incur facial fractures during injury
Upper Extremity Fractures	Incurred or did not incur upper extremity fractures during injury
Lower Extremity Fractures	Incurred or did not incur lower extremity fractures during injury
Pelvic Fractures	Incurred or did not incur pelvic fractures during injury
Heart Trauma	Incurred or did not incur trauma to heart during injury
Liver Trauma	Incurred or did not incur trauma to liver during injury
Lung Trauma	Incurred or did not incur trauma to lungs during injury
Abdominal Trauma	Incurred or did not incur trauma to abdomen during injury
Hemorrhage	Presence or absence of hemorrhage subsequent to traumatic brain injury
Hematoma	Presence of absence of hematoma from traumatic brain injury
Total Concomitant Injuries	Total number of the 13 concomitant injuries tracked present
Co-Existing Conditions: During Inpatient Rehabilitation	
UTI	Did or did not have a UTI during inpatient rehabilitation
Tracheotomy	Respiratory status requires tracheotomy tube
Pneumonia	Diagnosis of pneumonia during acute care and/or inpatient rehabilitation
Hydrocephalus	Did or did not have hydrocephalus during Iinpatient rehabilitation
Shunt	Hydrocephalus required VP shunt placement
Seizures	Did or did not have seizures during inpatient rehabilitation
Hypertonicity	Did or did not have hypertonicity during inpatient rehabilitation
Hypertension	Hypertension after injury when not present pre-injury
Hypothyroidism	Diagnosed with hypothyroidism during inpatient rehabilitation
DVT	Presence of Upper and/or Lower Extremity Deep Vain Thrombosis
CDIF	Diagnosis of Clostridium difficile infectious diarrhea
Total Conditions	Total number of co-existing conditions
Cognitive Impairments: Neurobehavioral Functioning during Inpatient Rehabilitation	
GCS1	GCS score at time of study enrollment
DOCS1	Baseline DOCS measure
DOCStotalchg	DOCS change from 1st to last DOCS is $\leq$ 3 OR > 3
DOCSchg1-2	DOCS change from 1st to 2nd is $\leq$ 4 OR > 4
DOCSchg1-3	DOCS change from 1st to 3rd DOCS is $\leq$ 5 OR > 5
DOCSchg1-4	DOCS change from 1st to 4thDOCS is $\leq$ 6 OR > 6
DOCSchg1-5	DOCS change from 1st to 5th DOCS is $\leq$ 8 OR > 8
Cognitive Impairments: Executive Functioning 1-Year after Injury	
CogInd	Level of independence with directing and supervising care attendant, assistance required for remembering, decision making and/or judgment at home and away from home, difficulty remembering important activities that must be done and independence with money management CHART Items 3, 4, 5, 7 and 8
FIM Cognitive	FIM cognition score 1 year after injury = Level of independence with comprehension, problem solving and remembering; FIM items 14, 17 & 18
Physical Independence 1-Year After Injury	
FIM Motor	FIM motor score 1 year after injury
Mobility	Amount Independent Mobility 1 year after injury; CHART Items 9 through 17
Assist	Hours / Amount of unpaid physical assistance provided; CHART Items # 1 & 2
Functional Status 1-Year after Injury	
Total FIM	FIM Cognition and FIM Motor Score 1 year after injury
Total CHART	Total CHART score with revised scoring and rescaled 0 to 100
Self Reported Life Satisfaction 1-Year after Injury	
SWLS	1-Year SWLS measure with 4 of 5 items and rescaled 0 to 100

The index of social interactions can range from a score of one to seven where a 1 indicates complete dependence for engagement in social interaction and where a seven indicates complete independence to engage in social interactions. The average of 5.54 SD 1.50 (median = 6.00) indicates that minimal assistance or no assistance was required to engage in social interactions.

The range of possible values for the measure indicating amount of social interaction is zero to twenty-seven with a higher number indicating more hours of social interaction weekly and monthly. The average social interaction measure for the sample was 9.52 SD 4.02 (median = 12.0) indicating that the entire sample experienced limited amount of interactions outside of their home. The majority of the sample spent two to three days each week outside of their home, but only one to two nights away from their home in the preceding year. The majority of the sample also spent a maximum of one hour per week in productive activities such as gainful employment, school, home making and home maintenance. They also spent two to three hours per week participating in recreational activities such as going to the movies, playing cards or participating in sporting activities. Visiting friends outside of their home was also limited to one to two times each month and only three (3/23) subjects visited business associates each month. This measure also indicates that the majority of participants interacted with strangers approximately one time per month.

Concomitant Injuries and Co-existing Conditions: The sample did not include any persons with spinal cord injuries or persons incurring trauma to their heart, but each subject incurred on average three concomitant injuries (mean = 2.75 SD 12.06; median = 3.00). The most common co-occurring injuries **(Table 22**) were intraventricular or subarachnoid hemorrhages (63%) and subdural or epidural hematomas (48%).

The average number of co-existing conditions (**Table 22**) was three per subject (mean = 3.40 SD 2.06; median = 3.0) and as expected the majority (88%) of participants had tracheotomy tubes. While none of the participants received nutrition orally or therapeutic feedings during inpatient rehabilitation, 56% incurred pneumonia during IP rehabilitation. A small portion of the sample (5/25; 20%) was diagnosed with hydrocephalus and four of the five subsequently required a shunt. About one-third (36%) of the sample experienced at least one urinary tract infection during inpatient rehabilitation as well as hypertension subsequent to the injury (32%) and a small portion experienced seizure activity (16%) requiring anti-epileptics.

Cognitive Impairments: Neurobehavioral Functioning during Inpatient Rehabilitation: At time of inpatient rehabilitation admission, the average DOCS neurobehavioral measure for the sample was 49.7 DOCunits (SD 10.77 units), indicating that the majority of the participants were in the VS (DOCS range of 40.58 – 49.82 indicates VS relative to comatose and MCS) exhibiting largely generalized responses (e.g., leg movement not present at baseline) to test stimuli (e.g., juice placed on lips)..

Neurobehavioral gains, as measured with the DOCS, ranged from an average of an eight unit gain over seven days (between 1st and 2nd DOCS evaluations) to a 23 unit gain over 24 days (between 1st and 5th DOCS evaluations). These gains indicated that within one week of inpatient rehabilitation, the majority of the sample progressed from a DOCS measure of 49.7 to a DOCS measure of 57.7 and over about three weeks the majority of the sample progressed to a DOCS measure of 72.7. Clinically, this means that the sample, overall, improved during one week of inpatient rehabilitation from VS where they demonstrated largely generalized responses to test stimuli to MCS (DOCS measures ranging from 50.98 to 60.22) where they demonstrated localized responses or contextually appropriate responses to test stimuli. Some persons also recovered consciousness prior to discharge from inpatient rehabilitation as indicated by DOCS measures greater than 62.0 and by either an ability to functionally/consistently communicate or to use objects appropriately or to interact with their environment.

Table 22. Descriptive Statistics: Central Tendency

	Means	Standard Deviations	Medians	Percentiles 25th	75th
Individual Characteristics: Demographic Variables					
Age at time of Injury (Age)	34.64	16.75	28.00	22.50	43.50
Gender					
Education Achieved at time of Injury					
Employment Status at Time of Injury					
Occupation of Employed Persons					
Gender					
Education Achieved at time of Injury					
Environment: Social Support and Social Interaction Variables					
Marital					
Social Support 1-Year after Injury	10.29	6.34	7.00	6.00	14.75
Amount of Interaction 1-Year after Injury (Interaction)	12.04	11.45	12.00	6.00	13.00
Social Independence	5.54	1.50	6.00	4.00	7.00
Household Income at Injury					
Household Income 1-Year after Injury					
Disposable Income 1-Year after Injury	$44,883	$34,054	$49,901	$13,000	$75,000
Environment: Rehabilitation and Insurance Variables					
Rehabilitation Length of Stay in Days (RehabLOS)	71.83	35.47	69.50	46.75	90.00
Insurance Type					
Veteran Benefits					
Concomitant Injuries					
Myocardial Infarction					
Spinal Cord Injury					
Paralysis					
Facial Fractures					
Upper Extremity Fractures					
Lower Extremity Fractures					
Pelvic Fractures					
Heart Trauma					
Liver Trauma					
Lung Trauma					
Abdominal Trauma					
Hemorrhage					
Hematoma					
Average Number of Concomitant Injuries per Subject	2.16	1.463			
Co-existing conditions					
Number of Co-existing Conditions during Rehabilitation (Total Conditions)	1.52	1.58	1.00	0.00	2.00
Cognitive Impairments: Neurobehavioral Functioning during Inpatient Rehabilitation					
GCS at time of Study Enrollment (GCS1)	8.55	2.26	8.50	7.75	11.00
Baseline DOCS Measure (DOCS1)	49.70	13.07	49.80	41.35	59.00
Absolute Change between 1st and Last DOCS (DOCStotalchg)	15.91	13.95	15.40	3.10	24.73
Actual Change between 1st and 2nd DOCS (DOCSchg1-2)	8.69	14.65	7.15	-1.30	16.00
Actual Change between 1st and 3rd DOCS (DOCSchg1-3)	14.16	10.77	15.60	6.80	24.60
Actual Change between 1st and 4th DOCS (DOCSchg1-4)	19.37	11.60	17.25	10.78	29.10
DOCSchg1-5					
Cognitive Impairments: Executive Functioning 1-Year after Injury					
Duration of Unconsciousness (DurConsc)	113.78	102.06	91.00	49.00	136.00
Cognitive Independence 1-Year after Injury (Cog Ind)	24.74	7.22	25.00	18.00	31.00
FIM Cognition Measure -1Year (FIM Cognitive)	5.71	.46	4.00	2.00	10.25
*Best GOAT Scores after Recovering Consciousness up to 1-Year after Injury	8.00	4.87	7.00	3.50	12.50
PTA					
Physical Impairments 1-Year After Injury					
FIM Motor Measure -1Year (FIM Motor)	64.75	28.27	77.00	37.00	90.00
Amount of Independent Mobility 1-Year after Injury (Mobility)	17.67	5.64	18.50	12.25	22.50
Amount of Physical Assistance Provided Daily 1-Year after Injury (Assist)	1.36	1.44	1.00	1.00	3.00
Functional Status 1					
Total FIM-1 Measure Year after Injury (Total FIM)	91.13	31.65	104.00	60.00	116.00
Total CHART Score 1-Year after Injury (Total CHART)	50.57	13.00	51.21	40.53	61.91
Self Reported Life Satisfaction 1-Year after Injury					
SWLS Measure 1-Year after Injury	39.63	19.94	37.52	28.29	48.30

Table 23 summarizes the relationship between the study variables and SWLS. Two DOCS neurobehavioral measures significantly correlated with SWLS were related to neurobehavioral change. More specifically, there was a significant correlation between SWLS and amount of neurobehavioral change between the baseline DOCS (DOCS1) and the 2nd DOCS (DOCS2) and Last DOCS indicating that as neurobehavioral functioning improves, life satisfaction scores also increased. This relationship was explored further by categorizing into four groups the amount of change (in DOC units) between the first and 2nd DOCS as: (a) $\geq$ 2 versus < 2, (b) $\geq$ 7 versus < 7, (c) $\geq$ 10 versus < 10, and (d) $\geq$ 16 versus < 16. The average SWLS measures for each of these four groups were then compared and only a 16 unit change in DOCS measures was significantly different ($t_{df = 12} = -2.137$; $p = .039$). That is, those persons with a 16 DOCunit or more of change (n = 4) reported significantly better life satisfaction (SWLS mean = 61.79 SD 26.92) one year after injury relative to those persons who had less than a 16 DOCunit change (n = 10) (SWLS mean = 39.81 SD 10.04).

Table 23. Relationships between Study Variables and SWLS

Study Variables	Test Statistics	P Values
Individual Characteristics:		
Age at time of Injury	r = 0.05	0.81
Gender	t = - 0.89 $_{22df}$	0.93
Education Achieved at time of Injury	r = 0.19	0.39
Employment Status at Injury	t = -0.960 $_{22\ df}$	0.35
** Occupation for Employed Persons	r = 0. 40	0.13
Environment: Social Support and Social Interaction Variables		
Marital Status at Time of Injury	r = 0.00	0.99
**Social Support 1-Year after Injury	r = -0.32	0.14
Independence with Interactions 1-Year after Injury	r = 0.01	0.97
Social Independence	r = 0.05	0.83
Household Income at Injury	r = 0.13	0.58
Household Income 1-Year after Injury	r = -0.11	0.66
Disposable Income 1-Year after Injury	r = -0.14	0.53
Environnent: Réhabilitation and Insurance Variables		
Rehabilitation Length of Stay	r = 0.00	0.99
Insurance Type	r = 0.05	0.80
Veteran Benefits	r = -0.21	0.33
Concomitant Injuries		
Myocardial Infarction	r = 0.15	0.58
Paralysis	r = 0.06	0.82
Facial Fractures	r = 0.31	0.25
** Upper Extremity Fractures	r = 0.47	0.07
Lower Extremity Fractures	r = 0.25	0.35
Pelvic Fractures	r = -0.01	0.97
Liver Trauma	r = 0.17	0.53
* Lung Trauma	r = 0.59	0.02
** Abdominal Trauma	r = -0.46	0.07
Hemorrhage	r = -0.14	0.53
Hematoma	r = -0.03	0.88
Total Concomitant Injuries	r = -0.08	0.70
Co-existing Conditions		
UTI	r = 0.22	0.31
Tracheotomy	r = -0.23	0.27
**Pneumonia	r = -0.41	0.06
Hydrocephalus	r = 0.23	0.28

Shunt	r = 0.31	0.15
Seizures	r = -0.16	0.50
** Hypertonicity	r = 0.40	0.08
Hypertension	r = -0.14	0.52
Hypothyroidism	r = 0.14	0.60
Deep Vain Thrombosis	r = -0.18	0.50
CDIF	r = -0.26	0.32
Total Number of Co-existing Conditions	r = 0.07	0.76
Cognitive Impairments: Neurobehavioral Functioning during Inpatient Rehabilitation		
GCS at time of Study Enrollment	r = -0.28	0.21
* Absolute Change between First and Last DOCS	r = 0.60	0.00
* Actual Change between 1st and 2nd DOCS	r = 0.53	0.03
Actual Change between 1st and 3rd DOCS	r = 0.23	0.49
Actual Change between 1st and 4th DOCS	r = 0.62	0.19
* Baseline DOCS	r = 0-.68	0.00
** DOCS Average	r = -0.32	0.14
Cognitive Impairments: Executive Functioning 1-Year after Injury		
** Duration of Unconsciousness	r = -0.39	0.08
Cognitive Independence	r = 0.02	0.93
FIM Cognition Measure -1Year	r = -0.24	0.28
Physical Independence 1-Year After Injury		
FIM Motor Measure -1Year	r = 0.17	0.45
Mobility	r = 0.09	0.68
**Assist	r = 0.30	0.15
Functional Status 1-Year after Injury		
Total FIM	r = 0.00	0.99
Total CHART	r = 0.06	0.78

To summarize, for the 25 persons who experienced prolonged unconsciousness after severe TBI and who recovered consciousness within first year of injury, life satisfaction one year after injury was poor and perceived life satisfaction was influenced by: (1) lung trauma, (2) abdominal trauma, (3) fractures, (4) levels and changes in neurobehavioral functioning, (5) duration of unconsciousness, (6) hypertonicity, (7) pneumonia, (8) social support, (9) independence with social interactions, (10) amount of social interaction, (11) independence with comprehension, (12) independence with expression, and (13) physical autonomy. The majority of participants reported poor life satisfaction, which was related to lung trauma, abdominal trauma, fractures, levels and changes in neurobehavioral functioning, duration of unconsciousness, hypertonicity, pneumonia, social support, independence with social interactions, amount of social interaction, independence with comprehension, independence with expression, and physical autonomy. Cognitive functioning measured with the DOCS during inpatient rehabilitation was significantly related to life satisfaction. A significant relationships between DOCS change and life satisfaction was observed. The potential contribution of the DOCS change to the prediction of life satisfaction one year after injury has important implications for identifying individuals at risk for low life satisfaction allowing for early intervention. In some cases, more severely injured patients (i.e., those with lower baseline DOCS measures) may also have come closer to mortality than those with less severe injuries. As a result, they may feel fortunate or grateful to have survived and are therefore less focused on the specific aspects of their recovery. It is also possible that those patients with more DOCS neurobehavioral gains during IP rehabilitation, have more awareness and insight. Increased awareness or insights may subsequently influence their perceptions about their recovery and progress. Response shift is a phenomenon that should be considered and/or measured in future longitudinal studies of persons recovering from severe TBI.

Chapter 4 – Test Administration & Scoring

Organization of the DOCS:

The DOCS consist of a baseline observation protocol, a three-point rating scale, and test stimuli. The test stimulus items in each subscale are in a hierarchical order from easy to difficult that was based upon the pilot data. The test stimuli are organized into the following subscales:

1. **Social Knowledge**
    a. Greet
2. **Taste & Swallowing**
    a. Taste
    b. Massage
3. **Olfactory**
    a. Odor
4. **Proprioceptive**
    a. Joint
5. **Tactile**
    a. Air
    b. Feather
    c. Hair
    d. Toe
    e. Hand (firm pressure)
    f. Scrub
    g. Swab
    h. Cube
6. **Auditory**
    a. Whistle
    b. Clap
    c. Name
    d. Bell
    e. Command
7. **Visual**
    a. Blink
    b. Focus Object
    c. Tracking objects
    d. Tracking familiar face
    e. Focus familiar face

Testing Guidelines:

The DOCS for non-research has 23 test stimuli. The DOCS used for research has additional items that are being tested **(see Chapter 9).** There are two scoring forms for the DOCS. Form A is the short form and Form B is the long form. Each stimulus has specific administration times (e.g. 5-10 seconds the stimulus is applied) and response times (e.g. the time the raters should then observe the patient after administering a test stimulus for a response). Please refer to the "**test stimuli administration**" section in this chapter for additional details. A wait period of 30-60 seconds is required between testing items. Each stimulus item may be administered as many times as needed and the rater should score the best response.

Timeframe to Repeat the DOCS:

Repeated DOCS evaluations conducted as far apart as 18 days detect a sufficient amount of change. If the anticipated length of stay will be under 59 days, the DOCS may be completed every 7 days. If an anticipated length of stay is longer (e.g., over 100 days), then it is recommended to repeat the

DOCS every 14 days. Further, the DOCS may be used for purposes in which shorter time periods (eg, 72 hours) between evaluation would be appropriate (e.g., evaluation of medication effectiveness).

Creating Optimal Testing Conditions - *Environment*:

With the administration of the DOCS, it is extremely important to first create an optimal testing environment prior to the initiation of the DOCS protocol. The following should be considered for the environment:

- Post a "Do Not Disturb" sign outside of the testing environment
- Notify nursing and/or caregiver to avoid any unnecessary interruptions
- Close the door to the testing environment to eliminate / reduce any hallway noise
- Eliminate any unpredictable noise (e.g., TV, radio, intercom, phone)
- Diminish bright lights (e.g., close or partially close blinds if sunlight is exceptionally bright)
- Avoid inadvertent tactile and auditory stimulation

Creating Optimal Testing Conditions - *Patient/ Positioning Guidelines:*

The patient must also be adequately prepared prior to beginning the baseline observation protocol and the administration of the test stimuli. There are several positioning and re-positioning guidelines that will promote testing readiness for the patient. By having the patient in the optimal position before and during the testing, it will help to discriminate between abnormal postural responses (e.g., flexion, extension patterns) and a true response to the test stimuli. Optimal positioning for the patient will assist with breaking up spastic patterns and inhibiting extensor tone. The general guidelines below describe overall positioning guidelines, positioning for sitting in a chair, laying in bed (supine), sitting on the side of a bed or mat, and while participating in the Taste & Swallowing subscale test items. Testing should be paused if a patient slips out of position. Pausing and repositioning allow the examiner to associate behavioral responses to test stimuli rather than positional discomfort.

The following positional guidelines should be considered for the patient when administering the DOCS:

- **Overall**
  - Remove splints and restraints if permitted
  - Stop testing and re-position the patient throughout the evaluation as needed
  - Wait 20-30 seconds before administering test stimuli after repositioning
- **Sitting in a chair:**
  - Feet should be placed on the foot pedestals
  - Head should be upright, at midline and supported
  - Arms should be on the arm rests
  - Trunk should be midline and supported to maintain midline position
- **Laying supine (bed or mat):**
  - Elevate head of bed between 45 and 90 degrees
  - Keep foot of bed level with angle of hips
  - Head should be upright, at midline and supported
- **Side of mat or bed:**
  - Feet should be flat
  - Knees should be level with hips
  - Trunk should be supported in midline
  - Head should be held upright
  - Arms should be bent/flexed at elbow

- **Taste & Swallow Items:**
  - Upright between 45° and 90°
  - Head and neck at midline and supported

ADMINSTERING TEST ITEMS / PROCEDURES

General Administration Instructions

Baseline observation procedures must be completed prior to administering test stimuli. The first test item is always the social knowledge item. Following the social knowledge item the examiner can administer the items in any order they prefer. Each test stimulus is applied for 3-5 seconds. The length of time for observation of a response following application of a stimulus should be 10-15 seconds. There should be 30-60 seconds in between the presentation of each test stimulus. The goal is to elicit the patient's best response. Procedures that can be used to elicit best responses include administering a test stimulus two or more times if the highest possible score is not given. Examiners may also try administering the item on the left and right side of the body.

Baseline Observations

Prior to the administration of any stimulus items, a behavioral baseline against which subsequent changes can be measured is conducted. The baseline observation is critical to accurate measurement during the administration of the DOCS. The baseline observation determines the level of neurobehavioral functioning associated with each response to the test stimuli. The baseline observations should last for approximately 2-5 minutes and should be conducted under the optimal testing conditions for both the environment and patient. The clinician should note any responses that are observed during the baseline observation. After completion of the baseline observations, the testing conditions for the environment and the patient should be re-evaluated.

Testing Readiness

Testing readiness is a general state of readiness to respond and it is observed and measured behaviorally during the baseline observation. Please refer to **Testing Readiness Score** at the end of this chapter. Four questions are assessed for testing readiness and include the following:

1. Is a third nerve palsy (i.e., third cranial nerve damage as evident by an inability to lift the 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 during this evaluation be defined?

If the patient demonstrates eye opening but a response of "yes" was indicated to one of the above referenced questions, then a motoric activity should be used. The reliable motoric pattern/movement that will be used to indicate Testing Readiness needs to be identified (e.g., head movement).

Scoring Items:

Table 24 summarizes the rating scale for scoring items on the DOCS. The clinician scores the best behavioral response to the test stimuli on a 3 point scale (0=No Response, 1=Generalized Response, 2=Localized Response). Each stimulus item is applied for 5 seconds and the raters should then observe the patient for 10-15 seconds after administering a test stimulus for a response. A wait period of 30-60 seconds is required between testing items. Each stimulus item may be administered as many times as needed and the rater should score the best response. Clinical judgment is required on the part of the person who is administering the DOCS in order to interpret the patient's response into the appropriate rating level. The table below outlines the rating scale used for the DOCS.

Table 24: Rating Scale Overview

Response Type	Rating	Descriptor
No Response	0	- No active movement or vocalization in responses to stimuli - Response to stimuli does not differ from behavior observed during baseline observation
Generalized Response	1	- Response is not contextually related to test stimuli but is different from baseline behavior - If different from baseline, then the following could be examples of a generalized response: reflexes differing from reflexes observed at baseline; changes in respiration; changes in tone (increased/decreased); muscle tensing or other movements unrelated to the area stimulated; unrelated vocalizations; blinking that deviates from baseline; deviation in blood oxygen levels from baseline range; deviation in heart rate from baseline range; eye opening - A generalized response is NOT predictable
Localized Response	2	- A response that is 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 - If different from baseline, then the following could be examples of Localized Responses: orienting or localizing movements toward the sound; vocalization or response indicating the patient's comprehension of a greeting.

Generalized Versus Localized Responses:

If the differentiation between a generalized response and a localized response is unclear, then this rule of thumb should be followed:

- A localized response is a response that is directly 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 this stimulation
- Localized response occur in relationship to the area stimulated and these responses are not attributable to reflexic activity

Test Stimuli Administration:

1. Starting the Test:

Verbal Instruction prior to administering the first test stimuli:
("Patient's first name) listen carefully to each thing we/ I ask you to do." (PAUSE) "Try to respond." (PAUSE) "This will allow us/me to help you."

2. Social Knowledge Subscale (item 1):

Verbal Instruction: **"Hi, I'm (say your name). How's it going?"**

Scoring Procedure:
0 = No Response (NR)*:* No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic or stereotypical response whereas a general response is not necessarily stereotypical. Generalize responses include:

- Eye opening
- Increased respiration
- Decreased tone or increased tone
- Muscle tensing or other movements unrelated to the area stimulated
- Unrelated vocalizations
- Blinking
- Deviation in blood oxygen levels from baseline range
- Deviation in heart rate from baseline range

2 = Localized Response (LR)*:* Reflects an ability of the patient to regulate incoming sensory information, that is constantly changing, and to control their motoric response to sensory input. Responses occur 10-15 seconds (unless otherwise specified) after the stimulation and the responses are related to the area stimulated. Localized Responses include:

- Orienting or localization movements toward the sound
- Vocalization or response indicating subjects comprehension of greeting

3. Taste & Swallowing Subscale (items 2 & 3):

This set of test items evaluate the patient's response to pre-swallowing stimulation and the patient's ability to swallow within 15-20 seconds of stimulation known to facilitate swallowing.

Required Materials:

- Two different tastes (e.g. juice, mild, soda, familiar taste, mouth wash)
- Cotton tip applicator
- Gloves
- Towels
- One bite block

Administration Guidelines:

- Patient must be upright within a range of 45-90 degrees
- Head should be midline and supported – eliminate or reduce neck extension
- Check with Speech Language Pathologist prior to placing anything beyond the teeth
- Present each test stimulus as many times as necessary to determine the subject's best response

- Each stimulus should be presented for 3-5 seconds
- Wait 15-20 seconds for a response and wait 30-60 seconds before administering another test item
- Score each test item after determining the subject's best response.
- Do **not** wait to score until all test items are administered.

Test Item and Administration Procedures for Test Stimuli:
Prior to presenting the test stimuli, the patient should be provided with information about the test stimuli. Tell the patient what you will be doing and what setting or time of day he/she would experience this taste (e.g., "Here is a taste of orange juice, we drink it for breakfast").

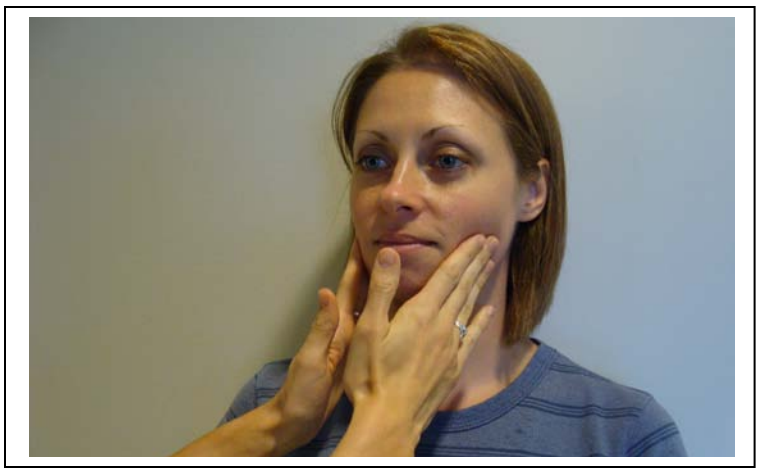
Scoring Procedure:
0 = No Response (NR)*:* No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR):
- Suckling
- Jaw movement
- Chomping / chewing motion
- Muscle tensing or other movements unrelated to the area stimulated Deviation of oxygen saturation level from baseline range
- Deviation of heart rate from baseline range

2 = Localized Response (LR):
- Oral motor movements, such as licking lips or lip compression
- Tongue pumping or movement
- Swallowing within 15-20 seconds of application of the stimuli
- Patient swipes at the examiner's hand, as an attempt to inhibit input
- Changes in facial expression appropriate to stimuli

A. Taste (Item 2):
- Apply small amount of the liquid to lower lip and gums using a cotton tip applicator
- If the subject will open his/her mouth, attempt to stimulate the top of the tongue

B. **Massage (Item 3):** Using finger tips provide firm pressure slowly downward along the masseter (jaw) muscle to the corner of lips.



4. Olfactory Subscale (items 4a & 4b)

This set of test items evaluates the patient's response to olfactory stimulation. Familiar odors may, for example, evoke memories or may serve as pre-cursors to salivation.

Required Materials:

- Flavored extracts (e.g., orange, vanilla, peppermint)
- Chewing tobacco (if the subject is a known long-term smoker)
- Cotton tip applicator

Administration Guidelines:

- Patient must be upright within a range of 45-90 degrees
- Head should be midline and supported – eliminate or reduce neck extension
- If the patient has a tracheostomy tube, check to see if the physician has stated that the tracheostomy tube may be momentarily occluded (with cuff tracheostomy tubes, the cuff must be deflated prior to attempting any occlusion trials)
- DO NOT OCCLUDE TRACHEOSTOMY TUBE IN THE ICU
- If the patient is unable to tolerate tracheostomy tube occlusion, check for upper airway movement through the nasal cavity with a small feather. Hold the feather ½" to 1" below the nostrils to see if the feather moves. If the feather moves then present each stimulus at this distance for 5-10 seconds. If the feather does not move, do NOT administer this subscale.
- Present each odor as many times as necessary to determine the patient's best response.
- Each odor should be presented for 3-5 seconds (please see above for exception with time frame for patients who cannot tolerate occlusion of the tracheostomy tube).
- Wait 10-15 seconds for a response and wait 30-60 seconds before administering another odor
- Score each test item after determining the subject's best response.
- Do **not** wait to score until both items are administered.

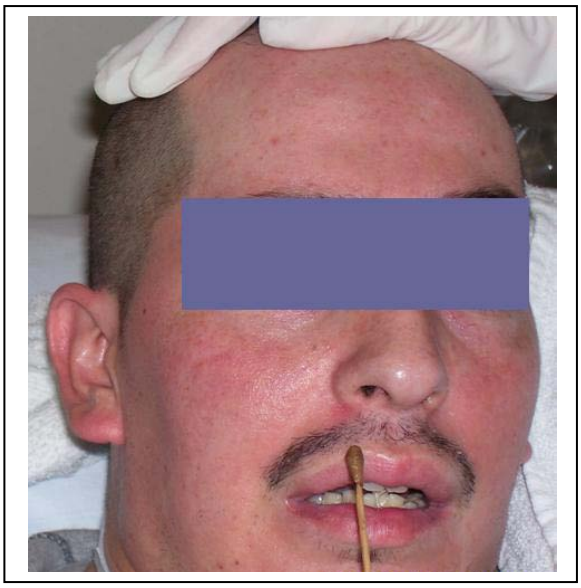
Test Item and Administration Procedures for Test Stimuli:
Prior to presenting the test stimuli, the patient should be provided with information about the test stimuli. Tell the patient what each odor is verbally and position in the patient's visual field before and after giving each stimulus (e.g., "This smells like (name of odor) _____").

Scoring Procedure:
0 = No Response (NR)*:* No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR):
- Suckling
- Jaw Movement
- Chomping/chewing motion
- Muscle tensing or other movements unrelated to the area stimulated
- Unrelated vocalization

2 = Localized Response (LR):
- Oral motor movements, such as licking lips or lip compression
- Tongue pumping or movements
- Swallowing within 10-15 seconds of application of odor
- Patient swipes at examiner's hand in an attempt to inhibit input
- Vocalization related to stimuli (e.g., "mmmmmmmm" or "ahhhhhhh")

A. Odor 1 (Item 4a)
B. Odor 2 (Item 4b)
- Soak an applicator with cooking extract (orange, peppermint or vanilla)
- Place the applicator ½" to 1" below the nostrils.
- If patient has a tracheotomy tube and there is medical clearance to occlude the tube, then occlude the tracheotomy tube for 3-5 seconds while applicator is beneath the nostrils
- Repeat procedure again for 4b odor test item using a **different** extract – **do not use the same odor that was used to Test item 4a.**
- If the patient demonstrates a localizes response to ordor1 (Item 4a); Odor 2 does not have to be administered.



5. Proprioceptive Subscale (item 5)

This test item evaluates the patient's response to passive range of motion.

Administration Guidelines:

- Present test item as many times as necessary to determine the patient's best response
- Wait 10-15 seconds for a response and wait 30 seconds before administering another test item
- Note any limits in range of motion on the response rating form – be aware of general limitations
- Do not range to the extent of pain
- If the patient does not get a score of 2, then range the other side or a different limb
- If required, ask your local occupational or physical therapist to demonstrate proper range of motion technique
- Head should be at midline and supported. Eliminate or reduce neck extension when moving the patient
- The subject may attempt to inhibit input or may demonstrate decreased or increased tone in the joint/limb being ranged.

Test Item and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the patient should be provided with information about the test stimuli. Tell the patient that you will be moving their arms and legs (e.g., **"Joe, I am going to move your arm"**).

Scoring Procedure:

0 = No Response (NR): No active movement or vocalization following the presentation of stimulus

1 = Generalized Response (GR):

- Eye Opening
- Increased respiration
- Decreased tone or increased tone
- Oral motor movements
- Muscle tensing or other movements unrelated to the area stimulated
- Increased flexion / extension

2 = Localized Response (LR):

- Patient swipes at the therapist's hand as an attempt to inhibit input
- Patient assists or resists movement or activity during passive movement stimulation
- Related vocalization (e.g., grunting)

6. Tactile Subscale (Items 6 – 13)

Required Material:

- Mini vibrator
- Feather
- Can of pressurized air
- Kitchen scouring pad
- Ice cubes or ice chips
- Alcohol swab

Administration Guidelines:

- Head should be midline and supported to eliminate or reduce neck extension
- Present each test item as many times as necessary to determine the patient's best response.
- Each sensation should be presented for 3-5 seconds
- Present each sensation on both the right and left side
- Wait 10-15 seconds for a response and wait 30-60 seconds before administering another sensation
- Score each test item after determining the patient's best response. Do not wait to score until all items have been administered
- If a patient does not get a score of 2 after presentation of sensation bilaterally, then present the sensation to the alternative location specified in the directions for the items.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with simple instructions that include the name of the body part you are planning to touch (e.g., "I am going to touch your arm now").

Scoring Procedure:

0 = No Response (NR): No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR):

- Decorticate posturing
- Abnormal flexion
- Eye Opening
- Increased respiration
- Decreased tone or increased tone
- Muscle tensing or other movements unrelated to the area simulated
- Blinking
- Deviation of oxygen saturation from baseline range
- Deviation of heart rate from baseline

2 = Localized Response (LR):

- Patient swipes at the examiner's hand as an attempt to inhibit input
- Orienting movement of the body part stimulated
- Moving body part stimulated
- Vocalizations in response indicating localization to the stimulus

A. Light Tactile (items 6-9)

a. **Air** (item 6): Using the can of pressurized air, direct stream of air as close as possible to center of back of neck.

b. **Feather** (item 7): Gently sweep the feather across the face over the nose and on the cheeks. Other body parts the feather can be used on include the knee (stroking downward slowly on the anterior and posterior surfaces of the knee) and the bicep (stroking downward slowly).

c. **Hair** (item 8): Without contacting the skin, lightly move the hair in the direction opposite to that of the hair growth pattern (e.g., eyebrows, beard, arms)

d. **Vibration to big toe or heel** (item 9): Apply vibrator to pad of big toe or heel

B. Firm Tactile (Items 10-11)

a. **Hand /Firm Pressure** (Item 10): Using fingertips, apply firm pressure down the inside surface of the right arm from the shoulder to the wrist. Repeat on left arm if no localized response.

b. **Scrub** (Item 11): Using the kitchen scouring pad, firmly apply a back and forth movement with firm pressure over the biceps, forearm and thigh areas on the right side of the body (exposed areas). Repeat procedure on the left side of the body if no localized response.

C. Temperature (Items 12-13)

a. Swab/ big toe or heel (Item 12): Using an alcohol prep wipe, swipe the big toe or heel without your fingers touching the patient's skin on the right side. Repeat this on the left side if no localized response.

b. Ice Cube (Item 13): Using light pressure, hold the ice cube on the right big toe or heel just until the ice starts to melt. Repeat this on the left side if no localized response.

7. Auditory Subscale (Items 14-18b)

Required Material:

- Whistle
- Bell

Administration Guidelines:

- Head should be midline and supported to eliminate or reduce neck extension.
- Present each test item as many times as necessary to determine the patient's best response.
- Each sensation should be presented for 3-5 seconds.
- Present each sensation on both the right and left side.
- Wait 10-15 seconds for a response; **for commands allow up to 30 seconds** for a response and wait 30-60 seconds before administering another sensation.
- Modify the immediate environment to reduce any auditory and/or visual distractions, such as a radio, televisions, and if possible medical machinery (i.e. check with attending physician).
- Stand outside of the patient's field of vision except when giving auditory commands.
- Stimulus should be applied to both the right and left ears.
- Avoid cueing with eye contact or gestures; specify commands (e.g., "move your fingers").
- Write down the commands used in the scoring grid.
- Score each test item after determining the patient's best response. Do **not** wait to score until all items have been administered.

Test Items and Administration Procedure for Test Stimuli:

No cues or introductions should be provided for the auditory startle and auditory localization test items (items 14-17). For the auditory comprehension test items (1 step command), simply state the command you are requesting the patient to follow. You may repeat the command as many times as necessary to elicit the optimal response.

Scoring Procedure:

0 = No Response (NR): No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR):

- Eye opening
- Increased respiration
- Decreased tone or increased tone
- Muscle tensing or other movements unrelated to the area stimuluated
- Unrelated vocalizations

- Blinking
- Deviation in oxygen saturation level from baseline
- Deviation in heart rate from baseline

2 = Localized Response (LR):

- Orienting or localization movements toward sound (if the test item is command following, then localization toward sound is considered a GR).
- Moving body part that subject was told to move
- Vocalizations or response indicating subject's comprehension of verbal command.
- For the startle items, a startle response if considered a localized response; for any other auditory items a startle response would be considered a generalized response.

A. Auditory Startle (Items 14 & 15)

a. **Whistle** (Item 14): Blow whistle sharply and loudly one time behind **each** ear
   - Right ear
   - Left ear

b. **Clap** (Item 15): Clap hands sharply and loudly one time behind **each** ear
   - Right ear
   - Left ear

B. Auditory Localization (Items 16 & 17)

a. Name (Item 16): Call out the patient's name (first name or last name or nickname)
   - When repeating the name, varying the inflection and loudness with each repetition
   - Right ear
   - Left ear

c. Bell (Item 17): Ring bell for 5-10 seconds near the patient's ear
   - Right ear
   - Left ear

C. Auditory Comprehension (Items 18a & 18b)

- **1-step command <Command 1>** (Item 18a)**:** Use a simple one step command that the patient is able to physically perform (e.g., "move your fingers").
- **1-step commands <Command 2>** (Item 18b): Use a different command within the patient's motoric capabilities

8. Visual Subscale (Items 19-23)

Required Material:

- Picture of a person familiar to the subject (known person at least one year prior to injury)
- Mirror
- Two 3-dimensional objects (tennis ball and blocks are provided in the DOCS kit)

Administrative Guidelines:

- If eye opening isn't achieved or re-established **do not** administer the visual items. Do attempt to administer at another time within 24 hours.
- If ptosis, unilateral or bilateral, is suspected, then eyelids should be propped open with finger tips. Give the patient 30 to 60 seconds to adjust to the pressure of the finger tip on the eyelids, then administer test stimulus.
- If administration during that 24 hours period is not possible or during the second session eye opening was still not achieved, then give a score of NR (0) for all visual items not administered secondary to limited eye opening.
- Consider administering the visual items first if there is a concern that the patient will not maintain eye opening for the entire evaluation session.
- Patients with dysconjugate/divergent gaze (i.e., non-symmetrical eye movement, the eyes are looking in 2 different directions) should be assessed with one eye patched or covered (please consult with your physician and/or members of your vision team such as the occupational therapist for guidance if needed).
- Present each test item as many times as necessary to determine the subject's best response.
- Wait 30-60 seconds before administering another test stimulus.
- Head should be midline and supported, eliminate or reduce neck extension.
- Score each test item after determining the patient's best response. Do **not** wait to score.

Test Items and Administration Procedure for Test Stimuli:

Prior to presenting each test stimuli, the patient should be provided with information about the test procedure. Tell the patient that you want him/her to look at the objects (e.g., "Joe look at the ball" or "Joe watch the ball" or "Joe keep your eyes on the ball").

Scoring Procedure:

0 = No Response (NR): No active movement or vocalization following the presentation of the stimuli.

1 = Generalized Response (GR):

- Eye Opening
- Increased respiration
- Decreased tone
- Oral Motor Movements
- Muscle tensing or other movements unrelated to the are stimulated
- Unrelated vocalizations
- Blinking (blinking can be a LR if it is in response to the blinking test item, but otherwise it is a GR)

2 = Localized Response (LR):

- Subject swipes at the therapist's hand, as an attempt to inhibit input
- Related vocalization (e.g., "ohhhhh")
- Facial movements
- Head turning
- Squinting
- Eye Closing (for blink test items)
- Eyelid fluttering (for blink test items)
- Visual orientation toward object

A. Blink Response (Items 19a-19e): Rapidly and abruptly move your hand toward the patient's face from a stationary position about 12 inches away to about 2 inches away and flick your fingers. Avoid the inadvertent tactile stimulation of a rush of air. Look for a blink response. Repeat this in each of the following:

- **a. Upper visual field** (19a)
- **b. Middle visual field** (19b)
- **c. Lower visual field** (19c)
- **d. Left visual field** (19d)
- **e. Right visual field** (19e)

B. Focus on Object (Items 20a-20e): Hold a 3-dimensional object in the visual fields, approximately 18" from the face for 5-10 seconds

- **a. Upper visual field** (20a)
- **b. Middle visual field** (20b)
- **c. Lower visual field** (20c)
- **d. Left visual field** (20d)
- **e. Right visual field** (20e)

C. Tracking Objects (Items 21a & 21b):

a. Horizontal (Item 21a): Present a 3-dimensional object in the left visual field and slowly move the object to the right, across midline. Next, present a 3-dimensional object in the right field moving the object to the left across **midline.** If the patient demonstrates an ocular-motor restriction (i.e. field cut) and in the clinical judgment of the examiner prohibits the crossing of midline for tracking, then if the patient demonstrates tracking in at least one visual field (right or left), a score of "2" should be recorded.

b. Vertical (Item 21b): Present a 3-dimensional object in the middle visual field and slowly move the object upward. Next, present a 3-dimensional object in the middle visual field and slowly move the object downward. If the patient demonstrates an ocular-motor restriction (i.e. field cut) and in the clinical judgment of the examiner prohibits the crossing of midline for tracking, then if the patient demonstrates tracking in at least one visual field (upward or downward), a score a "2" should be recorded. If the clinician suspects attention impairment is prohibiting patient from crossing midline then a score of "1" should be recorded. The distinction between ocular-motor and attention impairment is at the discretion of the evaluating clinician.

D. Tracking Familiar Faces (Items 22a & 22b)

a. Horizontal (Item 22a): Present a picture of a person familiar to the patient in the left visual field and slowly move the picture to the right, across midline. Next, present the picture in the right field moving the object to the left across midline. If the subject does not score a "2" tracking familiar face photo, use the mirror, and have the subject track themselves via mirror. If the patient demonstrates an ocular-motor restriction (i.e. field cut) and in the clinical judgment of the examiner prohibits crossing of midline for tracking, then if the patient demonstrates tracking in at least one visual field (right or left), a score a "2" should be recorded. The distinction between ocular-motor and attention impairment is at the discretion of the evaluating clinician. If a familiar person is present during the DOCS administration, they may place their actual face 18" from the patient to evaluate horizontal tracking as described above.

b. Vertical (Item 21b): Present a picture of a person familiar to the patient in the middle visual field and slowly move the picture upward. Next, present a 3-dimensional object in the middle visual field and slowly move the object downward. If the subject does not score a “2” tracking familiar face photo, use the mirror, and have the subject track themselves via mirror. If the patient demonstrates an ocular-motor restriction (i.e. field cut) that in the clinical judgment of the examiner prohibits crossing of midline for tracking, then if the patient demonstrates tracking in at least one visual field (upward or downward) a score a “2” should be recorded. The distinction between ocular-motor and attention impairment is at the discretion of the evaluating clinician. If a familiar person is present during the DOCS administration, they may place their actual face 18” from the patient to evaluate vertical tracking as described above.

E. Focus on Familiar Face (Items 23a-23e): Hold a picture of a person familiar to the patient for at least one year prior to injury approximately 18" from the face for 5-10 seconds in the visual fields listed below. If the patient does not score a “2” focusing on familiar face photo in at least one of the visual fields, use the mirror and have the patient focus on themselves via mirror. If a familiar person is present during the DOCS administration, they may place their actual face 18” from the patient in each visual field listed below.

a. Upper visual field (23a
b. Middle visual field (23b)
c. Lower visual field (23c)
d. Left visual field (23d)
e. Right visual field (23e)

TESTING READINESS SCORE

Administration Guidelines: The testing readiness score is calculated after you have administered the DOCS items. It is used for clinical tracking in order to determine the most optimal time to complete the DOCS evaluation. The testing readiness score can be used to interpret differences in results/ performance between testing sessions. When calculating the testing readiness score, circle one score (e.g. 0 or 1) for each category below. The total testing readiness score can range from 0 to 6.

1. **Auditory Stimuli:**
   Patient required their name to be spoken to re-establish “testing readiness” = 0
   Patient did not require their name to be spoken to re-establish “testing readiness” = 1

2. **Tactical/Deep Pressure Stimuli:**
   Patient required deep pressure to re-establish “testing readiness” = 0
   Patient did not require deep pressure to re-establish “testing readiness” = 1

3. **Passive Movement Stimuli:**
   Patient required passive movements to re-establish “testing readiness” = 0
   Patient did not require passive movement to re-establish “testing readiness” = 1

4. **Rolling Stimuli:**
   Patient required rolling to re-establish “testing readiness” = 0
   Patient did not require rolling to re-establish “testing readiness” = 1

5. **Rocking Stimuli:**
   Patient required rocking stimuli to re-establish “testing readiness” = 0
   Patient did not require rocking stimuli to re-establish “testing readiness” = 1

6. **Maintaining State of Testing Readiness:**
   Did the patient require stimulation intermittently throughout the evaluation to maintain a state of testing readiness? YES = 0 NO=1

Chapter 5: How to Build the DOCS Testing KIT

Creating a DOCS Kit:

To administer and score the DOCS, you will first need to create a DOCS test kit. The DOCS test kit can be compiled by you for approximately $50.00 - $75.00 (US Dollars) and the items can be purchased at your local stores or via the internet. Below is a list of items needed to create a DOCS test kit. Internet web sites are provided with the list below, but this does not mean that any particular brand names are recommended / endorsed. The web sites and brand names of items are simply provided as a means to assist clinicians who may not live in urban areas in the United States. These suggestions are meant to be helpful when purchasing these supplies. We do not endorse any one brand, store or website. The items that you will need to create a DOCS test kit are:

Table 25:Items for the DOCS Kit

Items	Places Where You can Purchase these Items
1. One Mini Vibrator	We use a vibrator with a small head and it was purchased through Sammons Preston, Item # 550487, Mini Vibrator; The price for this item as of March 12, 2009 is $28.49 (US Dollars). The internet address for Sammons Preston is http://www.sammonspreston.com
2. Flavor Extracts (vanilla, mint, orange)	Any grocery store
3. One penlight	Any hardware store or medical bookstore
4. One red block	Any toy store or department store selling children's toys
5. One small/hand held school bell	Any department store. We purchased ours at http://edumart.come/chalkboard/
6. One can of pressurized air	Any office supply store, computer supply store
7. Feathers	Any grocery, department or party store. We purchased ours at: http://edumart.com/chalkboard/ After using each feather we dispose of the feather. Follow the infection control procedures at your facility.
8. Kitchen scrubs (yellow sponge on one side and green coarse surface on the other side)	Any grocery or department store. We use Scotch Brite brand. We cut each sponge into 1x1 inch squares and then we dispose of eachsquare after using it. Follow the infection control procedures at your facility.
9. Alcohol prep swabs	Any pharmacy or First Aid section of a department store
10. Metal spoon	We suggest purchasing several inexpensive metal spoons and suggest using one spoon per patient. Follow the infection control procedures at your facility.
11. One—do not disturb sign	We make our own using bright (neon) pink paper and then we laminate the sign.
12. Cotton tipped applicators	These are available on most patient units or nursing supply departments. They can also be purchased at your local pharmacy.
13. Photographs of people familiar to the patient	We ask the families to bring/supply photographs of people familiar to the patient (i.e., faces not places). Familiar means that the patient knew the person for at least 1 year prior to the date of injury.
14. One Yellow Tennis Ball	Department stores such as Target, WalMart, Shopko, or specialty sporting goods stores.
15. A hand-held mirror: 4 inches by 6 inches	Health and Beauty departments in stores such as Target, WalMart or Shopko
16. One Coaches Whistle	Any sporting goods store. This is a whistle similar to that which an American Football and European Football (Soccer) coach might use

You will also need the following when administering the DOCS test:

- Ice chips
- Small amounts of juice, soda and/or a familiar taste
- Towels and/or a washcloth
- Latex and/or Non-latex gloves if you or the patient are allergic to latex
- Pulse Oximeter (We use a Finger Tip Pulse Oximeter to monitor changes in Heart Rate

Use of DOCS KIT:

It is recommended that you keep all of the test stimuli/items in a small toolbox that can be purchased at any hardware store. The items in the DOCS test kit (i.e., the stimuli) should **only** be used for testing and not for therapy. It is recommended that the toolbox be labeled as the **"DOCS TEST KIT"** and instruct therapists to NOT use it in therapy. We add this second label **"DO NOT USE IN THERAPY"** to remind the therapists to only use the kit for evaluation.

Chapter 6: Conversion of Raw DOCS Scores and Interpretation of DOCS Measures

The DOCS rating scale was constructed from the perspective that the ability to monitor neurobehavioral recovery or change after severe BI is related to our ability to measure the amount or level of neurobehavioral functioning within the continuum of altered consciousness. That is, the challenge is to capture behaviors reflective of true neurobehavioral functioning and to have the capacity to distinguish that from random error.

Examiners use the DOCS rating scale to assign a score of 0, 1, or 2 to behavior(s) elicited with a test stimulus. A higher score indicates a higher level of neurobehavioral integrity. Multiple responses can indicate neurobehavioral integrity, but only the best response is used for computing the DOCS measure of neurobehavioral functioning.

The rating scale defines neurobehavioral integrity according to a continuum ranging from no neurobehavioral response to test stimuli to contextually appropriate responses to test stimuli. The rating scale is based on the assumption that a finite set of prescribed or expected responses cannot serve as exhaustive indices of neurobehavioral functioning. Therefore, test stimuli are used to elicit behavioral responses and are rated relative to baseline behaviors. This scale is used to rate clinically an elicited behavior. Multiple behavioral responses to a test stimuli all indicate neurobehavioral integrity, but only the best response is used for computing the DOCS measure of neurobehavioral functioning. A higher score indicates a higher level of neurobehavioral integrity and more neurobehavioral functioning.

Method to Convert DOCS Raw Score into DOCS Measures

The DOCS raw scores are transformed into DOCS measures using the analytical methods described in Chapter 3. In addition to transforming raw scores into meaningful measures clinicians also need to readily convert raw scores into meaningful measures at the bedside. Therefore, scoring tables and corresponding conversion charts were created for use at the bedside. These scoring tables and conversion charts are not published in a peer-reviewed publication, but the methods used to create them were published in peer reviewed manuscripts.[49]

At the time of writing this manual, scoring tables and conversion charts available for the Total DOCS measure and DOCS measures by modalities. The modality measures are similar to sub scale scores and we are currently examining their value in predicting recovery of function.

At the time of writing this manual we are exploring the usefulness of additional sub-scale scores. As described in Chapter 3 in the Predictive Validity section, we are examining the value of combining DOCS items that require moderately complex (e.g., Command Item) cortical processing versus complex cortical processing (e.g., Name Item). These measures will reflect the extent of CNS processing required to receive the highest possible score of ‘2’ (i.e., localized response) on the DOCS. We are hopeful that different combinations according to complexity of cortical processing will have value for predicting long term functional recovery. These scoring tables and conversion charts are not available at this time, but after we complete our analyses, the manual will be updated to include these additional sub-scale measures.

The Total DOCS score conversion charts and DOCS Modality score conversion charts can be used when a complete DOCS test is administered and when circumstances do not permit administration of all test items. If the complete set of test items are not administered (i.e., skipped items) the chart provides predictions of what the raw score on the complete set of items would have been (i.e., expected score) if all items had been administered.

Scoring Tables and Conversion Charts: Total DOCS

The DOCS includes the 23 test items previously published and recommended for clinical practice. The conversion of the Total DOCS measures is based on these 23 items. **Table 25** is the ***DOCS Scoring Form*** that should be used to calculate the total DOCS raw score according to the 23 items demonstrated to be reliable and valid.[49] When summing the total DOCS raw score, if an item was skipped, write "skipped" in the cell and do not add it in the total. The total raw DOCS score can still be converted to a DOCS measure even if items are skipped. For additional details regarding why this is possible, see chapter three regarding probability models used to estimate DOCS measures.

Tables 26 & 27 represent the conversion charts used to convert the ***Total DOCS Raw Score to the DOCS Measures*** (i.e., DOCunit, Standard Error of Measurement, Percentile). **Table 26** is the conversion chart is for "traumatic brain injuries" and **Table 27** is the conversion chart is for "non traumatic brain injuries").

Scoring Tables and Conversion Charts: DOCS Modality Subscales

Three sub-scale or modality measures can be derived from the DOCS when using the 23 previously published items. The modality specific composite measures include auditory, visual, and tactile are each comprised of items requiring either reception and/or processing of sensory stimuli related to each particular modality. To calculate the DOCS Modality Raw Scores, you can use **Table 28 (*Modality Raw Scoring Tables for Tactile, Auditory, & Visual Table***). To convert the Total DOCS and DOCS Modality raw score into DOCS measures, you can use **Table 29 *(Conversion Chart: DOCS Modality Measures***).

Accuracy of Converted DOCS Measures: Total and Modality Measures

The conversion charts provided in this chapter have not been published at the time of writing this manual, but preliminary results indicate that the charts provide precise estimates of DOCS neurobehavioral measures. That is, the average difference between the actual and the estimated DOCS measures indicate that the actual measure was underestimated by four one hundredths of a DOC unit (Average Difference = -0.0446; Average Absolute Difference = 0.3489).

Interpretation

The converted measures provided in this chapter reflect raw scores transformed to logit measures and then re-scaled to a 0 to 100 scale. These logit measures, after re scaling, are equal interval and continuous measures. The measures indicate the odds (plus/minus error) that we are actually observing the neurobehavioral responses that we think we have observed. That is, the measures reflect the odds that, for each subject/patient, their neurobehavioral functioning/ ability is actually that which we have estimated it to be in the DOCS measures.

The standard error (SE) of each DOCS measure reflects the precision of the measure or estimate. It is the standard deviation of an imagined error distribution or reference standard outside of the actual data collected, which is created/modeled using the rating scale model (see Chapter 3). The size of the SE is influenced by the number of test items administered/direct observations made to derive the measure. Since the SE is a modeled estimation of variance, modeled using data outside of the actual data, we can use the converted DOCS measure from the study sample to define an individual patient's neurobehavioral functioning who was not a participant in the study sample (i.e., generalize results from study sample to patient population).

Table 26 – Total DOCS Scoring Table

Instructions: Regardless of patient etiology, use this scoring table to transfer best scores from rating form to this scoring table. Add the total score. If the patient has a traumatic brain injury, then use the traumatic BI conversion chart to convert the Total raw score into the Total 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 measure. For items that are administered more than one time or to different visual fields, take the best score for that item (ie, odor, command, blink, focus, & tracking).

Item #	DOCS Test Item	Best Raw Score 1st Evaluation	Best Raw Score 2nd Evaluation	Best Raw Score Evaluation	Best Raw Score Evaluation
C1	1. GREET				
S1	2. JUICE				
S2	3. MASSAGE (Masseter)				
O1	4. ODOR				
PV1	5. JOINT				
T1	6. AIR				
T2	7. FEATHER				
T3	8. HAIR				
T4	9. TOE (Vibration)				
T5	10. HAND (Massage)				
T6	SCRUB				
T7	SWAB				
T8	CUBE				
A1	WHISTLE				
A2	CLAP				
A3	NAME				
A4	BELL				
A5	COMMAND				
A6	BLINK				
V3	FOCUS (Object)				
V4	TRACKING (Object)				
V7	TRACKING (Familiar Face)				
V8	FOCUS FACE (Familiar Face)				
Total DOCS RAW SCORE					
DOCS Measure (Obtained from appropriate conversation chart)					

Table 27 – –Traumatic Brain Injury Conversion Chart for Total DOCS Measure

DOCS Raw Score	DOCunit	Standard Error	Percentile
0	5.0	18.2	1
1	16.8	9.9	1
2	23.5	6.9	3
3	27.4	5.7	4
4	30.2	4.9	6
5	32.4	4.4	7
6	34.1	4.1	9
7	35.7	3.8	12
8	37.0	3.6	13
9	38.3	3.4	15
10	39.4	3.3	16
11	40.4	3.2	19
12	41.4	3.1	21
13	42.3	3.0	22
14	43.2	2.9	25
15	44.0	2.9	28
16	44.8	2.8	30
17	45.6	2.8	33
18	46.3	2.7	37
19	47.1	2.7	41
20	47.8	2.7	43
21	48.6	2.7	44
22	49.3	2.7	47
23	50.0	2.7	49
24	50.7	2.7	51
25	51.4	2.7	54
26	52.2	2.7	56
27	52.9	2.7	59
28	53.7	2.7	62
29	54.4	2.8	66
30	55.2	2.8	70
31	56.0	2.9	72
32	56.8	2.9	73
33	57.7	3.0	76
34	58.6	3.1	79
35	59.6	3.2	81
36	60.6	3.3	83
37	61.8	3.4	84
38	63.0	3.6	85
39	64.3	3.8	87
40	65.9	4.1	90
41	67.6	4.4	92
42	69.8	4.9	93
43	72.6	5.7	95
44	76.5	6.9	97
45	83.1	9.9	98
46	95.0	18.2	99

***Conversion are based on 120 repeated DOCS examinations of 39 persons with severe TBI due open head injury, blunt trauma, closed head injury, and blast injury. Each DOCS examination included 23 test stimuli**

Table 28 – Non-traumatic Brain Injury Conversion Chart for Total DOCS Measure

DOCS Raw Score	DOCunit	Standard Error	Percentile
0	4.4	18.2	1
1	16.3	9.9	1
2	23.0	6.9	1
3	26.9	5.7	2
4	29.7	4.9	2
5	31.9	4.4	3
6	33.7	4.1	5
7	35.2	3.8	7
8	36.6	3.6	9
9	37.9	3.4	12
10	39.0	3.3	15
11	40.0	3.2	19
12	41.0	3.1	24
13	42.0	3.0	26
14	42.9	3.0	28
15	43.7	2.9	30
16	44.5	2.9	34
17	45.3	2.8	38
18	46.1	2.8	40
19	46.9	2.8	45
20	47.7	2.7	48
21	48.4	2.7	51
22	49.2	2.7	55
23	49.9	2.7	57
24	50.7	2.7	58
25	51.4	2.7	60
26	52.2	2.8	62
27	52.9	2.8	65
28	53.7	2.8	68
29	54.5	2.8	72
30	55.3	2.9	75
31	56.2	2.9	80
32	57.1	3.0	84
33	58.0	3.1	86
34	58.9	3.1	88
35	59.9	3.2	90
36	61.0	3.3	91
37	62.2	3.5	92
38	63.5	3.6	93
39	64.9	3.9	93
40	66.4	4.1	94
41	68.3	4.5	94
42	70.5	5.0	95
43	73.3	5.7	96
44	77.2	7.0	96
45	84.0	9.9	98
46	95.8	18.2	100

Conversions are based on 120 repeated DOCS examinations of 39 persons with severe BI due to an anoxic and/or vascular injury. Each DOCS examination included 23 test stimuli

Table 29 – Modality Scoring Tables: Tactile, Auditory, & Visual

Instructions: Regardless of patient etiology, use this scoring table to transfer best scores from rating form to this scoring table Add the total score in each modality table. For modality sub scales, we do not at the time of writing this manual have separate conversion charts for traumatic and non-traumatic etiologies. Therefore, use the conversion chart to convert the Total Modality score for each specific score regardless of etiology. If items were skipped, then write "skipped" in the cell and do not add it in the total. The total scores can then be converted to a measure if items are skipped and therefore not included in the total modality score.

TACTILE ITEMS

Tactile Item #	DOCS Tactile Test Item	Best Raw Score 1st Evaluation	Best Raw Score 2nd Evaluation	Best Raw Score ____ Evaluation	Best Raw Score ____ Evaluation
T1	1. AIR				
T2	2. FEATHER				
T3	3. HAIR				
T4	4. TOE (Vibration)				
T5	5. HAND (Massage)				
T6	6. SCRUB				
T7	7. SWAB				
T8	8. CUBE				
PV1	9. JOINT				
TOTAL RAW TACTILE SCORE					
DOCS Tactile Score (Obtained from modality conversion chart)					

AUDITORY ITEMS

Auditory Item #	DOCS Auditory Test Item	Best Raw Score 1st Evaluation	Best Raw Score 2nd Evaluation	Best Raw Score ____ Evaluation	Best Raw Score ____ Evaluation
C1	1. GREETING				
A1	2. WHISTLE				
A2	3. CLAP				
A3	4. NAME				
A5	5. BELL				
A6	6. COMMAND				
TOTAL RAW AUDITORY SCORE					
DOCS Auditory Score (Obtained from modality conversion chart)					

VISUAL ITEMS

Visual Item #	DOCS Visual Test Item	Best Raw Score 1st Evaluation	Best Raw Score 2nd Evaluation	Best Raw Score ____ Evaluation	Best Raw Score ____ Evaluation
V3	1. BLINK				
V4	2. FOCUS (On Objects)				
V5	3. TRACKING (Objects)				
V7	4. TRACKING (Familiar Face)				
V8	5. FOCUSFAC (Familiar Face)				
TOTAL RAW VISUAL SCORE					
DOCS Visual Score (Obtained from modality conversion chart)					

Table 30 – Conversion Chart: DOCS Modality Measures

Conversion Chart: DOCS Modality Measures for Traumatic & Non-Traumatic Etiologies

TACTILE

Conversion Table for Tactile Modality Scores			
Tactile Modality Raw Score	DOCunit Score for Tactile Items	Standard Error	Percentile
0	12.2	18.2	2
1	24.2	10.0	5
2	31.2	7.2	8
3	35.5	6.0	11
4	38.7	5.4	16
5	41.4	5.0	21
6	43.7	4.7	27
7	45.9	4.6	34
8	48.0	4.5	43
9	50.0	4.5	50
10	52.0	4.5	58
11	54.1	4.6	65
12	56.3	4.8	71
13	58.6	5.0	77
14	61.3	5.4	82
15	64.6	6.0	87
16	68.9	7.2	93
17	75.9	10.0	97
18	87.8	18.2	99

AUDITORY

Conversion Table for Auditory Modality Scores			
Auditory Modality Raw Score	DOCunit Score for Tactile Items	Standard Error	Percentile
0	14.5	18.4	4
1	27.0	10.3	12
2	34.6	7.6	19
3	39.5	6.5	26
4	43.4	6.0	35
5	46.8	5.7	43
6	50.0	5.6	50
7	53.2	5.7	58
8	56.6	6.0	65
9	60.5	6.5	73
10	65.4	7.6	80
11	73.0	10.3	88
12	85.5	18.4	96

VISUAL

Conversion Table for Visual Modality Scores			
Visual Modality Raw Score	DOCunit Score for Visual Items	Standard Error	Percentile
0	20.8	17.5	10
1	31.7	9.6	20
2	38.4	7.2	26
3	43.0	6.3	34
4	46.7	5.9	39
5	50.1	5.8	44
6	53.5	5.9	51
7	57.2	6.2	56
8	61.5	7.1	64
9	68.1	9.5	72
10	78.9	17.5	87

Chapter 7: Clinical & Rehabilitation Applications

Clinical Use of the DOCS & Development of Medical Rehabilitation Plan:

Currently there are no existing guidelines to the care of individuals with severely disordered consciousnesses.[68] The lack of standardized and effective rehabilitation guidelines for patients with disordered consciousness may result in suboptimal care.[23] The DOCS may be useful for development of medical rehabilitation plans. This weekly information has been used by therapists to document progress or lack of progress on a weekly basis. The weekly DOCS total score and modality scores may also be used by therapists to aid rehabilitation goal setting. Additionally, information regarding predicted probabilities and corresponding error, given each participant's DOCS change can be determined. This information can determine the appropriateness of when and if to share this information with families.

Magnitude of Change with DOCS:

The influence of DOCS change on outcome prediction was examined by comparing predicted probabilities according to 7-, 8- & 9-unit improvements and declines (**Table 31**). Quintiles for baseline DOCS represents baseline neurobehavioral functioning. A wider range of probabilities was estimated using 9-units of change as evidenced by probabilities ranging from 2% to 99%. The evidence is reported in this manner because it is informative to clinicians and families. That is, clinical applications of the evidence indicates that for baseline DOCS measures obtained within 94 days of injury and if subsequent DOCS measures used to define change are obtained at least 7 days and at most 18 days of the baseline DOCS, then the difference can be used to determine each patient's probability for recovering consciousness. We know further that these probabilities for recovery and lack of recovery will be accurate 88% (AUC = .88) of the time.

Table 31. Predicted Probabilities for Recovering Consciousness in One-Year

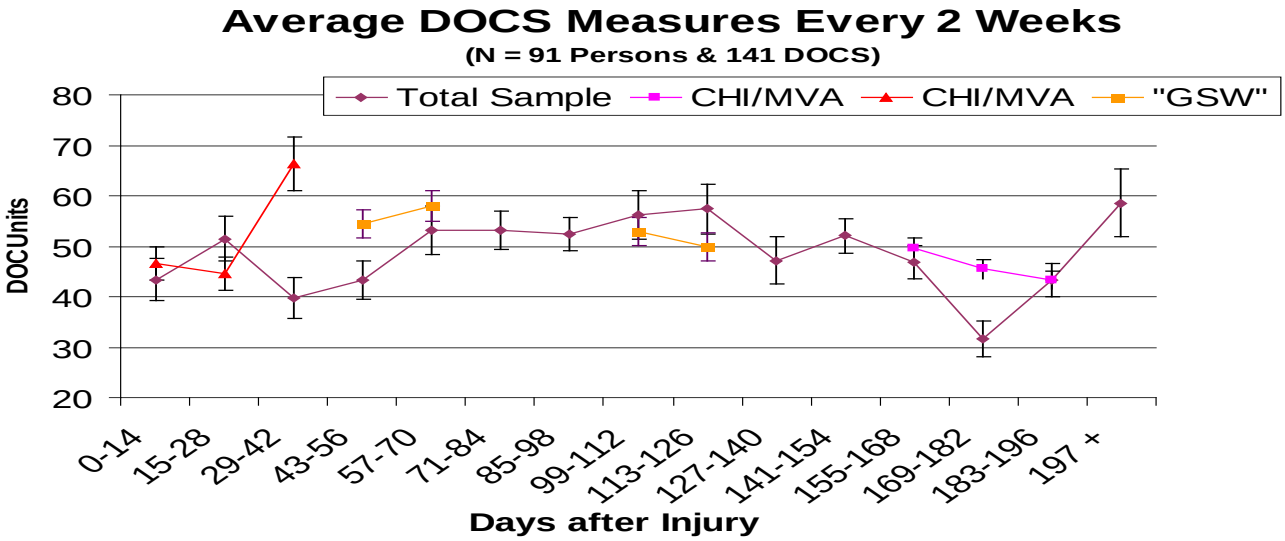
If Baseline DOCS Score is…	Change in DOCS (in DOCunits)																		
	Decline									Plateau	Improve								
	-27	-24	-21	-18	-16	-14	-9	-8	-7	0	7	8	9	14	16	18	21	24	27
	Absolute Probability of Regaining Consciousness in Year 1 of Injury																		
34.4	.016	.021	.029	.039	.047	.057	.091	.100	.110	.202	.340	.364	.388	.514	.564	.614	.683	.746	.799
43.3	.050	.067	.088	.116	.139	.166	.249	.268	.289	.453	.629	.653	.675	.776	.810	.839	.876	.906	.929
48.3	.092	.122	.158	.204	.239	.278	.391	.415	.440	.617	.767	.785	.801	.871	.892	.910	.932	.949	.962
53.0	.161	.207	.262	.325	.372	.421	.547	.573	.597	.752	.861	.873	.884	.927	.940	.950	.963	.972	.980
59.2	.306	.374	.448	.525	.575	.624	.735	.754	.773	.874	.934	.940	.946	.967	.973	.978	.983	.988	.991

The unanticipated finding of detecting a non-significant DOCS neurobehavioral change 7 days after baseline relative to detecting a significant neurobehavioral effect 15 days after baseline DOCS measures supports previous findings that the DOCS is sufficiently sensitive and stable over time to be used for repeated measures during coma recovery. These repeated DOCS measures can then be used to detect significant neurobehavioral changes in response to an intervention provided during coma recovery, which is consistent with previously reported evidence.[21,49] This finding is also consistent with previously reported evidence regarding the value of the DOCS in predicting recovery of consciousness at three time points in the first year of injury.[20]

Clinical Applications of DOCS

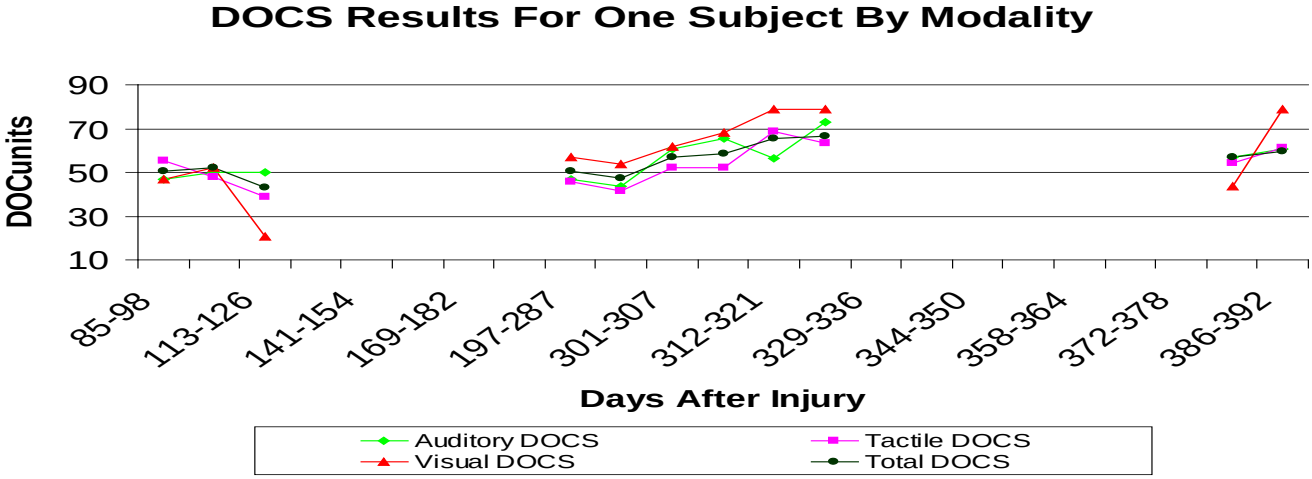
The DOCS scores that are obtained from each DOCS measure have proven useful for clinical applications in the rehabilitation setting. This information can be used in a number of ways including: family education, rehabilitation goal setting, monitoring effects of medication on neurobehavioral function, and monitoring overall recovery or lack of recovery over time. Each of these scenarios is illustrated and discussed below.

Figure 5



DOCS information can be used to educate families in a variety of ways. **Figure 5** shows the average DOCS measure for a sample of 91 persons over time in 2 week increments (Total Sample). In this plot, there are 3 other individual's DOCS measures exhibited. This information can be used to compare how 1 individual is progressing compared to a group of individuals who were unconscious at that same point during injury. As you can see the person with the red plot, made significant gains between DOCS 1 and DOCS 3, whereas the person with the pink plot showed a steady decline over 3 DOCS measures. This visual information assists clinicians in describing changes in overall neurobehavioral function and provides an objective format to present to other clinicians or families/caregivers.

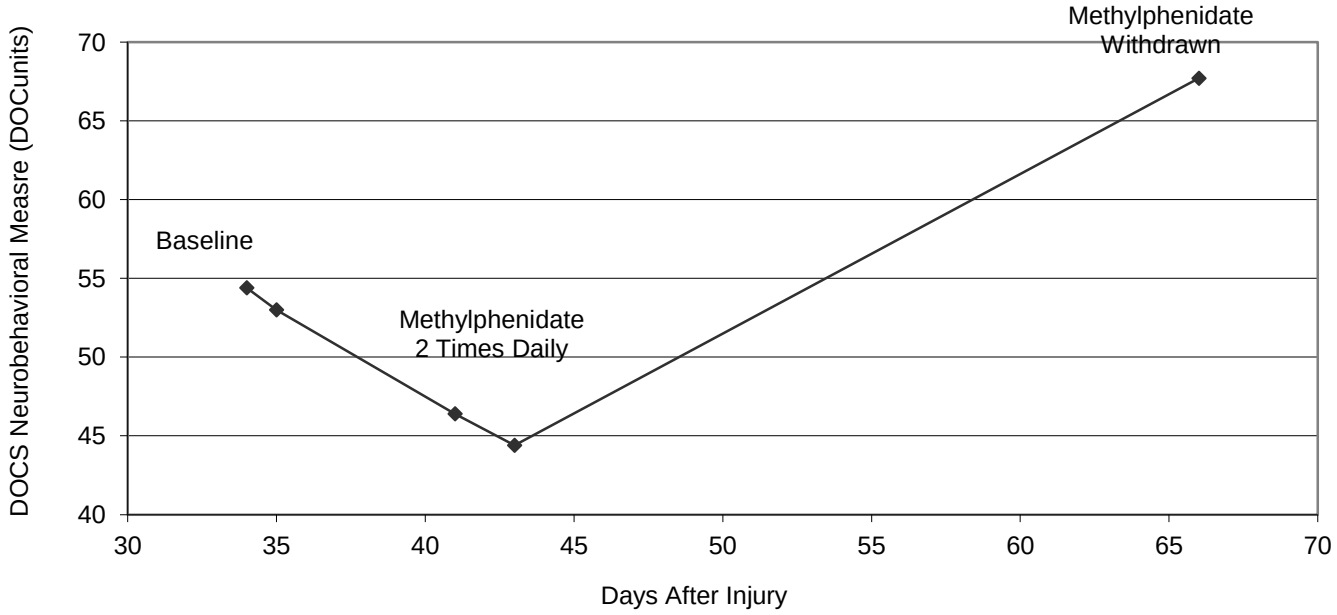
Figure 6



In addition to looking at the overall DOCS measures, the DOCS allow you to calculate modality measures. Currently, clinicians can calculate auditory, visual, and tactile composite scores. This information is illustrated in **Figure 6.** Given this individual's performance on the DOCS, the visual

modality showed the most steady improvement and the highest DOCS scores (Red Triangles) and the Tactile modality would be perceived as the weakest area (Pink Squares) with the Auditory scores being more inconsistent (green circles). This information could be used by clinicians to enhance their treatment plans and goal setting. Knowing that the visual modality is an area of strength for this patient, goals could be set with higher expectations for visual tracking/focus. This could also be helpful for therapists to know they should provide more visual cues with any therapy activity they are engaging this patient in. Modality plotting can also be useful when suspicion of hearing impairment or visual impairment are present. Plots that show good improvement in auditory and tactile scores when visual scores remain static could indicate cortical blindness. Hearing impairments could be suspected if the auditory scores remained static in light of good progress with visual and tactile. These modality measures are not meant to provide a diagnosis of any sensory deficit, but could provide additional objective information if these deficits are already suspected and may indicate further evaluation is warranted.

Figure 7 - Short-Term Effectiveness of a Neurostimulant



Neurostimulants are a commonly prescribed medication in patients with disordered consciousness. Often, new drugs are tried and it is difficult to assess whether they are impacting the level of alertness or not. **Figure 7** illustrates how the DOCS has been used to evaluate the short-term effectiveness of a neurostimulant. In this case, the patient was an 18 year old male. He had his baseline DOCS 34 days after injury and then was started on Methyphenidate (Ritalin) at day 36 post injury. Following the initiation of Ritalin therapists and family reported a decreased level of alertness and activity. Given the age of the patient, the physician suspected he was responding to the Ritalin as a pediatric patient would be expected to, in other words, the Ritalin was acting as a depressant instead of a stimulant. The patient was taken off the Ritalin on day 44. By day 46, therapists and family reported improved level of alertness. DOCS was done on day 66 indicating a significant improvement that could not be solely attributed to spontaneous recovery. Clinicians could use the DOCS to evaluate the short term effects of medication simply by completing a DOCS prior to the initiation of the medication and then repeating the DOCS once that medication is felt to be at a therapeutic level. To insure any neurobehavioral improvement is from the medication, clinicians could remove the medication, complete another DOCS once it is determined to be washed out, then restart the medication and complete an additional DOCS when the medication is therapeutic again.

Medication Analysis:

A retrospective analysis was completed with 84 patients (**Table 32)** comparing the time to consciousness for persons who received and did not receive methylphenidate (Ritalin) during acute rehabilitation using the DOCS as the main outcome measure to evaluate recovery of consciousness (Pape et al., 2010, unpublished raw data with manuscript under review). The results indicated that methylphenidate, at standard doses, has a long-term (1-year) therapeutic effect. Within the first year of recovery, the rate or speed of recovering consciousness is significantly better for persons who received methylphenidate during acute rehabilitation. Unequivocal findings indicating that receiving methylphenidate during acute rehabilitation speeds up time to consciousness within the first year of recovery have not been previously published.

Table 32. Description of Total Sample and Study Groups by Means ± Standard Deviation

	Total Sample (n = 84)	Methylphenidate (n = 29)	No- Methylphenidate (n = 55)	P Values
Age	38.00 ± 17.00	36.00 ±18.30	40.00 ± 16.30	0.37
Days of Hospitalization	65.40 ± 34.00	65.00 ± 29.00	65.70 ± 36.10	0.90
Therapy Hours per Day	2. 02 ± 0.56	2.100 ± 0.43	2.00 ± 0.61	0.11
Days btw. Injury & Hospital Admit	87.00 ± 224.00	42.50 ±23.40	110.10 ± 275.00	0.09
Baseline DOCS	48.80 ± 11.70	49.70 ± 6.20	48.80 ± 13.80	0.95
DOCS Change 1 _ 2	2.00 ± 11.10	1.30 ± 7.10	2.40 ± 12.90	0.65
DOCS Change 1_3	5.10 ± 9.10	9.20 ± 9.70	2.50 ± 7.70	0.01
DOCS Total Change	7.50 ± 12.20	13.20 ± 10.40	4.70 ± 12.10	0.00

The primary finding of an independent therapeutic effect of Methylphenidate is supported further by strongly comparable groups. We considered the possibility that etiology, injury severity, other medications, rehabilitation services, condition of brain prior to injury (i.e., age, blood alcohol levels at injury and alcohol abuse prior to injury), seizures requiring prophylaxis and other variables might influence time to consciousness, but the methylphenidate and no-methylphenidate groups are comparable on all variables except shunt. While the groups significantly differ according to the proportion of participants with or without shunts, the need for a shunt to manage hydrocephalus was not significant when used as a covariate in regression modeling.

Persons receiving methylphenidate during acute rehabilitation showed greater neurobehavioral gains between the first and third DOCS evaluations with an average of 15 days between these evaluations. We did not analyze how time to detect neurobehavioral change within the methylphenidate group relates to the starting and/or stopping of methylphenidate. Therefore, we cannot identify the optimal number of days (i.e., minimum/maximum number) that methylphenidate should be provided. A neurobehavioral effect is noted between 7 and 15 days after baseline DOCS measures. We know that the start of methylphenidate was within a few days of the baseline DOCS. Therefore, we can infer that a minimum of 8 to 15 days of methylphenidate is needed to facilitate time to consciousness. A patient receiving methylphenidate during acute rehabilitation may or may not be discharged on that medication and we did not track medication data after discharge. Therefore, a maximum number of days cannot be identified. Small sample sizes also precluded us from examining differences in time to consciousness according to methylphenidate doses (i.e., milligrams). We cannot, therefore, identify the optimal dose. Future research should be conducted to identify the optimal dose and future analyses could be conducted to determine whether or not the therapeutic dose for methylphenidate should also be thought of in terms of duration or days that methylphenidate is provided.

Chapter 8: Future Directions

The evidence indicates that the DOCS with 23 items is reliable, valid and useful for monitoring neurobehavioral recovery, establishing rehabilitation goals, predicting recovery of consciousness and measuring neurobehavioral effects of treatments provided during coma recovery. While these are milestone achievements, it is important that the DOCS continue to be refined. Ongoing and future research will enhance the clinical and research utility of the DOCS. Clinical utility can be enhanced by expanding the DOCS generalizability in terms of applicable patient populations (e.g., non-traumatic injuries) and applicable health care settings (e.g., sub-acute, nursing homes). Clinical utility can also be enhanced by making the DOCS shorter and by determining how many and how often DOCS evaluations need to be conducted. These refinements will be made while maintaining prognostic/predictive value as well as developing different methods for interpreting and translating DOCS test results. Future diagnostic studies will focus on minimizing errors and bias in diagnosing states of disordered consciousness, which will enable development of treatment plans and prognoses. Prognostication research, on the other hand, will focus on predicting meaningful outcomes to families, caregivers, care managers/coordinators, policy makers and researchers. These refinements will further enable researchers to develop and examine medical rehabilitation interventions that facilitate recovery of consciousness and function after severe brain injury.

Instrumental Development & Refinement:

The primary objective of an ongoing research project (i.e., scheduled completion 12/31/2010) is to eliminate redundant, over-fitting and/or under-fitting DOCS test items. This will shorten the clinical version of the test making it feasible to administer the DOCS in 20 to 30 minutes rather than 30 to 45 minutes while maintaining or improving value of the DOCS in predicting recovery of consciousness within the first year of injury. The ongoing project examines the original 23 DOCS tests in relationship to six experimental test items. Given preliminary data, the hypothesis is that eliminating items and replacing items will shorten the DOCS while increasing the predictive value of the DOCS when predicting recovery of consciousness.

While shortening the DOCS will make it a more feasible test to administer, knowledge regarding how often the DOCS needs to be repeated will streamline clinical planning. Therefore, analyses for the ongoing research will be conducted to identify the number of DOCS evaluations necessary for defining neurobehavioral change. The number of DOCS evaluations necessary will be the number that maximizes predictive values when predicting recovery of consciousness. The predictive value of DOCS change measures will also be examined in relationship to time after injury that DOCS evaluations are conducted, time between DOCS evaluations, and DOCS change by increments of time.

While conducting this research project, researchers are also developing methods to facilitate translation of research findings into daily practice and care. These tools are being developed to visually illustrate each patient's neurobehavioral status relative to a larger sample of persons in states of disordered consciousness, which can be used for goal setting and family/caregiver education.

Future research plans include examining the generalizability of the DOCS in terms of applicable patient populations (e.g., non-traumatic injuries) and applicable health care settings (e.g., sub-acute, nursing homes). This aspect of instrument refinement will require an analytical approach where measurement models are aligned with clinical needs and feasible sample sizes and where the analytical approach is to examine various combinations of independent variables that most strongly predict the outcome. While challenging, this aspect of refinement will maximize generalizability to a heterogeneous reference population.

Prognostication Research:

While evidence based prognoses after severe brain injury are challenging, we have developed the capacity to predict the recovery of consciousness within the first year of injury. We plan to conduct future research examining whether or not we can predict recovery of long term function. Evidence regarding likelihood of recovering specific functional skills can be used by care managers to guide referrals to different levels of medical rehabilitation care. Clinical teaching plans can also be developed for care managers to use when educating caregivers about expected levels of recovery and long-term care needs. Derived evidence could also be used to develop educational materials for caregivers. This information will help to shape expectations regarding care giving burden and long-term support needs subsequently helping families prepare for the future.

Diagnostic Research:

The diagnostic challenge for this patient population is capturing true neurobehavioral functioning distinguished from systematic error and random error. Analyses planned in 2011 using data available in a study database include examining the diagnostic accuracy of the DOCS. That is, Differential Item Functioning (DIF) will be examined. DIF examines to what extent individuals with the same trait have different probabilities of reporting a given response on an assessment tool. It ensures the instrument works the same way for all etiologies. When DIF analysis identifies items that do operate differently among groups, various strategies are available for resolving the issue so data remain comparable. We will then use Rasch regression to evaluate the extent to which the instrument can distinguish between levels of consciousness in the study sample. We will then conduct a future research project using this evidence to define the neural correlates of each state of disordered consciousness diagnosed with the DOCS.

Chapter 9: DOCS Research Study

Objective of Further DOCS Research:

As mentioned in Chapter 8 (Future Directions for the DOCS) the primary objective for continued DOCS Research Study is to further develop and refine this instrument to a shorter version of the DOCS from 23 items (30 minutes) to 18-20 items (20 minutes) while improving or maintaining predictive values of the DOCS; thereby enhancing clinical utility. The goal of the ongoing research is to eliminate redundant, over-fitting and/or under-fitting test items making the DOCS test as short as possible (i.e., goal of 18 to 20 items) without losing predictive utility.

Table 33 lists the six experimental items for the DOCS that are currently being evaluated along with the specific administration procedures and instructions. **Table 34** provides information regarding the corresponding neuroanatomical levels associated with each experimental item.

TABLE 33 - Experimental Test Items for the DOCS

Item Name	Item/ Stimuli	Administration Procedures and Instructions	Scoring Examples (0 = No response different from responses observed at baseline; Not an all inclusive Listing of Possible responses)	Highest Level of CNS Processing
Self Orientation	Two questions	First ask the patient: "Is your name" If the patient is male insert a female Name and If the patient is female insert a Male name (i.e., use an opposite gender name)? Then ask the patient "Is your name (Insert their real first name)?" If you don't get a response to the yes/no questions, you may also ask "What is your name?"	2 = Both questions are correctly answered or they say their name; 1 = Any other response that was not demonstrated at baseline	Superior Temporal Gyrus and/or Wernickes are in language dominant hemisphere
Environment Orientation	One Question	Ask the patient a yes/no question related to their immediate environment. Examples are: "Is your Mom in the room?" or "Is your wife in the room?"	2 = Question is answered correctly; 1 = Any other response that was not demonstrated at baseline	Superior Temporal Gyrus and/or Wernickes are in language dominant hemisphere
Funny Picture		Hold the weird picture of the man at midline, 18 inches from the face for 5-10 seconds. If the subject does not focus on objects at midline, present the picture in a visual field that the person demonstrated ability to focus with the 3 dimensional object	2 = facial expression or other emotional response indicating recognition of the strangeness of the picture; 1= visual focus or tracking of the object.	Fusiform Face Area
Heat	Hand warmers with average temperature of 100° F	Place thin protective fabric (e.g., 2 or 3 tissues, pillowcase) on palm of hand and then place a hand or toe warmer in the palm for 15 to 20 seconds.	2 = localized response to heat; any response that demonstrates awareness of the heat (e.g., relaxation); 1 = other generalized responses (e.g., changes in tonal pattern)	Parietal lobe (S1/S2)
Sweet vs. Sour	A contrast of sweet (sugar) and sour (lemonade concentrate) tastes	Dip a moist cotton tip applicator in sugar and apply to tongue tip (centered); wait 30 seconds then dip a moist cotton tip applicator in the sour (lemonade concentrate) and apply to the tip of the tongue (centered); if bit reflex prohibits tongue application then apply to lips	2 = response to sweet/sour contrast; any response that demonstrates awareness of the differences in the tastes (e.g., facial expressions) ; 1 = swallow and/or other generalized responses	Parietal Lobe (S1/S2) and/or Thalamus [73]
Toothbrush	Toothbrush	Hold the tooth brush up within 18 inches of face and say: "This is a toothbrush." Place the toothbrush in the patient's hand. Then say: "Brush your teeth"	2=attempt to use or use of the toothbrush to brush teeth; 1 = other responses such as conforming grip to shape of toothbrush	Frontal Lobe

Table 34:Research Test Item Selection & Corresponding Neuroanatomical Level

Subscale	Item Name	Highest Level of Central Nervous System Processing
Taste & Swallowing	Spoon (room temperature)	Swallowing motor sequence: Medulla, Nucleus tractus solatarius, Nucleus ambiguous and pre-central gyrus for motor programming and post-central gyrus in sensory cortex for oral sensory programming.
Taste & Swallowing	Spoon (Cold)	Swallowing motor sequence: Medulla, Nucleus tractus solatarius, Nucleus ambiguous and pre-central gyrus for motor programming and post-central gyrus in sensory cortex for oral sensory programming.
Taste & Swallowing	Taste (Contrasting Sweet & Sour)	Upper brain stem; possibly dicencephalon; and/or Thalamus
Visual	Dilation	Midbrain (Pretectal Nucleus)
Visual	Funny Picture	Fusiform Face Area
Auditory	Startle: Whistle	Pons (Lateral Lemniscus)
Orientation General Instructions	Self orientation	Superior Temporal Gyrus and/or Wernickes area in language dominant hemisphere
Orientation General Instructions	Environmental orientation	Superior Temporal Gyrus and/or Wernickes area in language dominant hemisphere
Functional Use of Object	Toothbrush	

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Appendix A

Test Stimuli & Highest Level of CNS Processing for DOCS Test Items

Test Stimuli & Highest Level of CNS Processing

Item Name	Item/ Stimuli	Administration Procedures and Instructions	Response Modes	Highest Level of CNS Processing
Command	2 to 3 verbal commands	Tell the patient to perform a one-step command that is within their motoric capacity; this item is always administered last so motoric capacity can be determined prior to administering the item	Motor Visual Verbal	Frontal Cortex, Pre-Central Gyrus
Tooth-brush	Toothbrush	Hold the tooth brush up within 18 inches of face and say: "This is a toothbrush." Place the toothbrush in the patient's hand. Then say: "Brush your teeth"	Motor Visual	Frontal Lobe
Greet	1 Greeting 1 Question	Say "Hi I'm "(state your name)." "How's it going?" Do not touch patient. Observe patient for a response for 5 – 10 seconds.	Visual Verbal Gesture Mouthing	Bilateral Hemispheric Function
Self orientation	Three questions	Ask the patient one or more of these three questions according to most likely response mode: "What is your name?" "Is your name_____?" (i.e., use an opposite gender name)? "Is your name _____?" (Insert their real first name)?"	Mouthing or Verbalizing answer Indicating Yes or No verbally or pointing to yes/no cards Pointing to written name	Superior Temporal Gyrus and/or Wernickes are in language dominant hemisphere
Environ. orientation	One Question	Ask the patient these questions related to their immediate environment. "Is _____ (Name a person) in the room?" "Who is in the room?" "Where are you?"	Mouthing or Verbalizing answer Indicating Yes or No verbally or via yes/no cards Pointing to written name	Superior Temporal Gyrus and/or Wernickes are in language dominant hemisphere
Funny Picture		Hold the weird picture of the man at midline, 18 inches from the face for 5-10 seconds. If the subject does not focus on objects at midline, present the picture in a visual field that the person demonstrated ability to focus with the 3 dimensional object	Visual Verbal Motor	Fusiform Face Area
Sweet Sour	A contrast of sweet (sugar) and sour (lemonade concentrate) tastes	Dip a moist cotton tip applicator in sugar and apply to tongue tip (centered); wait 30 seconds then dip a moist cotton tip applicator in the sour (lemonade concentrate) and apply to the tip of the tongue (centered); if bit reflex prohibits tongue application then apply to lips	Visual Motor Verbal	Parietal Lobe (S1/S2) and/or Thalamus [73]
Name	Verbal calling of subject's own name	Call out patient's name (first name or last name or nickname); with each repetition vary the inflection and loudness	Motor Visual Verbal	Midbrain (Inferior Colliculus)
Bell	Hand Held School Bell	Ring bell on left, wait for response then repeat on right side	Motor Visual	
Focus	3-dimensional object	Hold a 3-dimensional object in the visual fields, that are listed for each test item, approximately 18 inches from the face for 5 – 10 seconds Repeat the upper, middle, lower, left, and right visual fields or until the highest score is given.	Visual	Bilateral Occipital Lobe

Item Name	Item/ Stimuli	Administration Procedures and Instructions	Response Modes	Highest Level of CNS Processing
Tracking	3-dimensional object	Horizontal: Present a 3-dimensional object in the left visual field and slowly move the object to the right, across midline. Present a 3-dimensional object in the right visual field moving the object to the left across midline. Vertical: Present a 3-dimensional object in the middle visual field and slowly move the object upward. Present a 3-dimensional object in the middle visual field moving the object downward.	Visual	Thalamus (Lateral Geniculate Nucleus)
Track face	Photograph of a familiar (known to patient 1-year prior to injury)Face OR a Hand-held Mirror	Horizontal: Present a familiar photograph and/or mirror in the left visual field and slowly move the object to the right, across midline. Repeat this procedure, but start in the right visual field moving the familiar photograph to the left across midline. Vertical: Present a familiar photograph and/or mirror in the middle visual field and slowly move the object upward. Repeat – but present same familiar photograph in the middle visual field moving the object downward.	Visual	Cortex (Parieto-Occiptal Lobe) and possiby Sub-cortical structures
Focus Face	Photograph of a familiar (known to patient 1-year prior to injury) Face OR a Hand-held Mirror	Place a familiar photograph and/or mirror in the patient's visual fields using the same instructions (e.g., 18 inches from face) as stated with focusing test item. Observe patient for a response for 5 – 10 seconds. If additional trials are needed, then repeat procedure using different familiar pictures.	Visual	Bilateral Temporal-Occipital Lobe
Heat	Hand warmers with average temperature of 100o F	Place thin protective fabric (e.g., 2 or 3 tissues, pillowcase) on palm of hand and then place a hand or toe warmer in the palm for 15 to 20 seconds.	Motor Muscle Tone	Parietal lobe (S1/S2)
Juice	Small amount of juice	Using a juice soaked cotton tip applicator: Apply the taste to the lips.	Oral and Pharyngeal motor General Motor	Upper Brain Stem and possibly diencephalon
Massage	Fingertip pressure (Firm)	Using your fingertips provide firm pressure/massage slowly and downward along the masseter (i.e., jaw) muscle	Oral and Pharyngeal motor Head Movement Muscle Tone	Upper Brain Stem and possibly diencephalon
SpoonW	Metal Spoon at room temperature	Place room temperature metal spoon on patient's lower lip. The pressure placed on the spoon should resemble the same pressure you would place on your lips when eating. Observe patient for a response for 5 – 10 seconds. This item ALWAYS precedes SpoonC item.	Oral and Pharyngeal motor Head Movement Facial motor Muscle Tone	Upper brain stem and possibly diencephalon Swallowing motor sequence: Medulla, Nucleus tractus solatarius, Nucleus ambiguous and Pre-central gyrus for motor programming and Post-Central gyrus in sensory cortex for oral sensory programming. Uncus of temporal lobe

Item Name	Item/ Stimuli	Administration Procedures and Instructions	Response Modes	Highest Level of CNS Processing
SpoonC	Metal Spoon dipped in ice cubes	Place cold metal spoon (by placing it in a cup of ice chips) on patient's lower lip. The pressure placed on the spoon should resemble the same pressure you would place on your lips when eating. Observe patient for a response for 5 – 10 seconds.	Oral and Pharyngeal motor Head Movement Facial motor Muscle Tone	
Olf	Two pleasant (not noxious) scents	Using a cotton tipped applicator soaked with orange, peppermint or vanilla extract place the soaked applicator one ½ - inch below the nostrils while simultaneously occluding the tracheostomy tube	Oral and Pharyngeal motor Head Movement Facial motor Muscle Tone	
Joint	Proprioception	Passively range a limb (e.g., arm, leg). Do not range to the extent of pain.	Upper and/or lower extremity movement Muscle Tone	Parietal lobe
Toe	Vibrator	Apply vibrator to patient's big toe	Feet movement Leg mvement	Parietal lobe
Feather	Feather	Start at knee and move down, slowly move the feather down the front (top side) surface of the leg if skin is exposed; Alternatively can move feather across face	Facial muscles Oral motor Upper and lower extremity muscles Tonal	Parietal lobe

Appendix B

Consciousness Algorithm

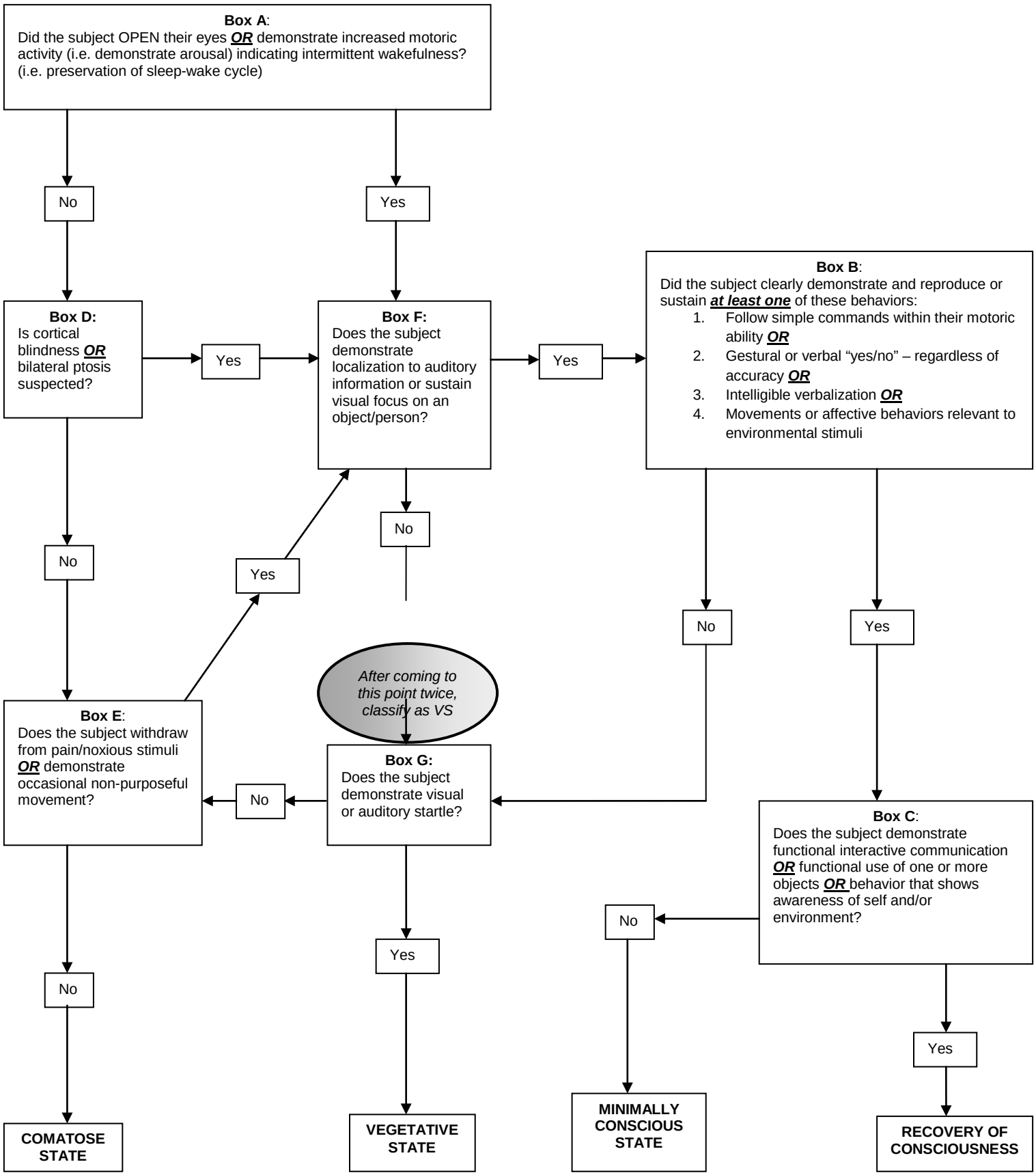
Probes Corresponding to Algorithm

Consciousness Scoring Form

CONSCIOUSNESS ALGORITHM

All clinical researchers participated in training prior to conducting consciousness evaluations. This training included instruction on how to use standard probes/questions to complete the consciousness algorithm. Probes relate to the criteria used to define consciousness and the questions are used to expand responses during monthly telephone interviews. The clinical researcher guides the interview and completes the consciousness algorithm according to the caregiver's responses to probes and follow-up questions.

Clinical Classification of Disordered Consciousness Relative to Consciousness



PROBES CORRESPONDING TO ALGORITHM

The probes are used during consciousness evaluations in conjunction with the Consciousness Algorithm to determine level of consciousness. The use of the probes helps in deriving a sufficient description of the subject's level of functioning, which in turn helps to determine the subject's level of consciousness. The probes/questions provided below each box correspond with a specific section of the consciousness algorithm.

The probes and questions provided do not represent a comprehensive list. If additional probes and questions are required to derive a sufficient description of the subject's level of functioning, then these additional questions/probes are used and documented on a case by case basis.

Algorithm Box A: Did the subject OPEN their eyes **OR** demonstrate increased motoric activity (i.e. demonstrate arousal) indicating intermittent wakefulness (i.e. preservation of sleep-wake cycle)?

- ☐ **Corresponding Probe:** Does the subject demonstrate periods of alertness throughout the day?
- ☐ **Corresponding Probe:** Are there periods during the day that the subject's eyes are open?
- ☐ **Corresponding Probe:** Does the subject seem to demonstrate of a schedule of sleep times and wakeful times?

Algorithm Box B: Did the subject clearly demonstrate and reproduce or sustain at least one of these behaviors:

1. Follow simple commands within their motoric ability **OR**
2. Gestural or verbal "yes/no" – regardless of accuracy **OR**
3. Intelligible verbalization **OR**
4. Movements or affective behaviors relevant to environmental stimuli

- ☐ **Corresponding Probe:** Does the subject have a system for communicating
- ☐ **Corresponding Probe:** Does the subject have a system, either verbal or nonverbal, for communicating basic needs? Describe how they use it? Is it used consistently?
- ☐ **Corresponding Probe:** What types of simple commands are they following?
- ☐ **Corresponding Probe:** Describe the method of yes/no response.
- ☐ **Corresponding Probe:** Describe the types of things the subject is saying.
- ☐ **Corresponding Probe:** Does the subject demonstrate facial expressions or emotions to certain people? Do they laugh or cry, etc to things they see on TV? If a joke is told will they laugh?
- ☐ **Corresponding Probe:** Are any of the behaviors described above consistent? Can you count on them every time the opportunity for the behavior arises?

Algorithm Box C: Does the subject demonstrate functional interactive communication **OR** functional use of one or more objects **OR** behavior that shows awareness of self and/or environment?

- ☐ **Corresponding Probe:** Is the subject able to communicate any basic needs consistently? (i.e. discomfort, bathroom, hunger, activity like turning on the TV, etc)
- ☐ **Corresponding Probe:** How does the subject communicate these needs?
- ☐ **Corresponding Probe:** Does the subject use any objects appropriately?
    - **Example:** If you place a washcloth in the subject's hand what do they do?
    - **Example:** Do they try to bring a toothbrush to their mouth?
    - **Example:**What do they do if you place the remote control in their hand?

- **Example:** Are there any motoric issues that would prevent the subject from using objects appropriately? (i.e. tone, paralysis, etc)

☐ **Corresponding Probe:** Are the behaviors described above consistent? Can you count on them every time the opportunity for the behavior arises?

☐ **Corresponding Probe:** Does the subject consistently respond to people entering the room? What is that response? (tracking them, facial expressions, verbalizations, etc)

☐ **Corresponding Probe:** How do they respond to different smells in the house (baking cookies, strong cologne, cigarette smoke, etc)?

☐ **Corresponding Probe:** Does the subject show appropriate emotional responses to information around them (laughing/smiling at a joke, crying at sad news)?

☐ **Corresponding Probe:** Does the subject attempt to use objects appropriately?

Algorithm Box D: Is cortical blindness **OR** bilateral ptosis suspected?

☐ **Corresponding Probe:** Does the subject respond to visual information? Describe what responses you see.

☐ **Corresponding Probe:** Does the subject react to things coming quickly toward his/her face?

☐ **Corresponding Probe:** Does the subject have difficulty opening his/her eyelids or keeping them open? If you help the subject to open the eyes is there increased response to visual information?

Algorithm Box E: Does the subject withdraw from pain/noxious stimuli **OR** demonstrate occasional non-purposeful movement?

☐ **Corresponding Probe:** How does the subject respond to pain? Do they pull their arms into their chest (decorticate posturing)? Do they extend their arms to the side and arch the head and back (decerebrate posturing)?

Algorithm Box F: Does the subject demonstrate localization to auditory information or sustain visual focus on an object/person?

☐ **Corresponding Probe:** If someone comes in the room does the subject follow that person around the room with their eyes?

☐ **Corresponding Probe:** Does the subject respond to different sounds in the room? Describe the response.

☐ **Corresponding Probe:** How does the subject respond when someone is talking to him/her?

Algorithm Box G: Does the subject demonstrate visual or auditory startle?

☐ **Corresponding Probe:** Does the subject inconsistently respond to light being shined in their eyes? Do their pupils get smaller?

☐ **Corresponding Probe:** Does the subject startle very easily? Give examples of what makes them startle.

CONSCIOUSNESS SCORING Form

Subject Number: _____ Evaluation Number: _____ Date: ___/___/___

Please refer to the consciousness algorithm to assist in determination of recovery of consciousness.

1) Does subject communicate or convey needs routinely either by talking or through another mode of communication?
   EXAMPLES:
   - Consistently responds to yes/no questions via verbal, gestural or use of device (i.e. picture board, letter board or electronic device).
   - Initiates requests for basic needs (i.e. hunger, thirst, positioning, bathroom, etc)

   Circle Answer: Yes or No

2) Does subject routinely (i.e., daily) use one or more objects appropriately?
   EXAMPLES:
   - Washing face with washcloth, brushing teeth, etc.

   Circle Answer: Yes or No

3) If the subject is not exhibiting behaviors covered in #1 or 2 above, is he/she exhibiting behaviors that show consistent awareness of himself/herself in the environment?
   EXAMPLES:
   - Facial expressions or emotional reactions indicating comprehension of things happening in the environment (i.e. laughing at a joke, recognizing familiar faces coming in the room, reaction to a procedure being done with the subject).
   - Other nonverbal behaviors that indicate awareness of the environment and subject's attempt to interact

Circle Answer: Yes or No

If **YES**, specify behavior below (subject following 1-step commands consistently in the absence of other behaviors described does not constitute a response of yes to this question). In order to respond yes to this questions, screener should discuss rationale for answering YES with a study team member. If not able to specify, then circle NO

_____

4) Is subject conscious?
   - Instructions: Patient is conscious if "yes" is answered **to any one** of the above three questions.

   Circle Answer: Yes = 01 No = 02

Appendix C

DOCS Scoring Table

Traumatic Brain Injury Conversion Chart for Total DOCS Measure

Non-Traumatic Brain Injury Conversion Chart for Total DOCS Measure

Modality Raw Score for Tactile, Auditory, & Visual

Conversion Chart: DOCS Modality Measure

Disclaimer: Reliability, Validity and Prognostication tables are based on clinicians viewing the DVD and administering 1 practice DOCS prior to applying this information to patient performance. The manual should be used as a reference.

Total DOCS Scoring Table

Instructions: Regardless of patient etiology, use this scoring table to transfer best scores from rating form to this scoring table. Add the total score. If the patient has a traumatic brain injury, then use the traumatic BI conversion chart to convert the Total raw score into the Total 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 measure. For items that are administered more than one time or to different visual fields, take the best score for that item (ie, odor, command, blink, focus, & tracking).

Item #	DOCS Test Item	Best Raw Score 1st Evaluation	Best Raw Score 2nd Evaluation	Best Raw Score Evaluation	Best Raw Score Evaluation
C1	1. GREET				
S1	2. JUICE				
S2	3. MASSAGE (Masseter)				
O1	4. ODOR				
PV1	5. JOINT				
T1	6. AIR				
T2	7. FEATHER				
T3	8. HAIR				
T4	9. TOE (Vibration)				
T5	10. HAND (Massage)				
T6	SCRUB				
T7	SWAB				
T8	CUBE				
A1	WHISTLE				
A2	CLAP				
A3	NAME				
A4	BELL				
A5	COMMAND				
A6	BLINK				
V3	FOCUS (Object)				
V4	TRACKING (Object)				
V7	TRACKING (Familiar Face)				
V8	FOCUS FACE (Familiar Face)				
Total DOCS RAW SCORE					
DOCS Measure (Obtained from appropriate conversation chart)					

Traumatic Brain Injury Conversion Chart for Total DOCS Measure

DOCS Raw Score	DOCunit	Standard Error	Percentile
0	5.0	18.2	1
1	16.8	9.9	1
2	23.5	6.9	3
3	27.4	5.7	4
4	30.2	4.9	6
5	32.4	4.4	7
6	34.1	4.1	9
7	35.7	3.8	12
8	37.0	3.6	13
9	38.3	3.4	15
10	39.4	3.3	16
11	40.4	3.2	19
12	41.4	3.1	21
13	42.3	3.0	22
14	43.2	2.9	25
15	44.0	2.9	28
16	44.8	2.8	30
17	45.6	2.8	33
18	46.3	2.7	37
19	47.1	2.7	41
20	47.8	2.7	43
21	48.6	2.7	44
22	49.3	2.7	47
23	50.0	2.7	49
24	50.7	2.7	51
25	51.4	2.7	54
26	52.2	2.7	56
27	52.9	2.7	59
28	53.7	2.7	62
29	54.4	2.8	66
30	55.2	2.8	70
31	56.0	2.9	72
32	56.8	2.9	73
33	57.7	3.0	76
34	58.6	3.1	79
35	59.6	3.2	81
36	60.6	3.3	83
37	61.8	3.4	84
38	63.0	3.6	85
39	64.3	3.8	87
40	65.9	4.1	90
41	67.6	4.4	92
42	69.8	4.9	93
43	72.6	5.7	95
44	76.5	6.9	97
45	83.1	9.9	98
46	95.0	18.2	99

***Conversion are based on 120 repeated DOCS examinations of 39 persons with severe TBI due open head injury, blunt trauma, closed head injury, and blast injury. Each DOCS examination included 23 test stimuli**

Non-traumatic Brain Injury Conversion Chart for Total DOCS Measure

DOCS Raw Score	DOCunit	Standard Error	Percentile
0	4.4	18.2	1
1	16.3	9.9	1
2	23.0	6.9	1
3	26.9	5.7	2
4	29.7	4.9	2
5	31.9	4.4	3
6	33.7	4.1	5
7	35.2	3.8	7
8	36.6	3.6	9
9	37.9	3.4	12
10	39.0	3.3	15
11	40.0	3.2	19
12	41.0	3.1	24
13	42.0	3.0	26
14	42.9	3.0	28
15	43.7	2.9	30
16	44.5	2.9	34
17	45.3	2.8	38
18	46.1	2.8	40
19	46.9	2.8	45
20	47.7	2.7	48
21	48.4	2.7	51
22	49.2	2.7	55
23	49.9	2.7	57
24	50.7	2.7	58
25	51.4	2.7	60
26	52.2	2.8	62
27	52.9	2.8	65
28	53.7	2.8	68
29	54.5	2.8	72
30	55.3	2.9	75
31	56.2	2.9	80
32	57.1	3.0	84
33	58.0	3.1	86
34	58.9	3.1	88
35	59.9	3.2	90
36	61.0	3.3	91
37	62.2	3.5	92
38	63.5	3.6	93
39	64.9	3.9	93
40	66.4	4.1	94
41	68.3	4.5	94
42	70.5	5.0	95
43	73.3	5.7	96
44	77.2	7.0	96
45	84.0	9.9	98
46	95.8	18.2	100

Conversions are based on 120 repeated DOCS examinations of 39 persons with severe BI due to an anoxic and/or vascular injury. Each DOCS examination included 23 test stimuli

Modality Scoring Tables: Tactile, Auditory, & Visual

Instructions: Regardless of patient etiology, use this scoring table to transfer best scores from rating form to this scoring table Add the total score in each modality table. For modality sub scales, we do not at the time of writing this manual have separate conversion charts for traumatic and non-traumatic etiologies. Therefore, use the conversion chart to convert the Total Modality score for each specific score regardless of etiology. If items were skipped, then write "skipped" in the cell and do not add it in the total. The total scores can then be converted to a measure if items are skipped and therefore not included in the total modality score.

TACTILE ITEMS

Tactile Item #	**DOCS Tactile Test Item**	**Best Raw Score 1st Evaluation**	**Best Raw Score 2nd Evaluation**	**Best Raw Score ____ Evaluation**	**Best Raw Score ____ Evaluation**
T1	1. AIR				
T2	2. FEATHER				
T3	3. HAIR				
T4	4. TOE (Vibration)				
T5	5. HAND (Massage)				
T6	6. SCRUB				
T7	7. SWAB				
T8	8. CUBE				
PV1	9. JOINT				
TOTAL RAW TACTILE SCORE					
DOCS Tactile Score (Obtained from modality conversion chart)					

AUDITORY ITEMS

Auditory Item #	**DOCS Auditory Test Item**	**Best Raw Score 1st Evaluation**	**Best Raw Score 2nd Evaluation**	**Best Raw Score ____ Evaluation**	**Best Raw Score ____ Evaluation**
C1	1. GREETING				
A1	2. WHISTLE				
A2	3. CLAP				
A3	4. NAME				
A5	5. BELL				
A6	6. COMMAND				
TOTAL RAW AUDITORY SCORE					
DOCS Auditory Score (Obtained from modality conversion chart)					

VISUAL ITEMS

Visual Item #	**DOCS Visual Test Item**	**Best Raw Score 1st Evaluation**	**Best Raw Score 2nd Evaluation**	**Best Raw Score ____ Evaluation**	**Best Raw Score ____ Evaluation**
V3	1. BLINK				
V4	2. FOCUS (On Objects)				
V5	3. TRACKING (Objects)				
V7	4. TRACKING (Familiar Face)				
V8	5. FOCUSFAC (Familiar Face)				
TOTAL RAW VISUAL SCORE					
DOCS Visual Score (Obtained from modality conversion chart)					

Conversion Chart: DOCS Modality Measures for Traumatic & Non-Traumatic Etiologies

TACTILE

Conversion Table for Tactile Modality Scores			
Tactile Modality Raw Score	**DOCunit Score for Tactile Items**	**Standard Error**	**Percentile**
0	12.2	18.2	2
1	24.2	10.0	5
2	31.2	7.2	8
3	35.5	6.0	11
4	38.7	5.4	16
5	41.4	5.0	21
6	43.7	4.7	27
7	45.9	4.6	34
8	48.0	4.5	43
9	50.0	4.5	50
10	52.0	4.5	58
11	54.1	4.6	65
12	56.3	4.8	71
13	58.6	5.0	77
14	61.3	5.4	82
15	64.6	6.0	87
16	68.9	7.2	93
17	75.9	10.0	97
18	87.8	18.2	99

AUDITORY

Conversion Table for Auditory Modality Scores			
Auditory Modality Raw Score	**DOCunit Score for Tactile Items**	**Standard Error**	**Percentile**
0	14.5	18.4	4
1	27.0	10.3	12
2	34.6	7.6	19
3	39.5	6.5	26
4	43.4	6.0	35
5	46.8	5.7	43
6	50.0	5.6	50
7	53.2	5.7	58
8	56.6	6.0	65
9	60.5	6.5	73
10	65.4	7.6	80
11	73.0	10.3	88
12	85.5	18.4	96

VISUAL

Conversion Table for Visual Modality Scores			
Visual Modality Raw Score	**DOCunit Score for Visual Items**	**Standard Error**	**Percentile**
0	20.8	17.5	10
1	31.7	9.6	20
2	38.4	7.2	26
3	43.0	6.3	34
4	46.7	5.9	39
5	50.1	5.8	44
6	53.5	5.9	51
7	57.2	6.2	56
8	61.5	7.1	64
9	68.1	9.5	72
10	78.9	17.5	87

Appendix D

Funny Face Picture (Experimental Item)

Appendix E

DOCS Rating Form A (Short Form)

DOCS Rating Form B: Non- Research (Long Form)

DOCS Rating Form A: Research / Experimental Items (Short Form)

DOCS Rating Form B: Research / Experimental Items (Long Form)

Disorders of Consciousness Scale (DOCS) Neurobehavioral Evaluation Score Form for Non-Research Purposes

BASELINE OBSERVATIONS

Location of Baseline Observation (specify):_____

Time and Nature of Previous Activity:_____

Evaluation was broken into 2 sessions: Yes or No If Yes, is this the: 1st session or 2nd session

Noise Level of Environment (Circle): Noisy Quiet Intermittent Noise Interruptions

Heart Rate: Lowest reading:_____ Highest Reading:_____

Blood Oxygen Level (via pulse oximetry): Lowest reading:_____ Highest Reading:_____

POSITION OF PATIENT (check position that patient is in during the baseline observations)**:**

___in bed lying on back ___in bed sitting up between 45 & 90 degrees ___side-lying in bed ___upright in chair

___reclined in chair

SPONTANEOUS/RANDOM MOVEMENTS: (check all that are observed)

___eyebrow movement (circle one: right left both) ___frown or grimace ___smiling ___biting or grinding of teeth

___mouth twitching or tremors ___tongue movement ___lip movement ___head movement ___LLE movement

___RLE movement ___LUE movement ___RUE movement ___none

RESPIRATION: (check the appropriate boxes) ___quiet ___shallow ___striderous ___fast ___other

SWALLOWING: Check the amount of drooling: ___constant ___occasional ___not observed ___none

Check location of drooling: ___right corner ___left corner ___midline ___all of these locations ___none

# of spontaneous swallows observed:_____

POSTURE: Describe the following as: tense, relaxed, spastic, flexed, extended or describe other posturing:

Facial Posture:_____

Neck Posture:_____

LUE Posture:_____

RUE Posture:_____

LLE Posture:_____

RLE Posture:_____

Whole Body Posture:_____

VISUAL: Does patient wear eye glasses? Yes No If yes, were they worn during this observation? Yes No

Level of illumination in room (check only one): ___dark ___dim ___bright

Duration & Frequency of Eye Opening: (check only one):

___eyes closed; no spontaneous eye opening

___eyes closed initially; spontaneous eye opening for less than 1 minute

___eyes closed initially; spontaneous eye opening for greater than 1 minute

___eyes open initially; spontaneously close after ___ seconds and remain closed

___eyes open initially; spontaneously close after ___ seconds, but reopened for ___ seconds

___eyes spontaneously open and remain open throughout the observation period

___partially open (circle amount that the eyes are open): 1/4 1/2 3/4

___eyes remain open all the time (circle one: without any blinking or with blinking)

___one eye open Right__ or Left__

Eye Positioning & Movement: (check all that are appropriate) ___could not observe eyes ___both eyes deviated right

___both eyes deviated left ___left eye deviated ___right eye deviated

___nystagmus (i.e., rhythmical oscillation of the eyeballs- either pendular or jerky)

___ptosis (i.e., drooping of the upper eyelid): left eye right eye bilateral

right pupil: ___dilated ___constricted left pupil: ___dilated ___constricted

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

Pape, T. L.-B., Senno, R., Guernon, A. Kelly, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Disorders of Consciousness Scale (DOCS) Neurobehavioral Evaluation
Score Form for Non-Research Purposes

TEST STIMULI BY MODALITIES

Social Knowledge Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Greet (Social Greeting): 1. "Hi, I'm" (say your name), "How's it going? ⇒⇒	0	1	2
Taste & Swallowing Items	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
Taste/Swallow: 2. Cotton Tip Applicator (w/ juice) ⇒⇒⇒⇒⇒	0	1	2
3. Massage (Masseter) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Olfactory Items	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
Odors: 4.a. Odor1 (name of odor:_____)⇒⇒⇒⇒⇒⇒	0	1	2
4.b. Odor2 (name of odor:_____)⇒⇒⇒⇒⇒⇒	0	1	2
Proprioceptive & Vestibular Items	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
Passive Movement: 5. Any Joint (limb ranged:_____)⇒⇒⇒⇒⇒	0	1	2
Tactile Items	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
Light Tactile: 6. Air ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
7. Feather ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
8. Hair ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
9. Vibration to BIG TOE or HEEL ⇒⇒⇒⇒⇒⇒⇒	0	1	2
Firm Tactile: 10. Hand ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
11. Scrub ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Temperature: 12. Swab (alcohol swab on big toe or heel) ⇒⇒⇒⇒⇒	0	1	2
13. Cube (cube on ankle, big toe or heel) ⇒⇒⇒⇒⇒	0	1	2
Auditory Items	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
Auditory Startle: 14. Whistle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
15. Clap ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Auditory Localization: 16. Name ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
17. Bell ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Auditory Comprehension: 18.a. 1-Step Command: _____	0	1	2
18.b. 1-Step Command:_____	0	1	2

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

Pape, T. L.-B., Senno, R., Guernon, A. Kelly, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Disorders of Consciousness Scale (DOCS) Neurobehavioral Evaluation
Score Form for Non-Research Purposes

Visual Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Blinking (Blink Response = LR**):**			
19.a. Upper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.b. Middle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.c. Lower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.d. Left⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.e. Right⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Focusing on Objects (Blink Response = GR**):**			
20.a. Upper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.b. Middle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.c. Lower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.d. Left⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.e. Right⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Tracking Objects:			
21.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
21.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Tracking Familiar Faces:			
22.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
22.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Focusing on Familiar Faces:			
23.a. Upper ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.b. Middle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.c. Lower ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.d. Left ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.e. Right ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

Source:

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Disorders of Consciousness Scale (DOCS) Neurobehavioral Evaluation
Score Form for Non-Research Purposes

TESTING READINESS ITEMS: Circle score or response for each test item

1. **Is a third nerve palsy (**i.e. third cranial nerve damage-inability to lift eyelids) **suspected?** **YES or NO**

2. **Is cortical blindness (**i.e. optic nerve damage) **suspected?** **YES or NO**

3. **Is bilateral ptosis (**i.e. drooping of the upper eyelid) **suspected?** **YES or NO**

4. **Auditory Stimuli:**

Patient required their name to be spoken to re-establish "testing readiness" = 0
Patient did not require their name to be spoken to rsse-establish "testing readiness" = 1

5. **Tactile/Deep Pressure Stimuli:**

Patient required deep pressure to re-establish "testing readiness" = 0
Patient did not require deep pressure to re-establish "testing readiness" =1

6. **Passive Movement Stimuli:**

Patient required passive movement to re-establish "testing readiness" = 0
Patient did not require passive movement to re-establish "testing readiness" = 1

7. **Rolling Stimuli:**

Patient required rolling to re-establish "testing readiness" = 0
Patient did not require rolling to re-establish "testing readiness" = 1

8. **Rocking Stimuli:**

Patient required rocking to re-establish "testing readiness" = 0
Patient did not require rocking to re-establish "testing readiness" = 1

9. **Maintaining State of Testing Readiness:**

Did the patient require stimulation throughout the evaluation to maintain a state of testing readiness ? Yes = 0 No = 1

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

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THE DISORDERS OF CONSCIOUSNESS SCALE (DOCS)
Rating Form B
Non-Research Version

By
Theresa Louise-Bender Pape, Dr.PH., M.A., CCC-SLP,
Sandra Lundgren, PhD, ABPP
James P. Kelly, MD,
Allen Heinemann, PhD, ABPP
Ann M. Guernon, MS, CCC-SLP

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

BASELINE OBSERVATIONS PROTOCOL

Instructions: Prior to providing stimulation, the evaluator should place the "Do Not Disturb" sign on the door and unobtrusively approach the subject (i.e. do not speak, do not touch the subject, do not close the door, do not disturb the subject) and document the subject's spontaneous behaviors at rest. The following checklist should be systematically completed. KEY: L = Left; R = Right; UE = Upper Extremity; LE = Lower Extremity

GENERAL INFORMATION:

Is the DOCS being co-administered?: Yes or No (if yes remember to score separately)

Disciplines completing this evaluation (circle all that apply): SLP PT OT Psychology Nursing Research Other_____

Date of evaluation:_____ Time of evaluation:_____ AM or PM

Location of Baseline Observation (specify):_____

Time of and Nature of Previous Activity:_____

Evaluation was broken into 2 sessions: Yes or No If yes, is this the: 1st session or 2nd session

Noise Level of Environment (Circle): Noisy Quiet Intermittent Noise Interruptions

Blood Oxygen Level (via pulse oximetry): Lowest reading:_____ Highest reading:_____

Heart Rate: Lowest reading: _____ Highest reading: _____

POSITION OF SUBJECT: (check one)

___in bed lying on back ___in bed sitting up between 45 & 90 degrees ___side-lying in bed ___upright in chair

___reclined in chair

SPONTANEOUS/RANDOM MOVEMENT: (check all that are observed)

___eyebrow movement (circle one: right left both) ___frown or grimace ___smiling ___biting or grinding of teeth

___mouth twitching or tremors ___tongue movement (describe:_____)

___lip movement (describe:_____) ___head movement

___LLE movement ___RLE movement ___LUE movement ___RUE movement ___none

RESPIRATION: (check the appropriate boxes)

___quiet ___shallow ___strideous ___fast ___other (describe:_____)

SWALLOWING:

Check the amount of drooling: ___constant ___occasional ___not observed ___none

Check the location of drooling: ___right corner ___left corner ___midline ___all of these locations ___none

Number of spontaneous swallows observed:_____

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

BASELINE OBSERVATIONS (continued)

POSTURE: Describe the following as: tense, relaxed, spastic, flexed, extended, or describe other posturing:

Facial posture:_____

Neck posture:_____

LUE posture:_____

RUE Posture:_____

LLE Posture:_____

RLE Posture:_____

Whole Body Posture:_____

VISUAL: Does subject wear eye glasses? Yes No If yes, were they worn during this observation? Yes No

Level of illumination in room (check only one): ___dark ___dim ___bright

Duration & Frequency of Eye Opening: (check only one)

___eyes closed; no spontaneous eye opening

___eyes closed initially; spontaneous eye opening for less than 1 minute (____# of occurrences)

___eyes closed initially; spontaneous eye opening for greater than 1 minute (____# of occurrences)

___eyes open; spontaneously close after ___seconds and remain closed

___eyes open initially; spontaneously close after ___ seconds, but reopened for ___seconds

___eyes spontaneously open and remain open throughout the observation period

___partially open (circle amounts that the eyes are open): ¼ ½ ¾

___eyes remain open all the time without any blinking

___one eye open ___Right or ___Left

Other:_____

Eye Positioning & Movement: (check all that are appropriate)

___could not observe eyes throughout baseline observation

___both eyes deviated right ___both eyes deviated left ___left eye deviated ___right eye deviated

Notes:_____

___nystagmus (i.e., rhythmical oscillation of the eyeballs- either pendular or jerky)

___ptosis (i.e., drooping of the upper eyelid) (circle one): left eye right eye bilateral

___other:_____

Right pupil: ___dilated ___constricted

Left pupil: ___dilated ___constricted

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

TESTING ENVIRONMENT

After completing the baseline observation--create a neutral environment without extreme insult to the sensory system. The testing environment should be regulated/controlled prior to administering test stimuli. The following guidelines should be followed to establish a non-intrusive evaluation environment, which will provide the subject with optimal opportunities to respond:

1. Post the "Do Not Disturb" sign, that is provided in the DOCS kit.
2. Close the door.
3. Eliminate unpredictable noises, such as the TV, radio or intercoms.
4. Diminish bright lights (e.g., close or partially close blinds if sunlight is exceptionally bright)
5. Avoid inadvertent tactile stimulation.

TESTING READINESS

DEFINE TESTING READINESS

1. Answer the following questions:

   Is a third nerve palsy (i.e., third cranial nerve damage-inability to lift eye lids) suspected? YES or NO

   Is cortical blindness (i.e., optic nerve damage) suspected? YES or NO

   Is a bilateral ptosis (i.e., drooping of the upper eyelid) suspected? YES or NO

2. "Testing Readiness" is defined as a general state of readiness to respond and it is observed and measured behaviorally.

   Testing Readiness for this subject, during this evaluation, is defined by: (Check Only One):

   _____Eye Opening

   _____Motoric Activity (use motoric activity as the measure <u>only</u> if yes was circled in one of questions above). Specify the reliable motoric pattern/movement that will be used to indicate Testing Readiness (e.g., head movement): _____

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

DOCS TEST PROTOCOL

POSITIONING GUIDELINES

During the evaluation the subject will be in different positions and there are specific positional instructions for some of the sub-scales. The administration of the taste and swallowing test stimuli, for example, requires that the subject be upright between 45 and 90 degrees with their head and neck at midline and supported. The general positional guidelines that should be followed throughout the evaluation are presented here. If these general guidelines are followed, then an observed behavioral response can be associated with the test stimuli rather than attributed to positional pain.

1) When sitting at side of mat or bed:

- feet should be flat,
- knees should be level with hips,
- trunk should be supported,
- head should be held upright, and
- arms should be bent/flexed at the elbow.

2) When 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, and
- trunk should be at midline and supported to maintain midline position.

3) If the subject slips out of position, during the evaluation, stop and reposition him/her.

INITIAL TEST STIMULI

Verbal instructions to be provided immediately prior to administering the first sub-scale:

"_____(SUBJECT'S FIRST NAME)_____ listen carefully to each thing we/I ask you to do---------(pause)---------try to respond-------(pause)---

---------this will allow us/me to help you"

TEST ITEMS AND ADMINISTRATION PROCEDURE

SOCIAL KNOWLEDGE ITEMS

1. "Hi, I'm (say your name), how's it going?"

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Repsonse (NR): No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalize responses include:

- eye opening
- increased respiration
- decreased tone or increased tone

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation in blood oxygen levels from baseline range
- deviation in heart rate from baseline range

2 = Localized Response (LR): Reflects an ability of the patient to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless otherwise specified) after the stimulation and the responses are related to the area stimulated. Localized Responses include:

- orienting or localization movements toward the sound
- vocalization or response indicating subjects comprehension of the greeting

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
⇒ A localized response is a response that is directly 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.

SCORING GRID

	No Response (NR)	**Generalized Response (GR)**	**Localized Response (LR)**
1. Social Greeting "Hi I'm (say your name), How's it going?"	0	1	2

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

TASTE AND SWALLOWING SUB-SCALE

Required Materials:

- 1 taste (e.g., juice, milk, soda, familiar tastes, mouth wash)
- cotton tipped applicators
- gloves
- towels
- one bite block

Administration Guidelines:

- Subject must be upright within a range of 45-90 degrees
- Head should be midline and supported—eliminate or reduce neck extension
- Check with the Speech Pathologist prior to placing anything (e.g., toothettes and spoon) beyond the teeth
- Present each test stimuli as many times as necessary to determine the subject's best response. Each stimuli should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another test item
- Score each test item after determining the subject's best response--Do **not** wait to score until all test items are administered

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject what you will be doing and what setting or time of day he/she would experience this taste (e.g., "Here is a taste of orange juice -- we drink it for breakfast").

Taste & Swallowing: This set of test items evaluate the subject's responses to pre-swallowing stimulation and the subject's ability to swallow within 5-10 seconds of stimulation known to facilitate swallowing**.**

Test Item 2. Cotton Tip Applicator: Using a juice soaked cotton tip applicator:

- Apply the taste to the lips and gums
- If the subject opens his/her mouth attempt to stimulate the top of the tongue and underneath the tongue.

Test Item 3. Massage: Using your finger tips provide firm pressure/massage slowly and downward along the masseter (i.e., jaw) muscle to the corner of the lips

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): no active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- suckling
- jaw movement
- chomping/chewing motion
- muscle tensing or other movements unrelated to the area stimulated
- deviation of oxygen saturation level from baseline range
- deviation of heart rate from baseline range

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10 – 15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- oral motor movements, such as licking lips or lip compression
- tongue pumping or movement
- swallowing within 15-20 seconds of application of the stimuli
- subject swipes at the therapist's hand, as an attempt to inhibit input
- changes in facial expression appropriate to the stimuli

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  ⇒ A localized response is a response that is directly 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Salivation & Taste: 2. Cotton Tip Applicator (w/ juice) ⇒	0	1	2
3. Massage to masseter ⇒	0	1	2

OLFACTORY SUB-SCALE

Required Materials:

- flavored extracts (e.g. orange, vanilla, peppermint)
- chewing tobacco if the subject is a known long –term smoker
- cotton tip applicator

Administration Guidelines:

- Subject must be upright within a range of 45-90 degrees
- Head should be midline and supported—eliminate or reduce neck extension
- If the subject has a tracheostomy tube check to see if the physician has stated that the tracheostomy tube may be momentarily occluded (i.e., for 1-5 seconds) ; DO NOT OCCLUDE IN ICU
- If the subject is trached and it is not desirable to occlude, then check the passage of air through the nostrils with a small feather. Hold the feather a 1/2" to 1" below the nostrils and see if the feather moves. If the feather moves then present each stimulus at this distance for 5-10 seconds. If the feather does not move do not administer this sub-scale.
- Present each odor as many times as necessary to determine the subject's best response. Each odor should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another odor
- Score each test item after determining the subject's best response--Do **not** wait to score until all three odors are administered

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject what each odor is verbally and position it in the subject's visual field before and after giving each stimulus (i.e., "This smells like _____(name of odor)_____")

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Olfactory: This set of test items evaluates the subject's responses to olfactory stimulation**.** Familiar odors may, for example, evoke memories or may serve as pre-cursors to salivation.

Test Item 4.a. Odor1: Using an applicator soaked with orange, peppermint **or** vanilla extract:

- Place the applicator ½ - 1 inch below the nostrils while simultaneously occluding the tracheostomy tube for 3 – 5 seconds.

Test Item 4.b. Odor2: Using an applicator soaked with orange, peppermint **or** vanilla extract (use a different extract—do not use the same odor that was used in Test Item 1.a.):

- Place the applicator ½ - 1 inch below the nostrils while simultaneously occluding the tracheostomy tube for 3 – 5 seconds.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): no active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- suckling
- jaw movement
- chomping/chewing motion
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- oral motor movements, such as licking lips or lip compression
- tongue pumping or movement
- swallowing within 10-15 seconds of application of the stimuli
- subject swipes at the therapist's hand, as an attempt to inhibit input
- vocalizations related to stimuli (e.g., "mmmmmm" or "ahhhhhh")
- sniffing (air inhaled through nose)

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  ⇒ A localized response is a response that is directly 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Odors: 4.a. Odor1_____ ⇒ (name of odor)	0	1	2
4.b. Odor2 _____ ⇒ (name of odor)	0	1	2

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

PROPRIOCEPTIVE SUB-SCALE

Administration Guidelines:

- Present each test item as many times as necessary to determine the subject's best response.
- Note any limits in range of motion on the response rating form--be aware of general limitations
- Head should be midline and supported—eliminate or reduce neck extension—when moving the subject
- Score each test item after determining the subject's best response--Do **not** wait to score.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject that you will be moving their armsns (e.g., "Joe, I am going to move your arm".)

Passive Movement: This test item evaluates the subject's response to passive range of motion. The subject may attempt to inhibit input or may demonstrate decreased or increased tone in the joint/limb being ranged.

Test Item 5. Any Joint: Passively range a limb (e.g., arm, leg). Do not range to the extent of pain. Be sure to range the right and left before scoring. If subject does not get a score of 2; then range a different limb.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- eye opening
- increased respiration
- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- increased flexion/extension

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10 – 15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- subject swipes at the therapist's hand, as an attempt to inhibit input
- subject assists or resists movement or activity during passive movement stimulation
- related vocalizations (e.g., grunting)

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
⇒ A localized response is a response that is directed toward 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.

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Passive Movement: 5. Any Joint:_____⇒ (write name of limb ranged)	0	1	2

TACTILE SUB-SCALE

Required Materials:

- mini vibrator
- feather
- can of pressurized air
- kitchen scouring pad
- ice cubes or ice chips
- alcohol swab

Administration Guidelines:

- Head should be midline and supported—eliminate or reduce neck extension
- Present each test item as many times as necessary to determine the subject's best response. Each sensation should be presented for 3-5 seconds.
- Be sure to present each sensation on the right and the left.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another sensation
- Score each test item after determining the subject's best response--Do **not** wait to score until all items have been administered.
- Be sure to present each sensation on the Right and Left. If subject does not get a score of 2 after presentation of sensation bilaterally, then present the sensation to the alternative location specified in the directions for the item.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with simple instructions that include the name of the body part you are planning to touch (e.g., "I am going to touch your arm now").

Light Tactile:

Test Item 6. Air: Using can of pressurized air direct a stream of air into the center of subject's neck; if necessary position subject's head and wait 20 seconds after positioning then direct stream of air to center back of neck.

Test Item 7. Feather: Gently sweep the feather across the face, over the nose and on the cheeks. You can also try slowly stroking downward the following body parts: leg from knee down, bicep, <u>or</u> behind knee.

Test Item 8. Hair: Without contacting the skin, lightly move the hairs on the top side of the right forearm, in the direction **opposite** to that of the hair growth pattern. If the subject does not have hair on the arms or the arms are not accessible administer this item using the eyebrow hair. Stroke the eyebrow hair in the **opposite** direction of hair growth pattern.

- ➢ Repeat same procedure on left arm, use right and left leg if the skin on arm is not exposed.

Test Item 9. Big toe or heel*:* Apply vibrator to pad of subject's toe or heel.

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Firm Tactile:

Test Item 10. Hand: Using your fingertips apply firm pressure down the subject's right arm on the inside surface, from the shoulder to the wrist

- Repeat on left arm

Test Item 11. Scrub: Using the kitchen scouring pad firmly apply a back and forth movement with firm pressure over the biceps, forearm and thigh areas on the right side of the body (exposed areas):

- Repeat procedure on left side of body

Temperature:

Test Item 12. Swab: Using an alcohol swab swipe the big toe or heel on the right side

- Repeat sequence on the left big toe or heel

Test Item 13. Cube: Using light pressure, hold ice cube on the right big toe or heel just until the ice starts to melt

- Repeat sequence on the left side

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): no active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- decorticate posturing
- abnormal flexion
- eye opening
- increased respiration
- decreased tone or increased tone
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation of oxygen saturation level from baseline range
- deviation of heart rate from baseline

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- subject swipes at the therapist's hand, as an attempt to inhibit input
- orienting movements of the body part stimulated
- moving body part stimulated
- vocalizations or a response indicating localization to the stimulus

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  - ⇒ A localized response is a response that is directed toward 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.

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SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Light Tactile:			
6. Air ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
7. Feather ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
8. Hair ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
9. Vibration to BIG TOE of HEEL⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Firm Tactile:			
10. Hand ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
11. Scrub ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Temperature:			
12. Swab (alcohol swab on big toe or heel) ⇒	0	1	2
13. Cube (cube on ankle, big toe or heel) ⇒⇒	0	1	2

AUDITORY SUB-SCALE

Required Materials:

- whistle
- bell

Administration Guidelines:

- Head should be midline and supported—eliminate or reduce neck extension
- Present each test item as many times as necessary to determine the subject's best response. Each stimulus should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another odor
- modify the immediate environment to reduce any auditory and/or visual distractions, such as radios, televisions, and if possible medical machinery (i.e., check with attending physician)
- Stand outside the subject's field of vision except when giving auditory commands.
- Stimulus should be applied to both the right and left ears
- Avoid cueing with eye contact or gestures; specify commands (e.g., "move your fingers")
- Write down the commands used in the scoring grid.
- Score each test item after determining the subject's best response--Do **not** wait to score until all items have been administered

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with simple instructions that include the name of the body part you are planning to touch (e.g., "I am going to touch your arm").

Auditory Startle:

Test Item 14. Whistle: Blow whistle sharply and loudly one time behind **each** ear
- right ear
- left ear

Test Item 15. Clap: Clap hands sharply and loudly one time behind **each** ear
- right ear
- left ear

Auditory Localization:

Test Item 16. Name: call out subject's name (first name or last name or nickname)
- when repeating the name vary the inflection and loudness with each repetition
- right ear
- left ear

Test Item 17. Bell: ring bell for 5-10 seconds near subject's ear
- right ear
- left ear

Auditory Comprehension:

Test Item 18.a. 1-step command (Command1): Use simple one step command that subject is able to physically perform (e.g., "move your fingers")

Test Item 18.b. 1-step Command (Command2): Use a different command within the subject's motoric capabilities

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:
- eye opening
- increased respiration
- decreased tone or increased tone
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation in oxygen saturation level from baseline
- deviation in heart rate from baseline

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

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- orienting or localization movements toward sound (if the test item is command following, then localization toward sound is considered a GR)
- moving body part that subject was told to move
- vocalizations or a response indicating subject's comprehension of verbal command

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:

⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Auditory Startle:			
14. Whistle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
15. Clap ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Auditory Localization:			
16. Name ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
17. Bell ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Auditory Comprehension:			
18.a. 1-Step Command (Command1): _____	0	1	2
18.b. 1-Step Command (Command2): _____	0	1	2

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

VISUAL SUB-SCALE

Required Materials:

- penlight
- two 3-dimensional objects (tennis ball and block are provided in the DOCS kit)
- picture of a person familiar to the subject
- eye patch
- small mirror

Administration Guidelines:

- If eye opening isn't achieved or re-established administer only the test items related to ambient light and pupillary constriction. Then the evaluation session should stop and it should be completed within 24 hours. If, during the 2nd session eye opening still isn't achieved score all remaining test items as NR (i.e., 0).
- The visual stimuli should be raised abruptly in one and/or both fields. The first horizontal or vertical movement occurring within a 5-10 second interval after stimuli presentation is to be interpreted as an indication of visual orientation to stimulus (i.e., localization).
- Subjects with dysconjugate/divergent gaze (i.e., non-symmetrical eye movement—the eyes are looking in 2 different directions) should be assessed with one eye patched or covered. Prior to using the eye patch you should consult with the subject's primary OT to discuss suspected visual impairment and determine the best eye for patching during the test.
- Present each test item as many times as necessary to determine the subject's best response.
- Wait 30 – 60 seconds before administering another test stimuli.
- Head should be midline and supported—eliminate or reduce neck extension
- Score each test item after determining the subject's best response--Do **not** wait to score

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting each test stimuli the subject should be provided with information about the test procedures. Tell the subject that you want him/her to look at objects (e.g., "Joe look at the ball" or "Joe watch the ball" or "Joe keep your eyes on the ball").

Blink Response: Rapidly and abruptly move your hand toward the subject's face from a stationary position about 12 inches away to about 2 inches away and flick your fingers. Avoid the inadvertent tactile stimulation of a rush of air. Repeat this in each of the following upper, middle, lower, left, and right visual fields. Look for a blink response.

Test Item 19.a. BUpper: Upper visual field.

Test Item 19.b. BMiddle: Middle visual field.

Test Item 19.c. BLower: Lower visual field.

Test Item 19.d. BLeft: Left visual field.

Test Item 19.e. BRight: Right visual field

Focus on Object: Hold a 3-dimensional object in the visual fields, approximately 18 inches from the face for 5 – 10 seconds. Tell the subject, "Look at the _____."

Test Item 20.a. FUpper: Upper visual field.

Test Item 20.b. Fmiddle: Middle visual field.

Test Item 20.c. Flower: Lower visual field.

Test Item 20.d. Fleft: Left visual field.

Test Item 20.e. Fright: Right visual field.

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Tracking Objects:

Test Item 21.a. Horizontal: Present a 3-dimensional object in the left visual field and slowly move the object to the right, across midline. Present a 3-dimensional object in the right visual field moving the object to the left across midline. Tell the subject, "Keep your eyes on the _____."

Test Item 21.b. Vertical: Present a 3-dimensional object in the middle visual field and slowly move the object upward. Present a 3-dimensiona object in the middle visual field moving the object downward. Tell the subject, "Keep your eyes on the _____."

Tracking Familiar Faces:

Test Item 22.a. Horizontal: Present a picture of a person familiar to the subject in the left visual field and slowly move the picture to the right, across midline. Next, present the picture in the right visual field moving the picture to the left, across midline. If subject does not score a "2" tracking familiar face photo, use the mirror included in DOCS kit, and have the subject track themselves via mirror. Tell the subject, "Keep your eyes on _____."

Test Item 22.b. Vertical: Present a picture of a person familiar to the subject in the middle visual field and slowly move the picture upward. Present the familiar picture in the middle visual field and slowly move the picture downward. If subject does not score a "2" tracking familiar face photo, use the mirror included in DOCS kit, and have the subject track themselves via mirror. Tell the subject, "Keep your eyes on _____."

Focus on Familiar Face: Hold a picture of a person familiar to the subject in the visual fields that are listed for each test item approximately 18 inches from the face for 5-10 seconds. If subject does not score a "2"focusing on familiar face photo in at least one visual field, use the mirror included in DOCS kit, and have the subject focus on themselves via mirror. Tell the subject, "Look at the _____."

Test Item 23.a. Upper: Upper visual field.

Test Item 23.b. Middle: Middle visual field.

Test Item 23.c. Lower: Lower visual field.

Test Item 23.d. Left: Left visual field.

Test Item 23.e. Right: Right visual field.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization after presenting the stimuli. An example of a NR rating is pupil dilation given a bright light.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses can include:

- eye opening
- increased respiration
- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking (blinking can be a LR if it is in response to the blinking test item, but otherwise it is a GR)

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- subject swipes at the therapist's hand, as an attempt to inhibit input
- related vocalizations (e.g., "ohhhhh")
- Pupillary constriction with bright light
- facial movements
- head turning
- squinting
- eye closing
- eyelid fluttering
- visual orientation toward object

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  - ⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
Blinking (Blink Response = LR):			
19.a. BUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.b. BMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.c. BLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.d. BLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
19.e. Bright ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Focusing on Objects (Blink Response = GR):			
20.a. FUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.b. FMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.c. FLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.d. FLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
20.e. Fright⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Tracking Objects :			
21.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
21.b.Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Tracking Familiar Face:			
22.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
22.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Focusing on Familiar Faces:			
23.a. Upper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.b. Middle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.c. Lower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.d. Left⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
23.e. Right⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

TESTING READINESS SCORE

Directions: Circle one score for each test item

1. Auditory Stimuli:

Subject required their name to be spoken to re-establish "testing readiness" = 0
Subject did not require their name to be spoken to re-establish "testing readiness" = 1

2. Tactile/Deep Pressure Stimuli:

Subject required deep pressure to re-establish "testing readiness" = 0
Subject did not require deep pressure to re-establish "testing readiness" = 1

3. Passive Movement Stimuli:

Subject required passive movement to re-establish "testing readiness" = 0
Subject did not require passive movement to re-establish "testing readiness" = 1

4. Rolling Stimuli:

Subject required rolling to re-establish "testing readiness" = 0
Subject did not require rolling to re-establish "testing readiness" = 1

5. Rocking Stimuli:

Subject required rocking stimuli to re-establish "testing readiness" = 0
Subject did not require rocking stimuli to re-establish "testing readiness" = 1

6 Maintaining State of Testing Readiness:

Did the patient require stimulation intermittently throughout the evaluation to maintain a state of testing readiness?
Circle One: Yes= **0** **No=1**

Version date: 5/5/2010
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Subject Number: _____ Therapist's Name OR Code: _____ Date of Evaluation: ____/___/___ Time: _____ AM PM

BASELINE OBSERVATIONS

Is the DOCS being co-administered: Yes or No (if yes remember to score separately)

Discipline(s)(circle all indicated**)**: SLP PT OT Psychology Nursing Research

Location of Baseline Observation (specify):_____

Time and Nature of Previous Activity:_____

If in the ICU: Previous Day's Highest ICP: _____ Today's Highest ICP: _____ Highest ICP during Evaluation: ____

Evaluation was broken into 2 sessions: Yes or No If Yes, is this the: 1st session or 2nd session

Noise Level of Environment (Circle): Noisy Quiet Intermittent Noise Interruptions

Weight: _____ Heart Rate: Lowest reading:_____ Highest Reading:_____

Blood Oxygen Level (via pulse oximetry): Lowest reading:_____ Highest Reading:_____

POSITION OF PATIENT (check position that patient is in during the baseline observations)**:**

___in bed lying on back ___in bed sitting up between 45 & 90 degrees ___side-lying in bed ___upright in chair ___reclined in chair

SPONTANEOUS/RANDOM MOVEMENTS: (check all that are observed)

___eyebrow movement (circle one: right left both) ___frown or grimace ___smiling ___biting or grinding of teeth

___mouth twitching or tremors ___tongue movement ___lip movement ___head movement

___LLE movement ___RLE movement ___LUE movement ___RUE movement ___none

RESPIRATION: (check the appropriate boxes) ___quiet ___shallow ___striderous ___fast ___other

SWALLOWING: Check the amount of drooling: ___constant ___occasional ___not observed ___none

Check location of drooling: ___right corner ___left corner ___midline ___all of these locations ___none

# of spontaneous swallows observed:_____

POSTURE: Describe the following as: tense, relaxed, spastic, flexed, extended or describe other posturing:

Facial Posture:_____

Neck Posture:_____

LUE Posture:_____

RUE Posture:_____

LLE Posture:_____

RLE Posture:_____

Whole Body Posture:_____

VISUAL: Does patient wear eye glasses? Yes No If yes, were they worn during this observation? Yes No

Level of illumination in room (check only one): ___dark ___dim ___bright

Duration & Frequency of Eye Opening: (check only one):

___eyes closed; no spontaneous eye opening

___eyes closed initially; spontaneous eye opening for less than 1 minute

___eyes closed initially; spontaneous eye opening for greater than 1 minute

___eyes open initially; spontaneously close after ___ seconds and remain closed

___eyes open initially; spontaneously close after ___ seconds, but reopened for ___ seconds

___eyes spontaneously open and remain open throughout the observation period

___partially open (circle amount that the eyes are open): 1/4 1/2 3/4

___eyes remain open all the time (circle one: without any blinking or with blinking)

___one eye open Right__ or Left__

Eye Positioning & Movement: (check all that are appropriate) ___could not observe eyes ___both eyes deviated right

___both eyes deviated left ___left eye deviated ___right eye deviated

___nystagmus (i.e., rhythmical oscillation of the eyeballs- either pendular or jerky)

___ptosis (i.e., drooping of the upper eyelid): left eye right eye bilateral

right pupil: ___dilated ___constricted left pupil: ___dilated ___constricted

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

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Subject Number: _____ Therapist's Name OR Code: _____ Date of Evaluation: ____/___/___ Time: _____ AM PM

DIRECTIONS: PRIOR to Administering Test Items use the clinical definitions and criteria below to classify the patient's state of altered consciousness.

CHECK ONLY ONE.

	Coma	Vegetative State	Minimally Conscious State	Conscious
Check ONE:				
Definitions	A state of unarousable neurobehavioral responsiveness	A state of arousal without behavioral evidence of awareness of self or capacity to interact with the environment	A condition in which minimal but definite evidence of self or environmental awareness is demonstrated.	Consciousness is inferred when a person adaptively responds to ongoing sensory input in a manner that is not reflexic, stereotypical or automatic.
Clinical Criteria	1. Does not show evidence of sleep-wake cycle, 2. Does not respond to auditory or visual stimuli, 3. Does not show evidence of language compre-hension or expression, 4. Demonstrates only reflexive and postural responses.	1. No evidence of sustained, reproducible, purposeful or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli; 2. No evidence of language comprehension or expression; 3. Intermittent wakefulness manifested by the preservation of sleep-wake cycles;	One or more of the following must be clearly discernible and occur on a reproducible basis: 1. Follows simple commands; 2. Gestural or verbal "yes/no" responses (regardless of accuracy); 3. Intelligible verbalization; 4. Movements of affective behaviors that occur in contingent relation to relevant environmental stimuli and are not attributable to reflexive activity	Reliable and consistent demonstration of at least one of the following: 1. Functional interactive communication; 2. Functional use of one or more objects; 3. Clearly discernable (able to be documented) behavioral manifestation of sense of self If applicable then briefly describe behavior in this space:

TEST STIMULI BY MODALITIES:

Social Knowledge Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Greet (Social Greeting): 1. "Hi, I'm" (say your name), "How's it going? ⇒⇒	0	1	2

Taste & Swallowing Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Taste/Swallow: 1.a. Cotton Tip Applicator (w/ juice) ⇒⇒⇒⇒⇒	0	1	2
1.b. Massage (Masseter) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.c. SpoonW (Warm) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.d. SpoonC (Cold) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1. e. SwetSour ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

Olfactory Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Odors: 1.a. Odor1 (name of odor:_____)⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Odor2 (name of odor:_____)⇒⇒⇒⇒⇒⇒	0	1	2

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

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Subject Number: _____ Therapist's Name OR Code: _____ Date of Evaluation: ____/___/___ Time: _____ AM PM

Proprioceptive & Vestibular Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Passive Movement: 1.a. Any Joint (limb ranged:_____)⇒⇒⇒⇒⇒	0	1	2

Tactile Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Light Tactile: 1.a. Vibration to BIG TOE or HEEL ⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Feather ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.c. Air ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.d. Hair⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Firm Tactile: 2.a. Scrub ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b. Hand ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Temperature: 3.a. Cube (cube on ankle, big toe or heel) ⇒⇒⇒⇒	0	1	2
3.b. Swab (alcohol swab on big toe, or heel)⇒	0	1	2
3. c. Heat (hand warmer in palm) ⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

Auditory Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Auditory Startle: 1.a. Whistle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Clap ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Auditory Localization: 2.a. Name ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b. Bell ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Auditory Comprehension: 3.a. 1-Step Command (Command1): _____	0	1	2
3.b. 1-Step Command (Command2):_____	0	1	2

Visual Items	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Pupillary Constriction (dilation = NR; constriction = LR) 1.a. Rpupuil (Right Pupil) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Lpupil (Left Pupil) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Tracking Objects (TrackOBJ): 2.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Focusing on Objects (FocusOBJ) (Blink Response = GR)**:** 3.a. FUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.b. FMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.c. FLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.d. FLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.e. FRight⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4. Blinking (Blink Response = LR)**:** 4.a. BUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.b. BMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.c. BLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.d. BLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.e. BRight⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

Visual Test items continued on next page….

Source:

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Pape, T. L.-B., Senno, R., Guernon, A. Kelly, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Subject Number: _____ Therapist's Name OR Code: _____ Date of Evaluation: ____/___/___ Time: _____ AM PM

Visual Items (Continued)	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
5. Tracking Familiar Faces (TrackFACE):			
5.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
5.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
*Was Mirror used instead of familiar face: YES / NO			
6. Focusing on Familiar Faces (FocusFACE): 6.a. Upper ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.b. Middle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.c. Lower ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.d. Left ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.e. Right ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
*Was Mirror used instead of familiar face: YES / NO			
7. Weird Picture: ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
Orientation Items (Administer these items after the Visual Items)	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
1. Orientation to Self: "Is your name_____?" (gender opposite name) "Is your name _____?" (correct name) OR "What is your name?"	0	1	2
2. Orientation to Environment: Yes/no question related to immediate environment. _____	0	1	2
Functional Use of Object Item	**No Response (NR)**	**Generalized Response (GR)**	**Localized Response (LR)**
1. Functional Object 1.a. Toothbrush. ("This is a toothbrush. Brush your teeth.")	0	1	2

TESTING READINESS ITEMS: Circle score or response for each test item

1. Is a third nerve palsy (i.e. third cranial nerve damage-inability to lift eyelids) **suspected? YES or NO**

2. Is cortical blindness (i.e. optic nerve damage) **suspected? YES or NO**

3. Is bilateral ptosis (i.e. drooping of the upper eyelid) **suspected? YES or NO**

4. Auditory Stimuli:

Patient required their name to be spoken to re-establish "testing readiness" = 0
Patient did not require their name to be spoken to rsse-establish "testing readiness" = 1

5. Tactile/Deep Pressure Stimuli:

Patient required deep pressure to re-establish "testing readiness" = 0
Patient did not require deep pressure to re-establish "testing readiness" =1

6. Passive Movement Stimuli:

Patient required passive movement to re-establish "testing readiness" = 0
Patient did not require passive movement to re-establish "testing readiness" = 1

7. Rolling Stimuli:

Patient required rolling to re-establish "testing readiness" = 0
Patient did not require rolling to re-establish "testing readiness" = 1

8. Rocking Stimuli:

Patient required rocking to re-establish "testing readiness" = 0
Patient did not require rocking to re-establish "testing readiness" = 1

9. Maintaining State of Testing Readiness:

Did the patient require stimulation throughout the evaluation to maintain a state of testing readiness ? Yes = 0 No = 1

Source:

Pape, T. L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma-Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 1-18.

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THE DISORDERS OF CONSCIOUSNESS SCALE (DOCS)

Rating Form B

By
Theresa Louise-Bender Pape, Dr.PH., M.A., CCC-SLP,
Sandra Lundgren, PhD, ABPP
James P. Kelly, MD,
Allen Heinemann, Ph.D., ABPP
Ann M. Guernon, M.S., CCC-SLP

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

BASELINE OBSERVATIONS PROTOCOL

Instructions: Prior to providing stimulation, the evaluator should place the "Do Not Disturb" sign on the door and unobtrusively approach the subject (i.e. do not speak, do not touch the subject, do not close the door, do not disturb the subject) and document the subject's spontaneous behaviors at rest. The following checklist should be systematically completed. KEY: L = Left; R = Right; UE = Upper Extremity; LE = Lower Extremity

GENERAL INFORMATION:

Is the DOCS being co-administered?: Yes or No (if yes remember to score separately)

Disciplines completing this evaluation (circle all that apply): SLP PT OT Psychology Nursing Research Other_____

Date of evaluation:_____ Time of evaluation:_____ AM or PM

Location of Baseline Observation (specify):_____

Time of and Nature of Previous Activity:_____

Evaluation was broken into 2 sessions: Yes or No If yes, is this the: 1st session or 2nd session

Noise Level of Environment (Circle): Noisy Quiet Intermittent Noise Interruptions

Blood Oxygen Level (via pulse oximetry): Lowest reading:_____ Highest reading:_____

Heart Rate: Lowest reading:_____ Highest reading:_____

POSITION OF SUBJECT: (check one)

___in bed lying on back ___in bed sitting up between 45 & 90 degrees ___side-lying in bed ___upright in chair

___reclined in chair

SPONTANEOUS/RANDOM MOVEMENT: (check all that are observed)

___eyebrow movement (circle one: right left both) ___frown or grimace ___smiling ___biting or grinding of teeth

___mouth twitching or tremors ___tongue movement (describe:_____)

___lip movement (describe:_____) ___head movement

___LLE movement ___RLE movement ___LUE movement ___RUE movement ___none

RESPIRATION: (check the appropriate boxes)

___quiet ___shallow ___strideous ___fast ___other (describe:_____)

SWALLOWING:

Check the amount of drooling: ___constant ___occasional ___not observed ___none

Check the location of drooling: ___right corner ___left corner ___midline ___all of these locations ___none

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Number of spontaneous swallows observed:_____

BASELINE OBSERVATIONS (continued)

POSTURE: Describe the following as: tense, relaxed, spastic, flexed, extended, or describe other posturing:

Facial posture:_____

Neck posture:_____

LUE posture:_____

RUE Posture:_____

LLE Posture:_____

RLE Posture:_____

Whole Body Posture:_____

VISUAL: Does subject wear eye glasses? Yes No If yes, were they worn during this observation? Yes No

Level of illumination in room (check only one): ___dark ___dim ___bright

Duration & Frequency of Eye Opening: (check only one)

___eyes closed; no spontaneous eye opening

___eyes closed initially; spontaneous eye opening for less than 1 minute (____# of occurrences)

___eyes closed initially; spontaneous eye opening for greater than 1 minute (____# of occurrences)

___eyes open; spontaneously close after ___seconds and remain closed

___eyes open initially; spontaneously close after ___ seconds, but reopened for ___seconds

___eyes spontaneously open and remain open throughout the observation period

___partially open (circle amounts that the eyes are open): ¼ ½ ¾

___eyes remain open all the time without any blinking

___one eye open ___Right or ___Left

Other:_____

Eye Positioning & Movement: (check all that are appropriate)

___could not observe eyes throughout baseline observation

___both eyes deviated right ___both eyes deviated left ___left eye deviated ___right eye deviated

Notes:_____

___nystagmus (i.e., rhythmical oscillation of the eyeballs- either pendular or jerky)

___ptosis (i.e., drooping of the upper eyelid) (circle one): left eye right eye bilateral

___other:_____

Right pupil: ___dilated ___constricted

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Left pupil: ___dilated ___constricted

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Subject #:_____
Therapist name or Code:_____
Date of Evaluation:_____

DIRECTIONS: PRIOR to Administering Test Items use the clinical definitions and criteria below to classify the patient's state of altered consciousness. **CHECK ONLY ONE.**

	Coma	Vegetative State	Minimally Conscious State	CONSCIOUS
Check ONLY One:				
Definitions	A state of unarousable neurobehavioral responsiveness	A state of arousal without behavioral evidence of awareness of self or capacity to interact with the environment	A condition in which minimal but definite evidence of self or environmental awareness is demonstrated.	Consciousness is inferred when a person adaptively responds to ongoing sensory input in a manner that is not reflexic, stereotypical or automatic.
Clinical Criteria	1. Does not show evidence of sleep-wake cycle, 2. Does not respond to auditory or visual stimuli, 3. Does not show evidence of language compre-hension or expression, 4. Demonstrates only reflexive and postural responses.	1. No evidence of sustained, reproducible, purposeful or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli; 2. No evidence of language comprehension or expression; 3. Intermittent wakefulness manifested by the preservation of sleep-wake cycles.	One or more of the following must be clearly discernible and occur on a reproducible basis: 1. Follows simple commands; 2. Gestural or verbal "yes/no" responses (regardless of accuracy); 3. Intelligible verbalization; 4. Movements of affective behaviors that occur in contingent relation to relevant environmental stimuli and are not attributable to reflexive activity.	Reliable and consistent demonstration of at least one of the following: 1. Functional interactive communication; 2. Functional use of one or more objects; 3. Clearly discernable (able to be documented) behavioral manifestation of sense of self If applicable then briefly describe behavior in this space:

TESTING ENVIRONMENT

After completing the baseline observation--create a neutral environment without extreme insult to the sensory system. The testing environment should be regulated/controlled prior to administering test stimuli. The following guidelines should be followed to establish a non-intrusive evaluation environment, which will provide the subject with optimal opportunities to respond:

1. Post the "Do Not Disturb" sign, that is provided in the DOCS kit.
2. Close the door.
3. Eliminate unpredictable noises, such as the TV, radio or intercoms.
4. Diminish bright lights (e.g., close or partially close blinds if sunlight is exceptionally bright)

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

5. Avoid inadvertent tactile stimulation.

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

TESTING READINESS

DEFINE TESTING READINESS

1. Answer the following questions:
   Is a third nerve palsy (i.e., third cranial nerve damage-inability to lift eye lids) suspected? YES or NO
   Is cortical blindness (i.e., optic nerve damage) suspected? YES or NO

   Is a bilateral ptosis (i.e., drooping of the upper eyelid) suspected? YES or NO

2. "Testing Readiness" is defined as a general state of readiness to respond and it is observed and measured behaviorally.

   Testing Readiness for this subject, during this evaluation, is defined by: (Check Only One):

   _____Eye Opening

   _____Motoric Activity (use motoric activity as the measure only if yes was circled in one of questions above). Specify the reliable motoric pattern/movement that will be used to indicate Testing Readiness (e.g., head movement): _____

DOCS TEST PROTOCOL

POSITIONING GUIDELINES

During the evaluation the subject will be in different positions and there are specific positional instructions for some of the sub-scales. The administration of the taste and swallowing test stimuli, for example, requires that the subject be upright between 45 and 90 degrees with their head and neck at midline and supported. The general positional guidelines that should be followed throughout the evaluation are presented here. If these general guidelines are followed, then an observed behavioral response can be associated with the test stimuli rather than attributed to positional pain.

1) When sitting at side of mat or bed:
   - feet should be flat,
   - knees should be level with hips,
   - trunk should be supported,
   - head should be held upright, and
   - arms should be bent/flexed at the elbow.

2) When 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, and
   - trunk should be at midline and supported to maintain midline position.

3) If the subject slips out of position, during the evaluation, stop and reposition him/her.

INITIAL TEST STIMULI

Verbal instructions to be provided immediately prior to administering the first sub-scale:

"_____(SUBJECT'S FIRST NAME)_____ listen carefully to each thing we/I ask you to do---------(pause)---------try to respond-------(pause)---

---------this will allow us/me to help you"

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TEST ITEMS AND ADMINISTRATION PROCEDURE

SOCIAL KNOWLEDGE ITEMS

1. "Hi, I'm (say your name), How's it going?"

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Repsonse (NR): No active movement or vocalization following the presentation of the stimuli

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalize responses include:

- eye opening
- increased respiration
- decreased tone or increased tone
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation in blood oxygen levels from baseline range
- deviation in heart rate from baseline range

2 = Localized Response (LR): Reflects an ability of the patient to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless otherwise specified) after the stimulation and the responses are related to the area stimulated. Localized Responses include:

- orienting or localization movements toward the sound
- vocalization or response indicating subjects comprehension of the greeting

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:

⇒ A localized response is a response that is directly 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Social Greeting "Hi I'm (say your name), How's it going?"	0	1	2

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

TASTE & SWALLOWING SUB-SCALE

Required Materials:

- 1 taste (e.g., juice, milk, soda, familiar tastes, mouth wash)
- ice
- cotton tipped applicators
- gloves
- towels
- one bite block
- sugar
- lemonade flavored drink mix powder
- spoon (metal, in DOCS kit)

Administration Guidelines:

- Subject must be upright within a range of 45-90 degrees
- Head should be midline and supported—eliminate or reduce neck extension
- Check with the Speech Pathologist prior to placing anything (e.g., toothettes and spoon) beyond the teeth
- Present each test stimuli as many times as necessary to determine the subject's best response. Each stimuli should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response (unless otherwise specified) and wait 30 – 60 seconds before administering another test item
- Score each test item after determining the subject's best response--Do **not** wait to score until all test items are administered

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject what you will be doing and what setting or time of day he/she would experience this taste (e.g., "Here is a taste of orange juice -- we drink it for breakfast").

1. **Taste & Swallowing:** This set of test items evaluate the subject's responses to pre-swallowing stimulation and the subject's ability to swallow within 15-20 seconds of stimulation known to facilitate swallowing**.**

   Test Item 1.a. Cotton Tip Applicator: Using a juice soaked cotton tip applicator:
   - Apply the taste to the lips and gums
   - If the subject opens his/her mouth attempt to stimulate the top of the tongue and underneath the tongue.

   Test Item 1.b. Massage: Using your finger tips provide firm pressure/massage slowly and downward along the masseter (i.e., jaw) muscle to the corner of the lips

   Test Item 1c. Warm Spoon: Place a warm (room temperature) spoon to the center of their mouth

   Test Item 1d. Cold Spoon: Place spoon in ice chips, when cold, direct to the center of their mouth

   Test Item 1.e. Contrasting Sweet and Sour: Use a cotton applicator to apply a small amount of sugar on the lips and tongue when possible. Wait 30 seconds then apply a small amount of lemon-flavored drink on lips and tongue. Scoring for this item is determined by the contrast in responses for sweet and sour. Localized Response (2) = Facial expression or other indication of a difference in the tastes. Generalized Response (1) = swallow, licking of lips, etc after both presentations.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization following the presentation of stimuli.

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1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- suckling
- jaw movement
- chomping/chewing motion
- muscle tensing or other movements unrelated to the area stimulated
- deviation of oxygen saturation level from baseline range
- deviation of heart rate from baseline range

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10 – 15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- oral motor movements, such as licking lips or lip compression
- tongue pumping or movement
- swallowing within 15-20 seconds of application of the stimuli
- subject swipes at the therapist's hand, as an attempt to inhibit input
- changes in facial expression appropriate to the stimuli

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
⇒ A localized response is a response that is directly 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Salivation & Taste: 1.a. Cotton Tip Applicator (w/ juice) ⇒	0	1	2
1.b. Massage to masseter ⇒	0	1	2
1.c. Spoon (warm) ⇒	0	1	2
1.d. Spoon (cold) ⇒	0	1	2
1.e. SweetSour	0	1	2

OLFACTORY SUB-SCALE

Required Materials:

- flavored extracts (e.g. orange, vanilla, peppermint)
- chewing tobacco if the subject is a known long –term smoker
- cotton tip applicator

Administration Guidelines:

- Subject must be upright within a range of 45-90 degrees
- Head should be midline and supported—eliminate or reduce neck extension

Version date: 6/2/2011
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- If the subject has a tracheostomy tube check to see if the physician has stated that the tracheostomy tube may be momentarily occluded (i.e., for 1-5 seconds) ; DO NOT OCCLUDE IN ICU
- If the subject is trached and it is not desirable to occlude, then check the passage of air through the nostrils with a small feather. Hold the feather a 1/2" to 1" below the nostrils and see if the feather moves. If the feather moves then present each stimulus at this distance for 5-10 seconds. If the feather does not move do not administer this sub-scale.
- Present each odor as many times as necessary to determine the subject's best response. Each odor should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another odor
- Score each test item after determining the subject's best response--Do **not** wait to score until both odors are administered

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject what each odor is verbally and position it in the subject's visual field before and after giving each stimulus (i.e., "This smells like _____(name of odor)_____")

1. **Olfactory:** This set of test items evaluates the subject's responses to olfactory stimulation**.** Familiar odors may, for example, evoke memories or may serve as pre-cursors to salivation.

   Test Item 1.a. Odor1: Using an applicator soaked with orange, peppermint **or** vanilla extract:

   - Place the applicator ½ - 1 inch below the nostrils while simultaneously occluding the tracheostomy tube for 3 – 5 seconds.

   Test Item 1.b. Odor2: Using an applicator soaked with orange, peppermint **or** vanilla extract (use a different extract—do not use the same odor that was used in Test Item 1.a.):

   - Place the applicator ½ - 1 inch below the nostrils while simultaneously occluding the tracheostomy tube for 3 – 5 seconds.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- suckling
- jaw movement
- chomping/chewing motion
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- oral motor movements, such as licking lips or lip compression
- tongue pumping or movement
- swallowing within 10-15 seconds of application of the stimuli
- subject swipes at the therapist's hand, as an attempt to inhibit input
- vocalizations related to stimuli (e.g., "mmmmmm" or "ahhhhhh")
- sniffing (air inhaled through nose)

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
⇒ A localized response is a response that is directly 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.

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SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Odors: 1.a. Odor1_____ ⇒ (name of odor)	0	1	2
1.b. Odor2 _____ ⇒ (name of odor)	0	1	2

PROPRIOCEPTIVE AND VESTIBULAR SUB-SCALE

Administration Guidelines:

- Present each test item as many times as necessary to determine the subject's best response.
- Note any limits in range of motion on the response rating form--be aware of general limitations
- Head should be midline and supported—eliminate or reduce neck extension—when moving the subject
- Score each test item after determining the subject's best response--Do **not** wait to score.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with information about the test stimuli. Tell the subject that you will be moving their arms and legs and putting them in different positions (e.g., "Joe I am going to move your arm" or "Joe I am going to help you sit up")

1. **Passive Movement:** This test item evaluates the subject's response to passive range of motion. The subject may attempt to inhibit input or may demonstrate decreased or increased tone in the joint/limb being ranged.

   Test Item 1.a. Any Joint: Passively range a limb (e.g., arm, leg). Do not range to the extent of pain. Be sure to range the right and left before scoring. If subject does not get a score of 2; then range a different limb.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- eye opening
- increased respiration
- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- increased flexion/extension

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10 – 15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

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- subject swipes at the therapist's hand, as an attempt to inhibit input
- subject assists or resists movement or activity during passive movement stimulation
- related vocalizations (e.g., grunting)

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Passive Movement: 1.a. Any Joint:_____⇒ (write name of limb ranged)	0	1	2

TACTILE SUB-SCALE

Required Materials:

- mini vibrator
- feather
- can of pressurized air
- kitchen scouring pad
- ice cubes or ice chips
- alcohol swab
- hand warmer

Administration Guidelines:

- Head should be midline and supported—eliminate or reduce neck extension
- Present each test item as many times as necessary to determine the subject's best response. Each sensation should be presented for 3-5 seconds.
- Be sure to present each sensation on the right and the left.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another sensation
- Score each test item after determining the subject's best response--Do **not** wait to score until all items have been administered.
- Be sure to present each sensation on the Right and Left. If subject does not get a score of 2 after presentation of sensation bilaterally, then present the sensation to the alternative location specified in the directions for the item.

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with simple instructions that include the name of the body part you are planning to touch (e.g., "I am going to touch your arm now").

1. Light Tactile:

Test Item 1.a. Big toe or heel*:* Apply vibrator to pad of subject's toe or heel.

Test Item 1.b. Feather: Gently sweep the feather across the face, over the nose and on the cheeks. You can also try slowly stroking downward the following body parts: leg from knee down, bicep, <u>or</u> behind knee.

Test Item 1.c. Air: Using can of pressurized air direct a stream of air into the center of subject's neck; if necessary position subject's head and wait 20 seconds after positioning then direct stream of air to center back of neck.

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Test Item 1.d. Hair: Without contacting the skin, lightly move the hairs on the top side of the right forearm, in the direction **opposite** to that of the hair growth pattern. If the subject does not have hair on the arms or the arms are not accessible administer this item using the eyebrow hair. Stroke the eyebrow hair in the **opposite** direction of hair growth pattern.

- Repeat same procedure on left arm, use right and left leg if the skin on arm is not exposed.

2. Firm Tactile:

Test Item 2.a. Scrub: Using the kitchen scouring pad firmly apply a back and forth movement with firm pressure over the biceps, forearm and thigh areas on the right side of the body (exposed areas):

- Repeat procedure on left side of body

Test Item 2.b. Hand: Using your fingertips apply firm pressure down the subject's right arm on the inside surface, from the shoulder to the wrist

- Repeat on left arm

3. Temperature:

Test Item 3.a. Cube: Using light pressure, hold ice cube on the right big toe or heel just until the ice starts to melt

- Repeat sequence on the left side

Test Item 3.b. Swab: Using an alcohol swab swipe the big toe or heel on the right side

- Repeat sequence on the left big toe or heel

Test Item 3.c. Heat: Place hand warmer in the palm of the right hand for 15-20 seconds

- Repeat in the left hand

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling either 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): no active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- decorticate posturing
- abnormal flexion
- eye opening
- increased respiration
- decreased tone or increased tone
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation of oxygen saturation level from baseline range
- deviation of heart rate from baseline

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- subject swipes at the therapist's hand, as an attempt to inhibit input
- orienting movements of the body part stimulated
- moving body part stimulated
- vocalizations or a response indicating localization to the stimulus

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:

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⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Light Tactile: 1.a. Vibration to big toe or heel⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Feather ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.c. Air ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.d. Hair ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Firm Tactile: 2.a. Scrub ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b. Hand (firm pressure) ⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Temperature: 3.a. Cube(cube big toe or heel) ⇒	0	1	2
3.b. Swab(big toe or heel)⇒⇒⇒⇒⇒⇒	0	1	2
3.c. Heat (palm of hand)	0	1	2

AUDITORY SUB-SCALE

Required Materials:

- whistle
- bell

Administration Guidelines:

- Head should be midline and supported—eliminate or reduce neck extension
- Present each test item as many times as necessary to determine the subject's best response. Each stimulus should be presented for 3-5 seconds.
- Wait 10-15 seconds for a response and wait 30 – 60 seconds before administering another odor
- Modify the immediate environment to reduce any auditory and/or visual distractions, such as radios, televisions, and if possible medical machinery (i.e., check with attending physician)
- Stand outside the subject's field of vision except when giving auditory commands.
- Stimulus should be applied to both the right and left ears
- Avoid cueing with eye contact or gestures; specify commands (e.g., "move your fingers")
- Write down the commands used in the scoring grid.

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- Score each test item after determining the subject's best response--Do **not** wait to score until all items have been administered

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting the test stimuli the subject should be provided with simple instructions that include the name of the body part you are planning to touch (e.g., "I am going to touch your arm").

1. **Auditory Startle:**

   Test Item 1.a. Whistle: Blow whistle sharply and loudly one time behind **each** ear
   - right ear
   - left ear

   Test Item 1.b. Clap: Clap hands sharply and loudly one time behind **each** ear
   - right ear
   - left ear

2. **Auditory Localization:**

   Test Item 2.a. Name: Call out subject's name (first name or last name or nickname)
   - when repeating the name vary the inflection and loudness with each repetition
   - right ear
   - left ear

   Test Item 2.b. Bell: Ring bell for 5-10 seconds near subject's ear
   - right ear
   - left ear

3. **Auditory Comprehension:**

   Test Item 3.a. 1-step command (Command1): Use simple one step command that subject is able to physically perform (e.g., "move your fingers")

   Test Item 3.b. 1-step Command (Command2): Use a different command within the subject's motoric capabilities

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): no active movement or vocalization following the presentation of stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses Include:

- eye opening
- increased respiration
- decreased tone or increased tone
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking
- deviation in oxygen saturation level from baseline
- deviation in heart rate from baseline

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

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Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- orienting or localization movements toward sound (if the test item is command following, then localization toward sound is considered a GR)
- moving body part that subject was told to move
- vocalizations or a response indicating subject's comprehension of verbal command

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:

⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Auditory Startle: 1.a. Whistle ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Clap ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Auditory Localization: 2.a. Name ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b. Bell ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Auditory Comprehension: 3.a. 1-Step Command (Command1): _____	0	1	2
3.b. 1-Step Command (Command2): _____	0	1	2

VISUAL SUB-SCALE

Required Materials:

- penlight
- two 3-dimensional objects (tennis ball and block are provided in the DOCS kit)
- picture of a person familiar to the subject
- weird picture
- eye patch
- small mirror

Administration Guidelines:

- If eye opening isn't achieved or re-established administer only the test items related to ambient light and pupillary constriction. Then the evaluation session should stop and it should be completed within 24 hours. If, during the 2nd session eye opening still isn't achieved score all remaining test items as NR (i.e., 0).

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Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- The visual stimuli should be raised abruptly in one and/or both fields. The first horizontal or vertical movement occurring within a 5-10 second interval after stimuli presentation is to be interpreted as an indication of visual orientation to stimulus (i.e., localization).
- Subjects with dysconjugate/divergent gaze (i.e., non-symmetrical eye movement—the eyes are looking in 2 different directions) should be assessed with one eye patched or covered. Prior to using the eye patch you should consult with the subject's primary OT to discuss suspected visual impairment and determine the best eye for patching during the test.
- Present each test item as many times as necessary to determine the subject's best response.
- Wait 30 – 60 seconds before administering another test stimuli.
- Head should be midline and supported—eliminate or reduce neck extension
- Score each test item after determining the subject's best response--Do **not** wait to score

Test Items and Administration Procedures for Test Stimuli:

Prior to presenting each test stimuli the subject should be provided with information about the test procedures. Tell the subject that you want him/her to look at objects (e.g., "Joe look at the ball" or "Joe watch the ball" or "Joe keep your eyes on the ball").

1. **Pupillary Constriction:** If spontaneous eye opening has not been observed or there is ptosis, gently hold the eyelids open, unless there are medical contraindications (e.g., stitches, infections). Hold the penlight 1-2 inches from the subject's eye, turn on penlight for 1- 3 seconds and observe response.

   Test Item 1.a. Rpupil: Shine the light into the right eye for 1-3 seconds and watch for pupillary constriction.

   Test Item 1.b. Lpupil: Shine the light into the left eye for 1-3 seconds and watch for pupillary constriction.

2. **Tracking Objects:**

   Test Item 2.a. Horizontal: Present a 3-dimensional object in the left visual field and slowly move the object to the right, across midline. Present a 3-dimensional object in the right visual field moving the object to the left across midline. Tell the subject, "Keep your eyes on the _____."

   Test Item 2.b. Vertical: Present a 3-dimensional object in the middle visual field and slowly move the object upward. Present a 3-dimensional object in the middle visual field moving the object downward. Tell the subject, "Keep your eyes on the _____."

3. **Focus on Object:** Hold a 3-dimensional object in the visual fields, approximately 18 inches from the face for 5 – 10 seconds. Tell the subject, "Look at the _____."

   Test Item 3.a. FUpper: Upper visual field.

   Test Item 3.b. Fmiddle: Middle visual field.

   Test Item 3.c. Flower: Lower visual field.

   Test Item 3.d. Fleft: Left visual field.

   Test Item 3.e. Fright: Right visual field.

4. **Blink Response**: Rapidly and abruptly move your hand toward the subject's face from a stationary position about 12 inches away to about 2 inches away and flick your fingers. Avoid the inadvertent tactile stimulation of a rush of air. Repeat this in each of the following upper, middle, lower, left, and right visual fields. Look for a blink response.

   Test Item 4.a. BUpper: Upper visual field.

   Test Item 4.b. BMiddle: Middle visual field.

   Test Item 4.c. BLower: Lower visual field.

   Test Item 4.d. BLeft: Left visual field.

   Test Item 4.e. BRight: Right visual field.

5. **Tracking Familiar Faces:**

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Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Test Item 5.a. Horizontal: Present a picture of a person familiar to the subject in the left visual field and slowly move the picture to the right, across midline. Next, present the picture in the right visual field moving the picture to the left, across midline. If subject does not score a "2" tracking familiar face photo, use the mirror included in DOCS kit, and have the subject track themselves via mirror. Please circle/indicate if mirror was used. Tell the subject, "Keep your eyes on _____."

Test Item 5.b. Vertical: Present a picture of a person familiar to the subject in the middle visual field and slowly move the picture upward. Present the familiar picture in the middle visual field and slowly move the picture downward. If subject does not score a "2" tracking familiar face photo, use the mirror included in DOCS kit, and have the subject track themselves via mirror. Please circle/indicate if mirror was used. Tell the subject, "Keep your eyes on _____."

6. Focus on Familiar Face: Hold a picture of a person familiar to the subject in the visual fields that are listed for each test item approximately 18 inches from the face for 5-10 seconds. If subject does not score a "2"focusing on familiar face photo in at least one visual field, use the mirror included in DOCS kit, and have the subject focus on themselves via mirror. Please circle/indicate if mirror was used. Tell the subject, "Look at the _____."

Test Item 6.a. Upper: Upper visual field.

Test Item 6.b. Middle: Middle visual field.

Test Item 6.c. Lower: Lower visual field.

Test Item 6.d. Left: Left visual field.

Test Item 6.e. Right: Right visual field.

7. Weird Picture: Hold a weird picture at midline, 18 inches from the face for 5-10 seconds. If the subject does not focus on objects at midline, present the picture in a visual field that the person demonstrated ability to focus with the 3 dimensional object. Localized Response = facial expression or other reaction indicating recognition of the strange picture. Generalized Response = visual focus or tracking of the object.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization after presenting the stimuli. An example of a NR rating is pupil dilation given a bright light.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses can include:

- eye opening
- increased respiration
- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations
- blinking (blinking can be a LR if it is in response to the blinking test item, but otherwise it is a GR)

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

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Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- subject swipes at the therapist's hand, as an attempt to inhibit input
- related vocalizations (e.g., "ohhhhh")
- pupillary constriction with bright light
- facial movements
- head turning
- squinting
- eye closing
- eyelid fluttering
- visual orientation toward object

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  - ⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Pupillary Constriction (dilation = NR; constriction = LR) 1.a. Rpupuil (Right Pupil)⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
1.b. Lpupil (Left Pupil) ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2. Tracking Objects (TrackOBJ): 2.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
2.b.Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3. Focusing on Objects (FocusOBJ) (Blink Response = GR): 3.a. FUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.b. FMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.c. FLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.d. FLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
3.e. Fright⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4. Blinking (Blink Response = LR): 4.a. BUpper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.b. BMiddle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.c. BLower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.d. BLeft⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
4.e. Bright ⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
5. Tracking Familiar Faces (TrackFACE): 5.a. Horizontal⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
5.b. Vertical⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒ *Was mirror used instead of familiar face: YES / NO	0	1	2

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Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

6. Focusing on Familiar Faces (FocusFACE): 6.a. Upper⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.b. Middle⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.c. Lower⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.d. Left⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2
6.e. Right⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒ Was mirror used instead of familiar face: YES / NO	0	1	2
7. WeirdPix :⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒⇒	0	1	2

ORIENTATION SUB-SCALE

Required Materials:

- Laminated yes/no cards

Administration Guidelines:

- Administer these items after the Visual Focusing Items in the Visual Subscale
- If patient does not demonstrate a motoric yes/no response place the laminated yes/no cards within the visual fields that the patient has already demonstrated ability to focus on an object. If patient did not demonstrate ability to focus place the cards at midline
- Present each test item as many times as necessary to determine the subject's best response.
- Wait 15-20 seconds for a response and wait 30 – 60 seconds before administering another test stimuli.
- Head should be midline and supported—eliminate or reduce neck extension

Test Items and Administration Procedures:

1. **Orientation to Self:** First ask the patient: "Is your name----------?" Use a gender opposite name. (If the patient is a male insert a female name and if the patient is female, insert a male name). Then ask the patient "Is your name------? (insert the correct name). If the patient does not respond to the questions phrased in this format, ask an open ended question, "What is your name?" If they respond accurately to the open ended question, a localized response is scored.
2. **Orientation to Environment:** Ask the patient a yes/no question related to their immediate environment. Example: "Is your Mom in the room?"; "Are the lights on?".

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization after presenting the stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses can include:

- Incorrect responses to either orientation question
- eye opening
- increased respiration

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- patient must respond accurately to both self orientation questions to receive a score of 2
- accurate response to environmental question

❖ If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:

⇒ A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	Generalized Response (GR)	Localized Response (LR)
1. Orientation to Self (OrienSel) "is your name _____?" (gender opposite name) "Is your name _____? (correct name) If no response; try phrasing the question as open ended "What is your name?"	0	1	2
2 Orientation to Environment (OrienEnv) **Yes/No question related to immediate environment** **_____?**	0	1	2

FUNCTIONAL USE OF OBJECT SUB-SCALE

Required Materials:

- toothbrush

Administration Guidelines:

- Prior to placing the toothbrush in the subject's hand show him/her the object.
- If subject has hemiparesis place the toothbrush in the non-hemiparetic hand
- If the subject does not have the motoric ability to hold the toothbrush in either hand then skip this item. DO NOT SCORE.

Test Items and Administration Procedures for Test Stimuli:

1. Toothbrush: Place the toothbrush in the subject's hand and tell him/her to brush their teeth.

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Scoring Procedures:

A three point rating scale is used to measure progressively improving levels of neurobehavioral functioning. Each test item that is administered should be rated by circling 0, 1 or 2 on the scoring grid below.

0 = No Response (NR): No active movement or vocalization after presenting the stimuli.

1 = Generalized Response (GR): A GR is one that is either a reflex or a response not related to the test stimuli provided. A reflex is an automatic and stereotypical response whereas a general response is not necessarily stereotypical. Generalized Responses can include:

- eye opening
- increased respiration
- decreased tone or increased tone
- oral motor movements
- muscle tensing or other movements unrelated to the area stimulated
- unrelated vocalizations

2 = Localized Response (LR): Reflects an ability of the subject to regulate incoming sensory information, that is constantly changing, and to control their motoric response to the sensory input. Responses occur 10-15 seconds (unless specified otherwise) after the stimulation and the responses are related to the area stimulated. Localized Responses Include:

- Functional use of the toothbrush or behavior indicating an attempt at using the toothbrush in a functional way. (i.e. attempting to bring toothbrush to mouth, opening the mouth, etc)

- If the differentiation between a GR and a LR is unclear, then this rule of thumb should be followed:
  - A localized response is a response that is directed toward 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.

SCORING GRID

	No Response (NR)	**Generalized Response (GR)**	**Localized Response (LR)**
1. Functional Use of Toothbrush	0	1	2

TESTING READINESS SCORE

Directions: Circle one score for each test item

1. Auditory Stimuli:

Subject required their name to be spoken to re-establish "testing readiness" = 0
Subject did not require their name to be spoken to re-establish "testing readiness" = 1

2. Tactile/Deep Pressure Stimuli:

Subject required deep pressure to re-establish "testing readiness" = 0
Subject did not require deep pressure to re-establish "testing readiness" = 1

3. Passive Movement Stimuli:

Subject required passive movement to re-establish "testing readiness" = 0

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Subject did not require passive movement to re-establish “testing readiness” = 1

4. Rolling Stimuli:

Subject required rolling to re-establish “testing readiness” = 0
Subject did not require rolling to re-establish “testing readiness” = 1

5. Rocking Stimuli:

Subject required rocking stimuli to re-establish “testing readiness” = 0
Subject did not require rocking stimuli to re-establish “testing readiness” = 1

6 Maintaining State of Testing Readiness:

Did the patient require stimulation intermittently throughout the evaluation to maintain a state of testing readiness?
Circle One: Yes**= 0 No=1**

Version date: 6/2/2011
Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.

Version date: 5/5/2010

Source: Pape, T.L.-B., Heinemann, A., Kelly, J.P., Hurder, A, G, Lundgren, S. (2005). A Measure of Neurobehavioral Functioning after Coma- Part I: Theory Reliability and Validity of the Disorders of Consciousness Scale, Journal of Rehabilitation Research and Development, Jen/Feb, 42 (1) 1-18. Pape, T.L.-B., Senno, R., Guernon, A. Ke;;y, J. (2005). A Measure of Neurobehavioral Functioning after Coma-Part II: Detection and Measurement of Meaningful Effects during Coma Recovery, Journal of Rehabilitation Research and Development, Jan/Feb, 42 (1) 19-28.