CNS Vital Signs Advancing TBI and Concussion Care

Adding Value to Your Practice by Providing Solutions for Measuring, Monitoring and Managing Neurocognitive and Behavioral Health…

CNS
Vital Signs®

www.CNSVS.com

Contents

The following pages have been assembled from various sources and publications and is meant to be a reference or roadmap guide to assist and inform how CNS Vital Signs can be used to improve clinical insight and care management, enable current guidelines, be integrated into a clinic or practice, and help improved practice revenues and performance.

Solutions for Measuring , Monitoring, and
Managing Neurocognitive and Behavioral Health

Why CNS Vital Signs?

CNS Vital Signs strives to provide clinicians a valid, reliable, and affordable, 'research quality' assessment platform. The CNS Vital Signs assessment platforms helps to support a practices comprehensive, state-of-the-art clinical assessment, and evidence-based treatment services for children, adolescents, and adults across the lifespan by:

- Accurately measuring and characterizing a patient's neurocognitive function based on his or her status or effort

- Facilitating the thinking about the patient's condition (50+ well known medical and health rating scales)and helping to explain the patient's current difficulties

- Optimizing serial administration which helps to monitor and guide effective intervention and enables evidence-based medicine and outcomes

CNS Vital Signs offers multiple assessment platform options that can be easily configured and deployed depending on each practices goals and needs.

Enhanced Patient Insight and Care Management

OBJECTIVE, PRECISE, and STANDARDIZED Assessments that Supports many NeuroPsych Clinical Guidelines
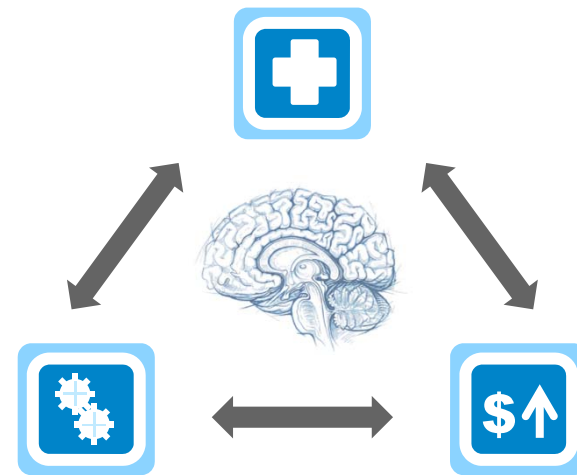
Extend Practice Efficiency

Objective and Evidence-Based Assessment Data Collected, Auto-Scored and Systematically Documented.

Develop Enhanced Revenue Streams

Well Established Billing Codes to Improve Practice Performance

WHY CNS Vital Signs?

Assessing Brain Function: CNS Vital Signs is a clinical testing procedure used by clinicians to evaluate and manage the neurocognitive state of a patient. Across the lifetime, serial testing allows ongoing assessments of a patient's condition, disease progression, or clinical outcome.

About CNS Vital Signs

Both Neurocognitive Testing and Evidence-Based Functional Ratings Scales in one Platform

The CNS Vital Signs MULTI-MODAL assessment platform enables the *efficient collection* and *systematic documentation* of important brain function and behavioral, symptom and comorbid clinical endpoints using *VALID & RELIABLE* standardized neurocognitive tests and evidence-based symptom, behavioral and functional rating scales.

As a clinical instrument, the CNS Vital Signs neurocognitive testing and evidence-based rating assessment tools have been used to *detect impairment, follow the course of an illness, and monitor response to treatment;* it has also been used as a research tool to screen for cognitive disorders in epidemiological / surveillance and pharmaceutical studies and to follow cognitive changes.

Clinician Benefits

- **RAPID INSIGHT…** computerized neurocognitive testing helps clinicians evaluate and describe the health of the cognitive or higher functions of the brain in a more granular and standardized fashion.

- **DASHBOARD VIEW…** Neurocognitive domain functions and functional status is presented in a summary view that is easy to interpret.

- **LONGITUDINAL VIEW…** Repeated testing allows clinicians to track disease progress and treatment/rehabilitation effects

- **DETAILED VIEW…** Each report presents the testing data in a detailed view. All results can be easily exported to EMR's or spreadsheets for clinical or research purposes.

- **VALID ACROSS the LIFE SPAN…** Peer reviewed normative data allows clinicians to examine patients from age 8 to 90.

Solutions for Measuring, Monitoring, and Managing Neurocognitive and Behavioral Health

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Introduction: CNS Vital Signs in Brain Injury

CNS Vital Signs provides clinicians and researchers with leading edge neurocognitive and behavioral health assessment technologies that efficiently collects valid and reliable brain & behavioral clinical endpoints for a more objective view of a patient's functional status, disease progression, and outcomes. The CNS Vital Signs Assessment platform supports a lifespan chronic care model and helps enable productive interactions between the family, caregivers, and a specialist practice team.

CNS Vital Signs computerized neuropsychological tests can enhance and support brain injury rehabilitation…

"A thorough evaluation of a persons cognitive strengths and weaknesses can help the clinician formulate… information important in planning intervention strategies… Neuropsychological test performance and behavioral data provide complimentary information and lead to a more clearly defined view of a persons abilities and disabilities. Identifying when a breakdown in functioning occurs (behavioral data) and for what reason (neuropsychological data) can help tailor a more individualized rehabilitation regimen that is most likely to benefit the client."

Adapted from: Neuropsychology of Everyday Functioning

CNS Vital Signs computerized neuropsychological tests can enhance efficiency and insight in assessing cognitive status and the difference between "normal performance" and a patients current status and provides the clinician with a normative comparison that can be paired with an interview, exam, and other valid test(s) or rating scales to help add validity to the evaluation and management brain injuries. Re-evaluation or serial testing with CNS Vital Signs supports the effective management and tailoring of medications or treatments and assessment of outcomes. A very detailed assessment of abilities is auto-scored, and the pattern of strengths and weaknesses can be used in treatment planning and measuring progress.

One of the most robust features of the CNS Vital Signs assessment is its randomization algorithm allowing for an almost infinite number of alternate forms. This allows for retesting patients and minimal practice effects. Clinicians establish a baseline and upon re-test, compare the results to assist in decision-making regarding the observed change in the patient's condition, monitor disease or recovery progress, measure treatment results, compliance, and outcomes e.g., Concussion Management, Brain Rehabilitation, Medication Optimization , Etc. Often Patients and families benefit from seeing testing results allowing the understanding of the status and nature of their or a loved one's neurocognitive function. CNS Vital Signs is one of many tools clinicians use in evaluating changes in a patient's condition.

If you have question or would like to register for a free in-service webinar go to www.CNSVS.com or email support@cnsvs.com or call 1.888.750.6941.

How Can CNS Vital Signs Help?

Mild traumatic brain injury: a neuropsychiatric approach to diagnosis, evaluation, and treatment

A thorough physical and neuropsychiatric examination is an essential part of the evaluation of the brain-injured individual. The physical examination should include a detailed neurological examination, including assessment for primitive reflexes ("frontal release signs") and other neurological "soft-signs" that may reflect subtle neurological dysfunction not evidenced by routine ("elemental") neurological examination. Neuropsychiatric assessment should include a thorough general mental status examination…

…as well as a detailed cognitive examination; the latter examination should emphasize timed tests of attention and information processing, memory encoding and retrieval, and executive function.

Clinicians should be aware that the Mini-Mental State Examination (MMSE) (Folstein et al 1975) is not generally regarded by brain injury specialists as an adequate tool with which to screen for the types of cognitive impairment produced by mild TBI.

Cognitive, emotional, behavioral, and physical impairments are common sequelae of mild TBI and may in a nontrivial minority of persons persist into the late period following injury.

Typical postconcussive symptoms include headache, dizziness, and visual disturbances; attention, memory, and other cognitive impairments; irritability, anxiety, depression, and other emotional disturbances; and behavioral problems such as apathy or impulsivity. The evaluation of postconcussive symptoms requires an understanding of the multiple factors relevant to the production and maintenance of symptoms following trauma to the brain…

Source: **Mild traumatic brain injury: a neuropsychiatric approach to diagnosis, evaluation, and treatment**; David B Arciniegas, C Alan Anderson, Jeannie Topkoff, and Thomas W McAllister; Neuropsychiatr Dis Treat. 2005 December; 1(4): 311–327.

Valid & Reliable in Assessing TBI Impairment

A Computerized Test Battery Sensitive to Mild and Severe Brain Injury

C. Thomas Gualtieri, MD, *Medical Director* and Lynda G. Johnson, PhD

Gualtieri. Departments of Neuropsy... ...Carolina Neuropsychi...
North C...

Objective

Computerized neurocognitive testing (CNT) appears to be suited to measure relatively mild degrees of neurocognitive impairment in circumstances where speed, efficiency, and low cost are important. Computerized tests are used in the evaluation and management of patients who have had mild brain injuries; the objective is to determine if computerized testing is equally reliable and valid in the evaluation of patients who have had more severe brain injuries.

Participants

141 patients, aged 18–65 years, who had sustained traumatic brain injuries (TBIs): 13 patients with postconcussion syndrome; 15 who had recovered from mild brain injuries; 85 patients who had had severe brain injuries, but who had recovered, and were living independently; and 28 severe brain injury patients who were unable to live without assistance; compared with 145 normal controls.

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2390690/?log$=activity

Design

A cross-sectional, naturalistic study of brain injury patients compared with normal controls.

Setting

An outpatient neuropsychiatry clinic.

Main Outcome Measures

The CNS Vital Signs (CNS VS) battery is a PC-based system that includes tests of verbal and visual memory, psychomotor speed, complex attention, reaction time, and cognitive flexibility.

Results

Performance on the CNS VS battery was related to severity of brain injury and degree of recovery. Tests of psychomotor speed and cognitive flexibility were the most relevant to TBI status. Patients who had recovered from mild brain injuries scored almost as well as normal controls. The Neurocognition Index (NCI), a summary score based on performance on all the tests in the battery, was 100 for normal controls and 98 for recovered mild brain injury patients. Postconcussive patients scored 82 on the MCI, and severe brain injury patients scored 66 on the NCI if they were living independently and 47 if they were not.

Conclusions

Computerized tests like CNS VS allow clinicians the advantage of precise neurocognitive measurement in the service of diagnosis and appropriate treatment. CNTs are never going to replace the flexibility or comprehensiveness of conventional neuropsychological testing, but they have a role to play in circumstances where a full test battery is not feasible, such as screening and serial assessment

Valid & Reliable in Assessing TBI Impairment

CNS Vital Signs: A Computerized Test Battery Sensitive to Mild and Severe Brain Injury

Computerized tests like CNS Vital Signs allow clinicians the advantage of precise neurocognitive measurement in the service of evaluation, management, and appropriate treatment. CNT's are never going to replace the flexibility or comprehensiveness of conventional neuropsychological testing, but they have a role to play in circumstances where a full test battery is not feasible, such as patient in-take (Neurobehavioral Status Exam 96116) and serial assessment.
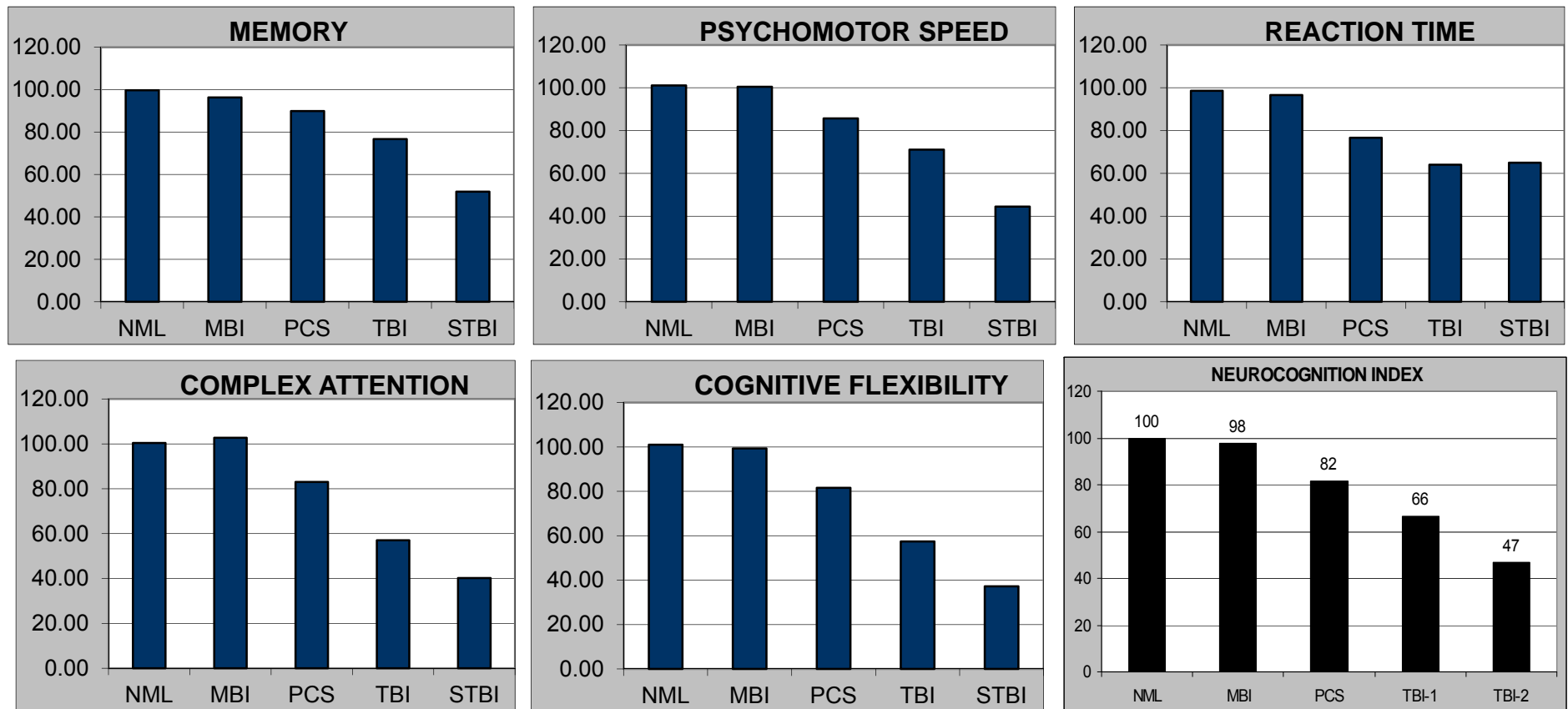
Source: CNS Vital Signs: A Computerized Test Battery Sensitive to Mild and Severe Brain Injury; C Thomas Gualtieri MD, Lynda G Johnson PhD; Medscape J Med. 2008; 10(4): 90.

Why Use CNS Vital Signs to Assess Brain Injury?

The CNS Vital Signs VSX Assessment Platform represents a legacy of innovation and a commitment to advancing neurocognitive and behavioral clinical assessment tools that help support a TEAM MANAGEMENT concept.

Clinical Pathology
Measure and Monitor

Comorbid Status
Measure and Monitor

Serial Assessment
Longitudinal View

Assess BRAIN FUNCTION and Determine the Existence or Level of IMPAIRMENT...

CNS Vital Signs computerized neurocognitive testing allows clinicians to *assess abnormal neurocognitive impairment* by comparing patients to a 'PEER REVIEWED' normative data set from *ages 8 to 90* across the lifespan

Provides a broad spectrum of clinical domains and the sensitivity to assess neurocognitive function to reveal abnormality in the absence of positive findings in CT and MRI scans e.g. concussion.

Assess symptoms or COMORBID conditions...

CNS Vital Signs supports many BRAIN INJURY guidelines.

Evidence-based rating scales and neurocognitive testing can help clinicians *sort out symptom, behavioral, and comorbid issues* and help better understand possible brain and behavior relationships.

50+ Free Rating Scales:

Zung Depression & Anxiety, Neurobehavioral Symptom Inventory, Dizziness Handicap Inventory, Etc.

KEY ADVANTAGE

...contains an *auto-randomization algorithm*... **Ideal for serial testing with an** *almost unlimited number of alternate forms* **(other systems use a pseudo-randomization or limited number of alternate forms).**

This allows practices to shift toward new assessment approaches that allow for monitoring of change/ recovery over time aiding the conventional neuropsychological examination documenting the patient's cognitive state at a point in time by adding a more efficient in-take and serial testing of the patient's ongoing recovery.

Neuropsychological testing is the "gold standard" for evaluation of patients who have had brain injuries. But there are hardly enough qualified neuropsychologists to keep up with the 2 million or so Americans who have brain injuries every year, and even if there were, the cost of repeated evaluations as the patient recovers (or fails to recover, as the case may be) would be prohibitive. Neuropsychologists have tried to address this problem by introducing brief screening batteries, rating scales, or CNT batteries. Adapted from: Medscape J Med. 2008; 10(4): 90.

Advancing Brain Injury Care

CNS Vital Signs TBI – Concussion Toolbox

Clinician Expertise

Brain Function: Memory, Attentional, Executive, Psychomotor Speed & more

Behaviors, Symptoms, and Comorbidities

Computerized Neurocognitive Testing

- Nine Neurocognitive Domains Measured
- Memory – Immediate and Delayed
- Frontal Lobe / Executive Control Tests
- Processing and Psychomotor Speed
- Immediate Auto – Scored Reports
- Rapid Assessment - 30 Minute Initial Assessment/Baseline, 15 Minute Follow-up for Treatment Effect
- Easy to Interpret
- Systematic & Standardized Documentation for Patient Registry/Research
- HIPAA Compliant

Computerized Medical and Health Rating Scales*

- Neurobehavioral Symptom Inventory (NSI)
- Dizziness Handicap Inventory (DHI)
- Head Injury Questionnaire (HIQ)
- PTSD Checklist – Civilian, Military, Stressor
- NeuroPsych Questionnaire NPQ-207 & NPQ-45 both Child & Adult
- Epworth Sleepiness Scale
- Pittsburgh Sleep Quality Index
- Drug Use Questionnaire (DAST)
- Zung Self-Rating Depression Scale

Meets the Defense and Veterans Brain Injury Center (DVBIC) Mild Traumatic Brain Injury (mTBI) Clinical Guidance

Used with permission… Free use of rating scales

Optimized for Brain Injury Assessments

Patient

Caregiver & Informants

Health Outcomes

Evaluation and Management
Brain ● Behavior

e.g. Spouse, Athletic Trainer, etc.

Objective Neurocognitive Assessment

Evidence - Based Health Rating Scales

Care Management Reports
Brain Function ● Symptoms ● Comorbidities

Standardized and Secure Data
Easy Export to EMR and Spreadsheet for Analysis
1600+ Norms from Age's 8 to 90 ● Systematic Documentation

Care Team

CNS Vital Signs Neurocognitive Battery in Brain Injury

"The purpose of this study… was to evaluate the discriminant validity of the CNS VS battery in patients with a spectrum of TBIs. The results of the investigation indicate that the CNS VS battery does have discriminant validity. When administered in a clinical setting to brain injury patients, the test battery generates results that are similar to conventional neuropsychological tests and other computerized test batteries…

On the CNS VS battery, patients with acute post-concussional symptoms were found to have measurable cognitive deficits. Patients who were more than 12 months post concussion performed normally on the test battery."

Adapted from: A Computerized Test Battery Sensitive to Mild and Severe Brain Injury; Medscape J Med. 2008;10(4):90.

The CNS Vital Signs AD/HD Toolbox helps clinicians systematically collect brain function, symptoms, and comorbidities data, automatically scoring and systematically documenting the resulting clinical endpoints.

A Systems Based Approach

Neurocognitive Tests	WEB & COMPUTER Based Testing	**Brain Injury Rating Scales**

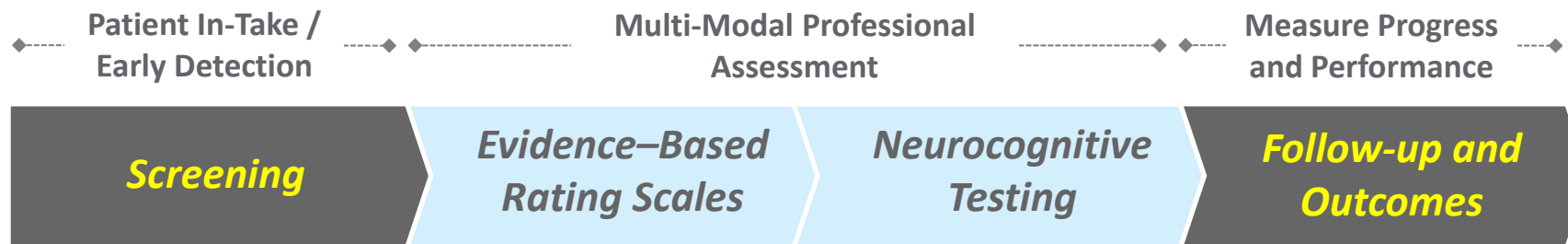*CNS Vital Signs is a computerized neurocognitive health assessment platform that enables the* **OBJECTIVE EVALUATION of COGNITION**…

…identifying **symptoms, possible comorbidities, behavioral issues**, *and other important clinical information.*

Patient In-Take / Early Detection — **Multi-Modal Professional Assessment** — **Measure Progress and Performance**

Screening	**Evidence–Based Rating Scales**	**Neurocognitive Testing**	**Follow-up and Outcomes**

Identify
- *Possible Behavioral or Comorbid Issues*
- *Cognitive Status - Baseline*
- *NeuroPsych, Mental, and Behavioral Health Issues (symptoms that can effect educational or vocational productivity and performance)*

Behavioral
- *Neuropsychiatric Symptoms & Comorbidities*
- *Attentional Issues*
- *Internalizing (anxiety – depression – PTSD) Issues*
- *Externalizing (behavioral – conduct) issues …and many more.*

Brain
- *Memory*
- *Attentional*
- *Executive Control*
- *Processing Speed*
- *Cognitive Flexibility*
- *Social Acuity*
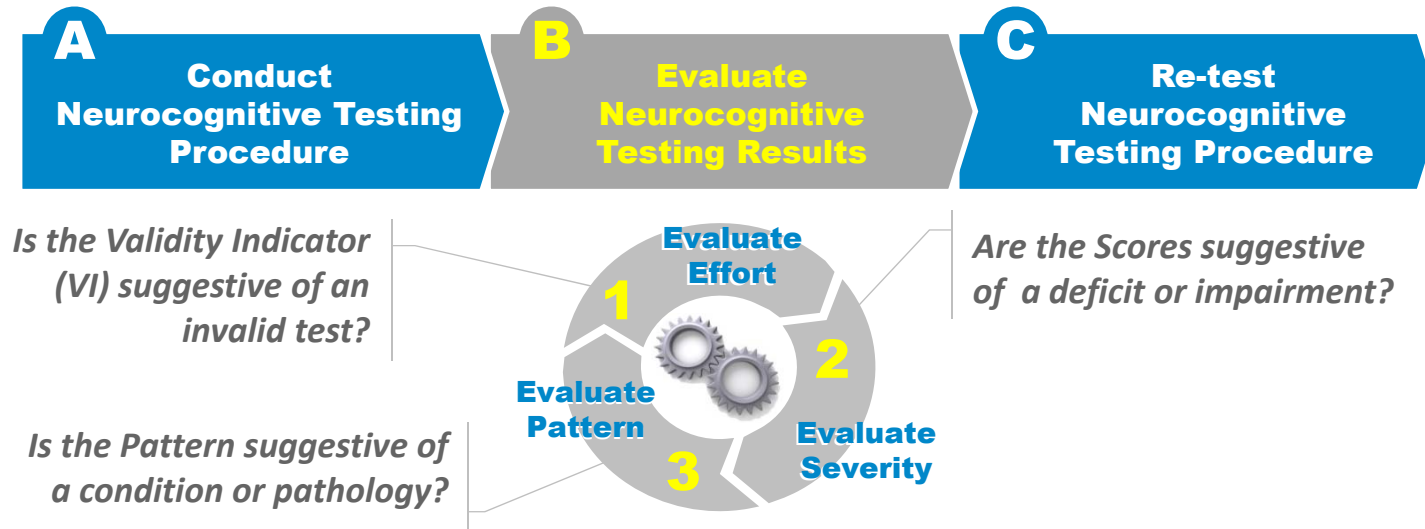- *Reasoning*
- *Working Memory …and many more*

Monitor
- *Assess Medication Effect*
- *Measure Progress or Changes*
- *Document for Outcomes and/or Research*
- *Conduct Web Based Mental and Behavioral Health Surveillance*
- *Improve Compliance*

SOPHISTICATED… *yet…* **SIMPLE** Systems-Based approach to Screening, Assessment, & Surveillance…

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

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HOW? CNS Vital Signs begins with...

A Conduct Neurocognitive Testing Procedure → **B** Evaluate Neurocognitive Testing Results → **C** Re-test Neurocognitive Testing Procedure

Is the Validity Indicator (VI) suggestive of an invalid test?

Is the Pattern suggestive of a condition or pathology?

1 Evaluate Effort
2 Evaluate Severity
3 Evaluate Pattern

Are the Scores suggestive of a deficit or impairment?

A: Conducting a Valid Assessment (Refer to the Test Administration Guide.) To begin the staff should collect information about the CHIEF or REFERRAL COMPLAINT. This will be a primary driver for the selection of tests and rating scales. For initial evaluations or in complex presentations, a broad spectrum battery is always an appropriate starting point.

B: Review the immediately auto-scored report to ① validate testing effort, ② evaluate the Domain Dashboard to quickly assess the level of impairment or grade the deficit, and ③ Evaluate the Domain Pattern to help rule-in, rule-out, or confirm certain clinical conditions. Feedback to the patient on the testing results may be presented at the clinical encounter or at a subsequent patient visit.

C: If invalid test results were noted then consider re-testing the patient to confirm clinical results. If the test results were valid, then, as part a continuum of care, reschedule testing to track disease progression and measure ongoing status or outcomes.
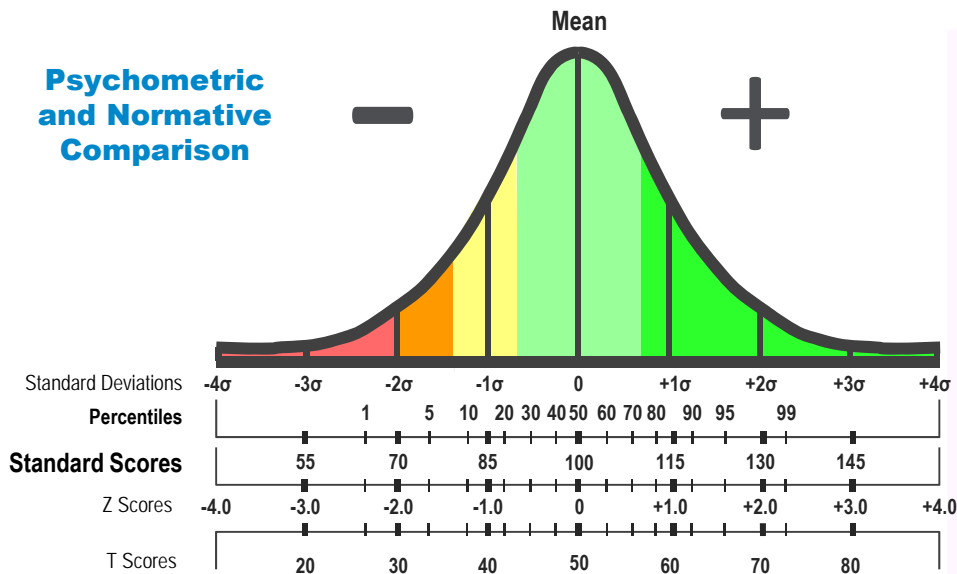
NOTE: The *Validity Indicator* denotes a guideline for representing the possibility of an invalid test or domain score. "No" means a clinician should evaluate whether or not the test subject understood the test, put forth their best effort, or has a clinical condition requiring further evaluation.

Evaluate Severity – Impairment Status

CNS Vital Signs grades *severity of impairment* based on an age-matched normative comparison database... mTBI Example

Psychometric and Normative Comparison

− Mean +

Standard Deviations	-4σ	-3σ	-2σ	-1σ	0	+1σ	+2σ	+3σ	+4σ
Percentiles			1	5 10 20 30 40 50 60 70 80	90 95	99			
Standard Scores		55	70	85	100	115	130	145	
Z Scores	-4.0	-3.0	-2.0	-1.0	0	+1.0	+2.0	+3.0	+4.0
T Scores		20	30	40	50	60	70	80	

Above:	> 110	High Function and High Capacity
Average:	90 - 110	Normal Function and Normal Capacity
Low Average:	80 - 90	Slight Deficit and Slight Impairment
Low:	70 - 79	Moderate Deficit and Impairment Possible
Very Low:	< 70	Deficit and Impairment Likely

Standard Scores

CNS Vital Signs Clinical Report				Test Date: July 23 2011 10:48:38				
Subject ID: mTBI or AD/HD				Administrator: Technician				
Language: English (United States)				Age: 27				

Patient Profile:	Percentile Range				> 74	25 - 74	9 - 24	2 - 8	< 2
	Standard Score Range				> 109	90 - 109	80 - 89	70 - 79	< 70
Domain Scores	Subject Score	Standard Score	Percentile	VI**	Above	Average	Low Average	Low	Very Low
Neurocognition Index (NCI)	NA	85	16	Yes			x		
Composite Memory	102	103	58	Yes		x			
Verbal Memory	51	93	32	Yes		x			
Visual Memory	51	110	75	Yes	x				
Processing Speed	48	79	8	Yes				x	
Executive Function	34	75	5	Yes				x	
Psychomotor Speed	174	93	32	Yes		x			
Reaction Time*	555	107	68	Yes		x			
Complex Attention*	21	56	1	Yes					x
Cognitive Flexibility	26	63	1	Yes					x
Total Test Time (min: secs)	29:12		Total time taken to complete the tests shown.						

Domain Dashboard: Above average domain scores indicate a standard score (SS) greater than 109 or a Percentile Rank (PR) greater than 74, indicating a high functioning test subject. Average is a SS 90-109 or PR 25-74, indicating normal function. Low Average is a SS 80-89 or PR 9-24 indicating a slight deficit or impairment. Below Average is a SS 70-79 or PR 2-8, indicating a moderate level of deficit or impairment. Very Low is a SS less than 70 or a PR less than 2, indicating a deficit and impairment. Reaction times are in milliseconds. An * denotes that "lower is better", otherwise higher scores are better. Subject Scores are raw scores calculations generated from data values of the individual subtests.
VI – Validity Indicator:** Denotes a guideline for representing the possibility of an invalid test or domain score. "No" means a clinician should evaluate whether or not the test subject understood the test, put forth their best effort, or has a clinical condition requiring further evaluation.

Verbal Memory Test (VBM)	Score	Standard	Percentile	
Correct Hits - Immediate	13	102	55	**Verbal Memory Test:** Subjects have to remember 15 words and recognize them in a field of 15 distractors. The test is repeated at the end of the battery. The VBM test measures how well a subject can recognize, remember, and retrieve words e.g. exploit or attend literal representations or attribute. "Correct Hits" refers to the number of target words recognized. Low scores indicate verbal memory impairment.
Correct Passes - Immediate	14	95	37	
Correct Hits - Delay	9	85	16	
Correct Passes - Delay	15	109	73	
Visual Memory Test (VIM)	Score	Standard	Percentile	
Correct Hits - Immediate	13	107	68	**Visual Memory Test:** Subjects have to remember 15 geometric figures, and recognize them in a field of 15 distractors. The test is repeated at the end of the battery. The VIM test measures how well a subject can recognize, remember, and retrieve geometric figures e.g. exploit or attend symbolic or spatial representations. "Correct Hits" refers to the number of target figures recognized. Low scores indicate visual memory impairment.
Correct Passes - Immediate	14	117	87	
Correct Hits - Delay	13	111	77	
Correct Passes - Delay	11	93	32	
Finger Tapping Test (FTT)	Score	Standard	Percentile	
Right Taps Average	64	104	61	The FTT is a test of motor speed and fine motor control ability. There are three rounds of tapping with each hand. The FTT test measures the speed and the number of finger-taps with each hand. Low scores indicate motor slowing. Speed of manual motor activity varies with handedness. Most people are faster with their preferred hand but not always.
Left Taps Average	60	105	63	
Symbol Digit Coding (SDC)	Score	Standard	Percentile	
Correct Responses	50	80	9	The SDC test measures speed of processing and draw upon several cognitive processes simultaneously, such as visual scanning, visual perception, visual memory, and motor functions. Errors may be due to impulsive responding, misperception, or confusion.
Errors*	2	92	30	
Stroop Test (ST)	Score	Standard	Percentile	
Simple Reaction Time*	231	108	70	The ST measures simple and complex reaction time, inhibition / disinhibition, mental flexibility or directed attention. The ST helps assess how well a subject is able to adapt to rapidly changing and increasingly complex set of directions. Prolonged reaction times indicate cognitive slowing / impairment. Errors may be due to impulsive responding, misperception, or confusion.
Complex Reaction Time Correct*	542	100	50	
Stroop Reaction Time Correct*	568	112	79	
Stroop Commission Errors*	8	5	1	
Shifting Attention Test (SAT)	Score	Standard	Percentile	
Correct Responses	47	82	12	The SAT measures executive function or how well a subject recognizes set shifting (mental flexibility) and abstraction (rules, categories) and manages multiple tasks simultaneously. Subjects have to adjust their responses to randomly changing rules. The best scores are high correct responses, few errors and a short reaction time. Normal subjects may be slow but accurate, or fast but not so accurate. Attention deficit may be apparent.
Errors*	13	75	5	
Correct Reaction Time*	1003	97	42	
Continuous Performance Test (CPT)	Score	Standard	Percentile	
Correct Responses	40	104	61	The CPT measures sustained attention or vigilance and choice reaction time. Most normal subjects obtain near-perfect scores on this test. A long response time may suggest cognitive slowing and/or impairment. More than 2 errors (total) may be clinically significant. More than 4 errors (total) indicate attentional dysfunction.
Omission Errors*	0	104	61	
Commission Errors*	0	108	70	
Choice Reaction Time Correct*	400	99	47	

Neurocognitive Domain Dashboard mTBI Example

CNS Vital Signs presents testing results in Subject (raw), Standard Scores, and Percentile Ranks. **NOTE: See the CNS Vital Signs Interpretation Guide for more information.**

>115	100	85	70	<55
+1SD	-1SD		-2SD	-3SD
Above: Above Expected Level	**Average:** At Expected Level	**Low Average:** Borderline	**Low:** Below Expected Level	**Very Low:** Well Below Expected Level

Patient Profile:	Percentile Range				> 74	25 - 74	9 - 24	2 - 8	< 2
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Total Test Time (min: secs)	29:12				Total time taken to complete the tests shown.				

SD = Standard Deviation from the MEAN

CNS Vital Signs Embedded Indicators of Valid Effort

One factor that has been consistently shown to be related to poor outcome after a TBI is litigation/compensation. For example, a meta-analysis of 17 studies on the effects of financial incentives on recovery after TBI found that involvement in litigation for financial compensation was consistently associated with poor outcomes after MTBI (Binder & Rohling, 1996(49)). In that study the authors noted the effect was strongest for mild head injury.

A key advantage to the VSX assessment platform is the autoscoring of embedded indicators of patient testing effort. As with all psychological and neuropsychological testing neuropsychiatric patients can feign their responses due to incentives. When analyzing test data, either in research, or in clinical practice, it is important to know whether a test result is valid or not. Clinicians need to know if testing subjects are generating "dubious results" or a "non-credible response pattern." CNS Vital Signs has developed "validity indicators" for its tests and domains that indicate whether the patient gave poor effort or generated invalid results. Should a subject test abnormally low triggering an "invalid" test (NO as displayed in the Validity Indicator section of the report) then that would be a reason for retesting the individual, unless your clinical judgment makes you believe that is the best score the patient can achieve. Additional Information is available at our website

Clinical Domains	TEST VALIDITY INDICATORS
Composite Memory	Both Verbal and Visual Memory valid.
Verbal Memory	Verbal Memory raw score > 30.
Visual Memory	Visual Memory raw score > 30.
Processing Speed	SDC: more than 20 correct responses.
Executive Function	SAT errors < SAT correct responses.
Psychomotor Speed	FTT: total taps > 40 & or SDC: > 20 correct responses
Reaction Time	Stroop: Simple RT < Complex RT < Stroop RT
Complex Attention	Valid Stroop, CPT, and SAT. Correct > incorrect response in all tests.
Cognitive Flexibility	Valid Stroop and SAT. Correct > incorrect responses in all tests.
Non-Verbal Reasoning	NVR correct responses > 4. Correct > incorrect responses.
Social Acuity	POET correct responses > 3. Correct > incorrect responses
Sustained Attention	Valid 4PCPT: Part 2 > 2 correct; part 3 > 5 correct; part 4 > 5 correct. Correct > incorrect
Working Memory	responses in all parts.

FTT - Finger Tapping Test; SAT – Shifting Attention Test; SDC – Symbol Digit Coding Test; RT – Reaction Time; CPT – Continuous Performance Test; POET – Perception of Emotions Test; NVR – Non-verbal Reasoning; 4PCPT – Four Part CPT

Calculating Domain Scores

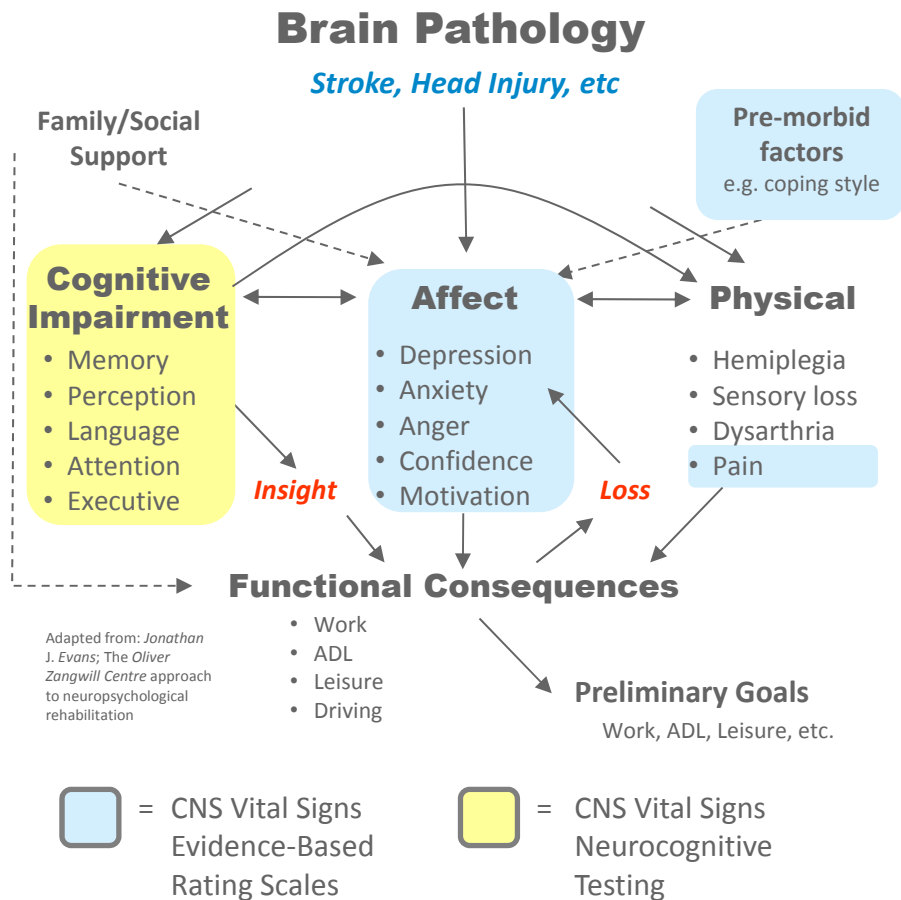| VSX BRIEF-CORE Clinical Domains	Domain Score Calculations: 1600+ Norms, Ages 8 to 90
Neurocognition Index - NCI	Average of five domain scores: Composite Memory, Psychomotor Speed, Reaction Time, Complex Attention , and Cognitive Flexibility ; representing a form of a global score of neurocognition
Composite Memory	VBM Correct Hits Immediate + VBM Correct Passes Immediate + VBM Correct Hits Delay + VBM Correct Passes Delay + VIM Correct Hits Immediate + VIM Correct Passes Immediate + VIM Correct Hits Delay + VIM Correct Passes Delay
Verbal Memory	VBM Correct Hits Immediate + VBM Correct Passes Immediate + VBM Correct Hits Delay + VBM Correct Passes Delay
Visual Memory	VIM Correct Hits Immediate + VIM Correct Passes Immediate + VIM Correct Hits Delay + VIM Correct Passes Delay
Processing Speed	SDC Correct Responses - SDC Errors
Executive Function	SAT Correct Responses - SAT Errors
Psychomotor Speed	FTT Right Taps Average + FTT Left Taps Average + SDC Correct Responses
Reaction Time	(ST Complex Reaction Time Correct + Stroop Reaction Time Correct) / 2
Complex Attention	Stroop Commission Errors + SAT Errors + CPT Commission Errors + CPT Omission Errors
Cognitive Flexibility	SAT Correct Responses - SAT Errors - Stroop Commission Errors
VSNP Clinical Domains	Domain Score Calculations: 700+ Norms, Ages 8 to 90
Working Memory	(4PCPT Part 4 Correct Responses) - (4PCPT Part 4 Incorrect Responses)
Sustained Attention	(4PCPT Part 2 Correct Responses + 4PCPT Part 3 Correct Responses + 4PCPT Part 4 Correct Responses) – (4PCPT Part 2 Incorrect Responses + 4PCPT Part 3 Incorrect Responses + 4PCPT Part 4 Incorrect Responses)
Social Acuity	POET Correct Responses – POET Commission Errors
Reasoning (non-verbal)	NVRT Correct Responses – NVRT Commission Errors

Abbreviations Defined:

VBM – Verbal Memory Test; VIM – Visual Memory Test; SDC – Symbol Digit Coding Test; SAT – Shifting Attention Test; FTT - Finger Tapping Test; ST – Stroop Test; CPT – Continuous Performance Test; 4PCPT – Four Part CPT; POET – Perception of Emotions Test; NVR – Non-verbal Reasoning Test.

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

Brain Injury & Rehabilitation

CNS Vital Signs Provides a Quick Documentation of Neurocognitive Function for Goal Setting and Assessing Treatment Outcomes

Brain Pathology

Stroke, Head Injury, etc

Family/Social Support

Pre-morbid factors
e.g. coping style

Cognitive Impairment
- Memory
- Perception
- Language
- Attention
- Executive

Insight

Affect
- Depression
- Anxiety
- Anger
- Confidence
- Motivation

Loss

Physical
- Hemiplegia
- Sensory loss
- Dysarthria
- Pain

Functional Consequences
- Work
- ADL
- Leisure
- Driving

Adapted from: *Jonathan J. Evans*; The *Oliver Zangwill Centre* approach to neuropsychological rehabilitation

Preliminary Goals
Work, ADL, Leisure, etc.

☐ = CNS Vital Signs Evidence-Based Rating Scales

☐ = CNS Vital Signs Neurocognitive Testing

Rehabilitation has been defined in may ways, but generally, it is concerned with maximizing the quality of life of daily living activities after an injury or illness. Traumatic Brain Injury (TBI) and a Stroke can significantly affect many neurocognitive, physical, and psychological skills. "Neurocognition" refers to the higher brain functions: learning, remembering, concentrating, solving problems and making decisions. Neurocognitive processes are active in virtually all of our day-to-day activities. Neurocognitive testing helps you MEASURE, MONITOR, and MANAGE the health of these higher functions of the brain. "Rehabilitation" is generally not synonymous with "Restoration" of normal function. However, with CNS Vital Signs normative standardization sample (1600+ Norms from ages 8 to 90) clinicians can better understand and communicate the level of dysfunction or disability the patient is experiencing.

CNS Vital Signs helps you identify the level of impairment on in-take, serially assess and monitor, and educate the family members, support network, and the patient about the level of activity, challenges, and participation (disability & handicap) that might be encountered.

CNS Vital Signs in Brain Injury & Rehabilitation
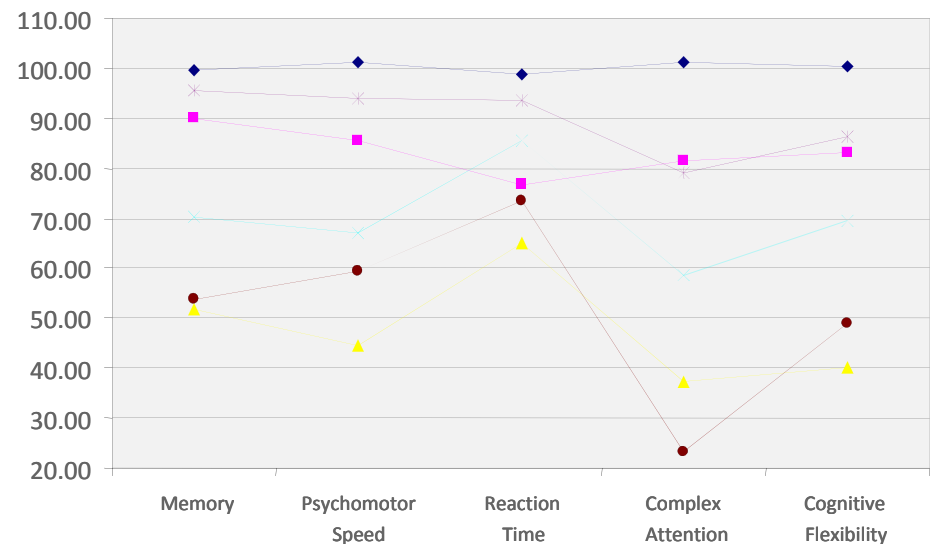
50+ Evidence-Based Rating Scales
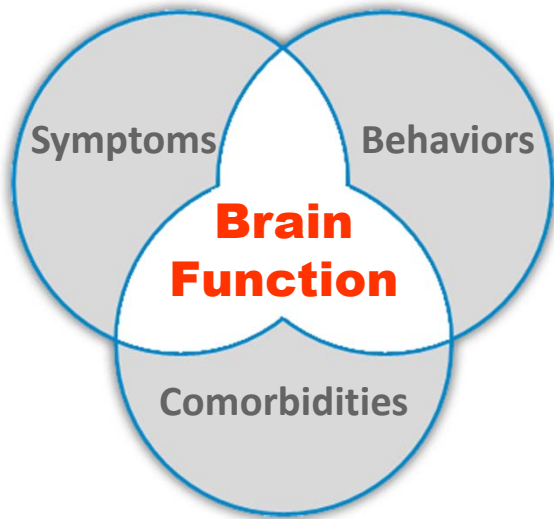
Automatically scored
…Immediate reporting
…Data SYNCed and
stored securely…
Enabling enhanced
clinical insight and clinic
efficiencies.

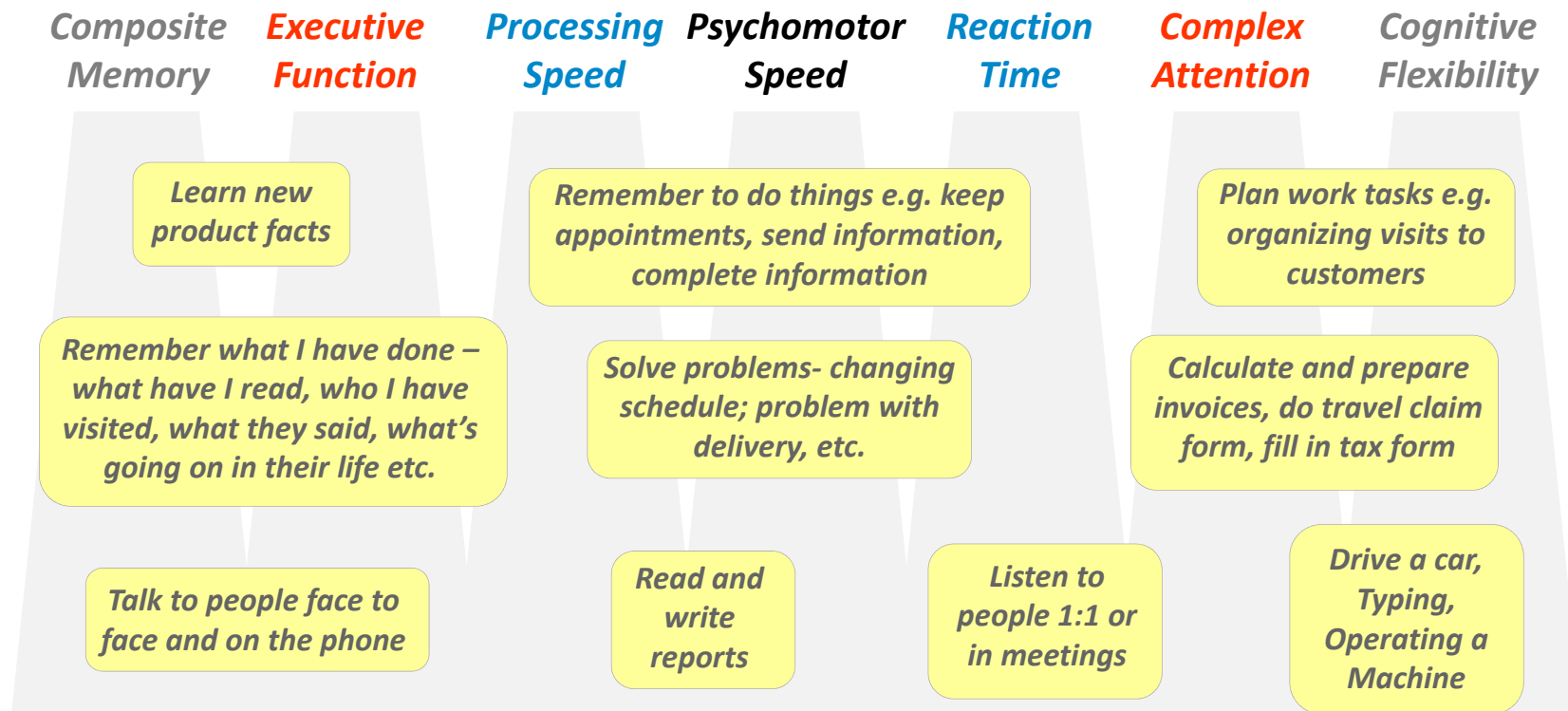| Domain	Score	Severity	Description
Attention	140	Mild	The Neuropsych Questionnaire asks patients (or an appropriate observer) a series of questions about their clinical state. The questions are about the symptoms of various neuropsychiatric disorders. The terminology is similar to that used in the diagnostic manuals, and in many familiar clinical questionnaires and rating scales; but it has been simplified, and all symptoms are scored on the same metric.
Impulsive	150	Moderate	
Learning	115	Mild	
Memory	56	Not a problem	
Anxiety	230	Severe	
Panic	83	Mild	
Agoraphobia	100	Mild	
Obsessions & Compulsions	111	Mild	
Social Anxiety	125	Mild	Scores are reported on a scale of 0 (not a problem) to 300 (severe). As a rule, scores above 225 indicate a severe problem; scores from 150-224 indicate a moderate problem; and scores from 75-149, a mild problem. A high score on the Neuropsych Questionnaire means that the patient is reporting more symptoms of greater intensity.
Depression	212	Moderate	
Mood Stability	192	Moderate	
Mania	100	Mild	
Aggression	150	Moderate	
Psychotic	143	Mild	
Somatic	78	Mild	
Fatigue	150	Moderate	It doesn't necessarily mean that the patient has a particular condition; just that he or she (or their spouse, parent or caregiver) are saying that they have a lot of intense symptoms. Conversely, a low score simply means that the patient (or caregiver) is not reporting symptoms associated with a particular condition, at least during the period of time specified. It does not mean that the patient does not have the condition. Just as some people over-state their problems, others tend to under-state their problems. The Neuropsych Questionnaire is not a diagnostic instrument. The results it generates are only meant to be interpreted by an experienced clinician in the course of a clinical examination.
Sleep	225	Severe	
Suicide	300	Severe	
Pain	100	Mild	
Substance Abuse	133	Mild	
Average Symptom Score	142	Mild	
PTSD	222	Moderate	
Bipolar	155	Mild	
Autism	158	Mild	
Aspergers	153	Mild	
ADHD	153	Moderate	
MCI	108	Mild	
Concussion	172	Moderate	
Anxiety/Depression	226	Severe	

Reported Symptoms / Possible Comorbidities

Valid and Reliable Neurocognitive Tests

CNS Vital Signs Supports Integrated Neurocognitive Care

- ◆ Normal
- ■ Post Concussion Syndrome
- ▲ Severe Brain Injury
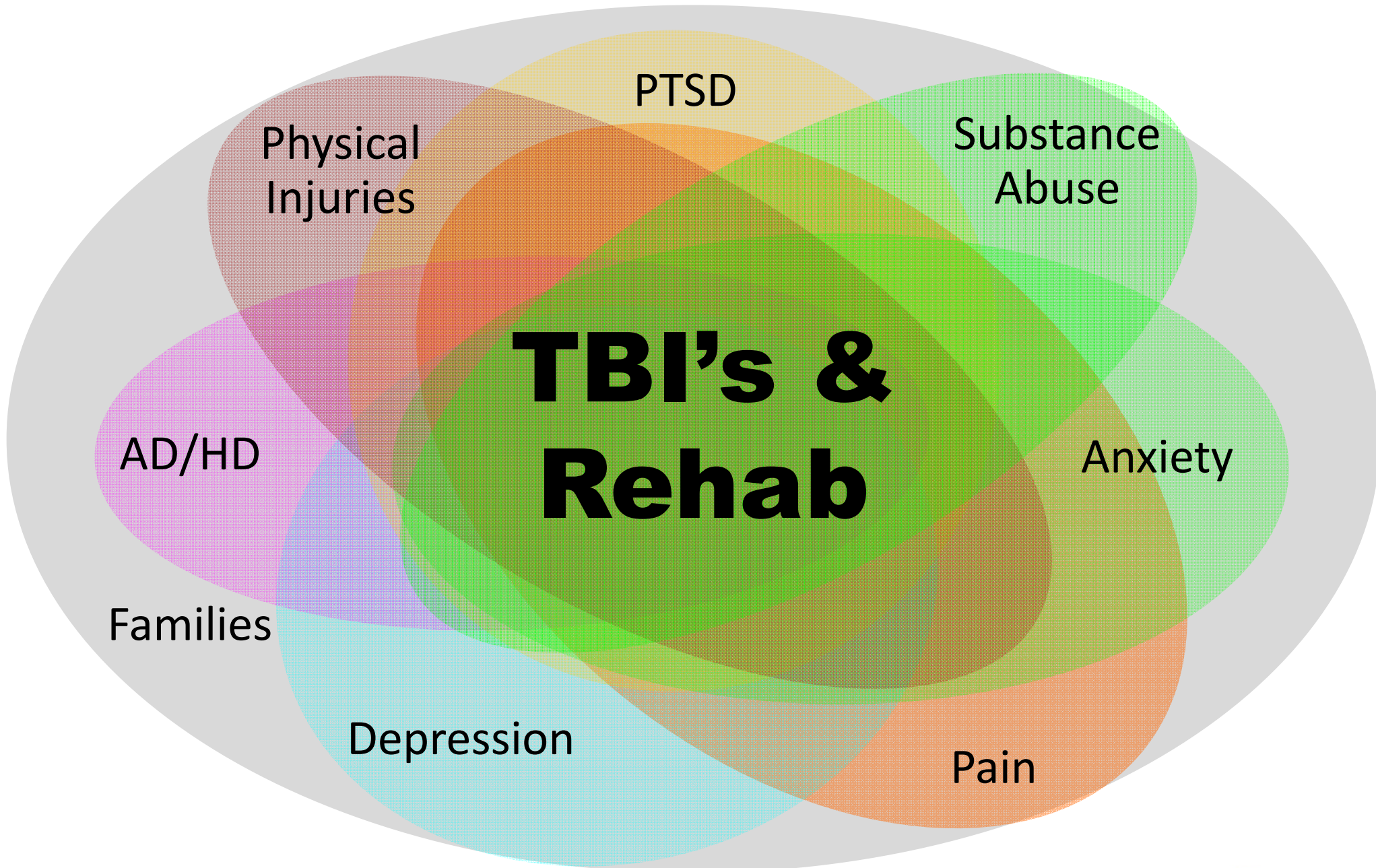- ✕ PTSD
- ✳ Depression
- ● Conversion Disorder

CNS Vital Signs in Brain Injury & Rehabilitation

Composite Memory	Executive Function	Processing Speed	Psychomotor Speed	Reaction Time	Complex Attention	Cognitive Flexibility

Learn new product facts

Remember to do things e.g. keep appointments, send information, complete information

Plan work tasks e.g. organizing visits to customers

Remember what I have done – what have I read, who I have visited, what they said, what's going on in their life etc.

Solve problems- changing schedule; problem with delivery, etc.

Calculate and prepare invoices, do travel claim form, fill in tax form

Talk to people face to face and on the phone

Read and write reports

Listen to people 1:1 or in meetings

Drive a car, Typing, Operating a Machine

EXAMPLE: A baseline using VSX BRIEF-CORE 7 neurocognitive tests, the Medical Outcomes Survey SF-36, the Epworth Sleepiness Scale, and the NPQ- 45 NeuroPsych Questionnaire take about 40 minutes to take. Using the CNS Vital Signs assessment will allow you to form a better understanding of the challenges the patient and their family face, and what contributing factors (symptoms, comorbidities, behaviors) may be involved. The information generated in the auto-scored report can be used in discussions with the patient and their family, to plan future clinical work or other services, and to individualize a treatment program designed to meet the patients specific needs as well as track individual progress and outcomes.

TBI's can be Comorbid & Multifactorial in Nature

PTSD

Physical Injuries

Substance Abuse

AD/HD

TBI's & Rehab

Anxiety

Families

Depression

Pain

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

Tools to Help Assess TBI and Comorbidities

NPQ – 207

Rapid In-take to Assess the Neuro–Psych Status of a Patient

Autoscores Twenty NeuroPsych Symptoms and Eight Possible Comorbidities

Symptoms · Behaviors · Comorbidities

Brain Function
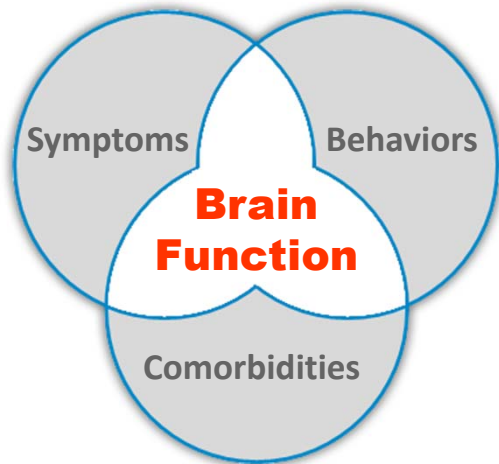
NeuroPsych Questionnaire (NPQ) LF-207 (Page 1 of 9)			
Subject Reference/ID: warfighter		Test Date: February 11 2009 11:24:43	
Age: 23		Administrator: Med Tech	
Total Test Time: 10:31 (min:secs)		Language: English (United States)	

Reported Symptoms

Domain	Score	Severity	Description
Attention	140	Mild	The Neuropsych Questionnaire asks patients (or an appropriate observer) a series of questions about their clinical state. The questions are about the symptoms of various neuropsychiatric disorders. The terminology is similar to that used in the diagnostic manuals, and in many familiar clinical questionnaires and rating scales; but it has been simplified, and all symptoms are scored on the same metric.
Impulsive	150	Moderate	
Learning	115	Mild	
Memory	56	Not a problem	
Anxiety	**230**	**Severe**	
Panic	83	Mild	
Agoraphobia	100	Mild	
Obsessions & Compulsions	111	Mild	
Social Anxiety	125	Mild	*Scores are reported on a scale of 0 (not a problem) to 300 (severe). As a rule, scores above 225 indicate a severe problem; scores from 150-224 indicate a moderate problem; and scores from 75-149, a mild problem. A high score on the Neuropsych Questionnaire means that the patient is reporting more symptoms of greater intensity.*
Depression	212	Moderate	
Mood Stability	192	Moderate	
Mania	100	Mild	
Aggression	150	Moderate	
Psychotic	143	Mild	
Somatic	78	Mild	
Fatigue	150	Moderate	
Sleep	**225**	**Severe**	It doesn't necessarily mean that the patient has a particular condition; just that he or she (or their spouse, parent or caregiver) are saying that they have a lot of intense symptoms. Conversely, a low score simply means that the patient (or caregiver) is not reporting symptoms associated with a particular condition, at least during the period of time specified. It does not mean that the patient does not have the condition. Just as some people over-state their problems, others tend to under-state their problems. The Neuropsych Questionnaire is not a diagnostic instrument. The results it generates are only meant to be interpreted by an experienced clinician in the course of a clinical examination.
Suicide	**300**	**Severe**	
Pain	100	Mild	
Substance Abuse	133	Mild	
Average Symptom Score	142	Mild	

Possible Comorbidities

Domain	Score	Severity
PTSD	222	Moderate
Bipolar	155	Mild
Autism	158	Mild
Aspergers	153	Mild
ADHD	153	Moderate
MCI	108	Mild
Concussion	172	Moderate
Anxiety/Depression	**226**	**Severe**

Helping Assess Comorbidities

Cognition and Depression

ARTICLE INFO

ABSTRACT

Background: We hypothesized that only a minority of patients with mood disorders have measurable cognitive impairment, and this minority drives the small-to-medium effect sizes detected in group studies. Removal of this minority from group statistical analyses ... the majority appear to ha... ...ctioning.
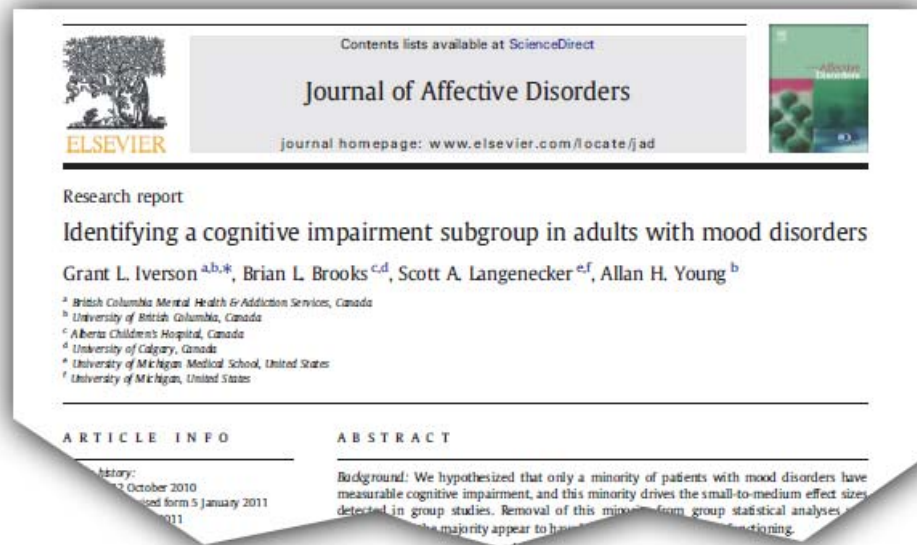
"Indeed, there is some suggestion that cognitive or executive functioning deficits may be a trait risk factor for depression (Douglas and Porter, 2009; Frasch et al., 2009; Micco et al., 2009; Reppermund et al., 2009). Furthermore, worse neuropsychological test performance at baseline is associated with poorer response to treatment (Dunkin et al., 2000; Kampf-Sherf et al., 2004; Mohlman and Gorman, 2005), and cognitive deficits are more pronounced in patients who are unemployed (Baune et al., 2010). It is possible that treatment refractory depression is a subtype characterized in part by cognitive impairment.

The accurate identification and quantification of neurocognitive impairment are important for research relating to neurobiological underpinnings, treatment, and functional outcome in patients with mood disorders. It is essential, methodologically, that we have accurate methods for identifying those patients who are objectively cognitively impaired and separate them from patients who have the subjective experience of poor thinking skills or thinking that is easily perturbed by negative affect, but perform normally on cognitive testing in controlled conditions. The treatments and outcomes for these two groups may differ markedly, as well as the prognosis."

Source: Identifying a cognitive impairment subgroup in adults with mood disorders. J Affect Disord. 2011 Aug;132(3):360-7. Epub 2011 Mar 25.

http://www.ncbi.nlm.nih.gov/pubmed/21439647

Cognition and Depression

Cognitive Flexibility

Domain scored from two venerable AD/HD tests

- ● Healthy Control
- ■ Mood Disorder, Normal Cognition
- ◆ *Mood Disorder, Cognitive Impairment*
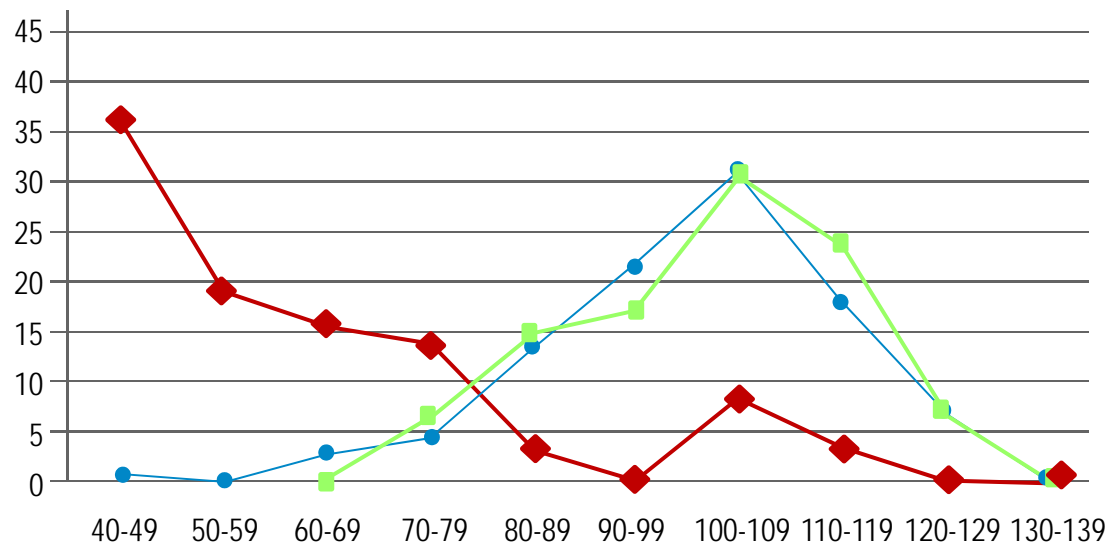
Fig. 3. Distributions of **CNS Vital Signs** *cognitive flexibility* index score in patients with or without impaired cognition. Figure note: Healthy control, N=660. Mood disorder, normal cognition, n=128. Mood disorder, cognitive impairment, n=58. *Normative scores were truncated at 40. Each value represents the percentage of subjects in that score range.

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

50+ Rating Scales: Easy to Interpret Reports
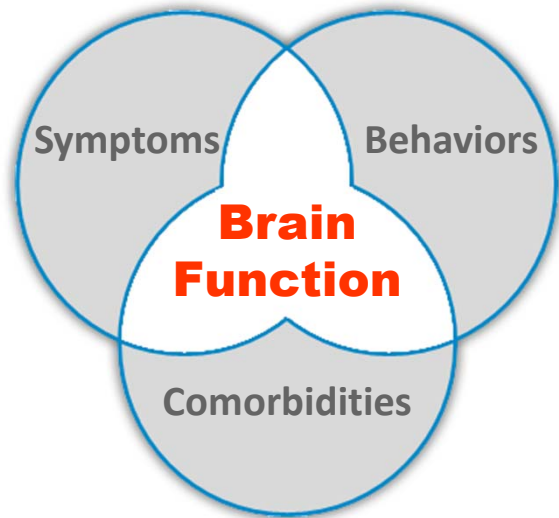
Symptoms · Behaviors · **Brain Function** · Comorbidities

Automatically scored …Immediate reporting …Data SYNCed and stored securely… Enabling enhanced clinical insight and clinic efficiencies.

Medical Outcomes Short Form Health Survey (SF-36) Questions

Domain	Score	Standard	Percentile	
Physical Functioning	95	113	81	As part of the Medical Outcomes Study (MOS) — a multi-year, multi-site study to explain variations in patient outcomes — RAND (www.rand.org) developed the 36-Item Medical Outcomes Survey (SF-36). SF-36 is a set of generic, coherent, and easily administered quality-of-life measures. These measures rely upon patient self-reporting and are now widely utilized by managed care organizations and by Medicare for routine monitoring and assessment of care outcomes in adult patients.
Role Functioning - Physical	0	81	10	
Role Functioning - Emotional	0	76	5	
Energy/ Fatigue	10	72	3	
Emotional Well Being	12	60	1	
Social Functioning	0	54	1	
Pain	100	117	87	
General Health	45	91	27	
Health Change	25	78	7	

NeuroPsych Questionnaire (NPQ) SF-45

Domain	Score	Severity	Description
Attention	280	Severe	The Neuropsych Questionnaire Short Form asks patients (or an appropriate observer) a series of questions about their clinical state. The questions are about the symptoms of various neuropsychiatric disorders. The terminology is similar to that used in the diagnostic manuals, and in many familiar clinical questionnaires and rating scales; but it has been simplified, and all symptoms are scored on the same metric. Scores are reported on a scale of 0 (not a problem) to 300 (severe). As a rule, scores above 225 indicate a severe problem; scores from 150-224 indicate a moderate problem; and scores from 75-149, a mild problem. A high score on the Neuropsych Questionnaire Short Form means that the patient is reporting more symptoms of greater intensity. It doesn't necessarily mean that the patient has a particular condition; just that he or she (or their spouse, parent or caregiver) are saying that they have a lot of intense symptoms. Conversely, a low score simply means that the patient (or caregiver) is not reporting symptoms associated with a particular condition, at least during the period of time specified. It does not mean that the patient does not have the condition. Just as some people over-state their problems, others tend to under-state their problems. The Neuropsych Questionnaire Short Form is not a diagnostic instrument. The results it generates are only meant to be interpreted by an experienced clinician in the course of a clinical examination.
Impulsive	280	Severe	
Memory	225	Severe	
Anxiety	300	Severe	
Panic	167	Moderate	
Depression	300	Severe	
Mood Stability	275	Severe	
Aggression	125	Mild	
Fatigue	233	Severe	
Sleep	300	Severe	
Suicide	250	Severe	
Pain	175	Moderate	

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

CNS Vital Signs: TBI and PTSD
Potential Clinical Presentation

PTSD   **TBI**

Flashbacks

Nightmares

Attentional Problems

Depression

Anxiety

Headaches

Dizziness

Irritability
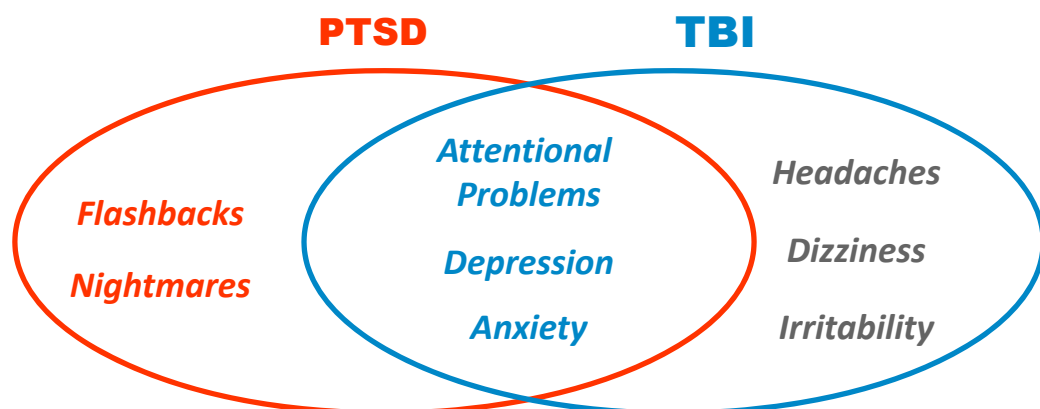
ABSTRACT

Every year, more than 2M Americans sustain brain injuries and at least 10% are moderate to severe, with lasting motor or sensory deficits, cognitive impairment and emotional instability. The judicious application of psychotropic drugs and other somatic treatments has the potential to improve their cognitive deficits and neurobehavioral symptoms. Monitoring treatment response usually entails serial cognitive testing.

In 2008, we demonstrated the reliability and validity of a computerized neurocognitive test battery for the evaluation of patients who had the post concussion syndrome (PCS, N=13); who had recovered from mild brain injuries (MBI, N=15); who had had moderate-to-severe traumatic brain injuries (TBI1, N=85); and who had had severe and disabling TBI (TBI2, N=28) (Gualtieri & Johnson, A computerized test battery sensitive to mild and severe brain injury. The Medscape Journal of Medicine, 2008. Posted 04/15/08.) The Neurocognition Index, a summary scored based on tests of verbal and visual memory, finger tapping, coding, shifting attention, continuous performance and the Stroop test, demonstrated a graded level of cognitive performance relative to injury severity.

Measures of psychomotor speed (FTT & SDC) and cognitive flexibility (SAT & ST), and the NCI, were the best discriminators between normals and people who had had concussions.

Subjects, Method: This study involves 219 patients who had moderate to severe brain injuries but who were ambulatory and verbal, and independent in most of their activities of daily living; 121 patients with post-traumatic stress disorder; 98 patients who had the post-concussion syndrome; and 219 normal controls. The age of the Ss was 15 to 69. The four groups were successfully matched for age, race, gender and computer familiarity, but not for education (F=12.5, Sig < 0.001), which was accordingly entered as a covariate in the subsequent analyses.

CNS Vital Signs: TBI and PTSD

The 2008 study* utilized the conventional VS7 battery (verbal and visual memory, VBM, VIM), finger tapping (FTT), symbol digit coding (SDC), the Stroop test (ST), shifting attention (SAT) and the continuous performance test (CPT). In this study, an expanded test battery was used in a larger subject sample. This allows us to assess a wider range of variables as candidates for an optimal TBI battery. The conventional seven tests of the VS7 battery have been augmented with measures of reaction time variability for every test, and these, together, generate an RTV index. The conventional battery also generates new domains of executive function and processing speed. In addition, four new tests have been added to the battery: the perception of emotions test, which measures social acuity; tests of nonverbal reasoning and working memory; and a test of multitasking, the dual task test.

Results: The chart on the right indicates the results of the conventional VS7 battery, and the chart on the left, the expanded battery. The results are largely the same, with exceptions:

NORMALS > MBI > PTSD > TBI

NMLvTBI	Area	Asymptotic Sig	Effect Size
PSYCHOMOTOR SPEED	0.846	1.86657E-09	1.18
REACTION TIME	0.820	2.75162E-08	1.03
DUAL TASK TEST	0.811	6.43318E-08	0.99
DUAL TASK %	0.796	2.64678E-07	0.82
EXECUTIVE FUNCTION	0.782	9.57359E-07	1.06
COGNITIVE FLEXIBILITY	0.775	1.71874E-06	1.02
DUAL TASK CORRECT	0.757	7.78578E-06	0.59
MEMORY	0.747	1.7412E-05	0.91
COMPLEX ATTENTION	0.707	0.00032257	0.60
WORKING MEMORY	0.700	0.000504357	0.64
SOCIAL ACUITY	0.700	0.00051113	0.56
REACTION TIME VARIABILITY	0.689	0.00102528	0.64
NONVERBAL REASONING	0.654	0.007503006	0.55

	AUC	Asymptotic Sig
PSYCHOMOTOR SPEED ss	**0.752**	**0.0170**
NEUROCOGNITION INDEX ss	**0.747**	**0.0192**
COGNITIVE FLEXIBILITY ss	**0.708**	**0.0485**
COMPLEX ATTENTION ss	0.643	0.1761
MEMORY ss	0.620	0.2567
REACTION TIME ss	0.618	0.2644

NEUROCOGNITION INDEX*

NML	MBI	PCS	TBI-1	TBI-2
100	98	82	66	47
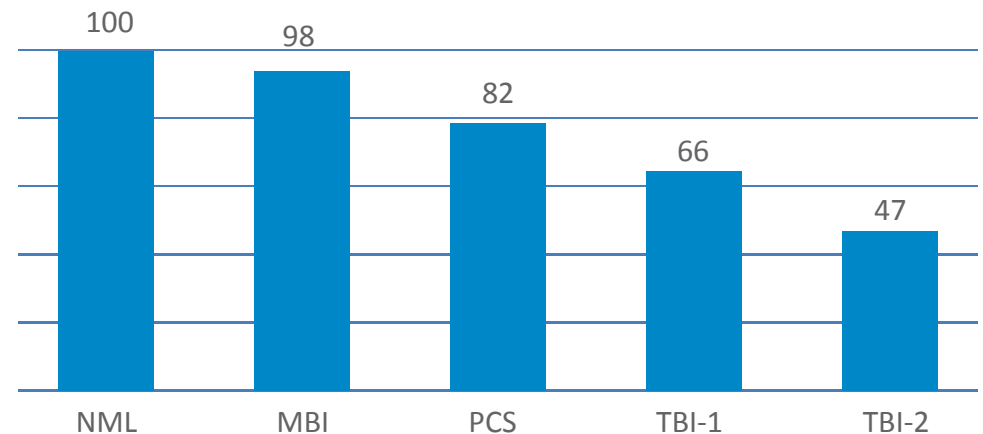
CNS Vital Signs: TBI and PTSD

NORMALS > MBI > PTSD > TBI

It is a moot point that severe TBI patients score lower than normals on neurocognitive tests, and that computerized tests are capable of demonstrating those differences.   The issue that is of concern in recent days, especially in military medicine, is how one should neurocognitive testing to evaluate patients with mild brain injuries (MBI) and whether it is possible to distinguish them from patients PTSD. Theoretically, brain injury patients should score lower than patients with an anxiety disorder like PTSD. In fact, the opposite is the case. In almost every domain, PTSD patients score lower than MBI patients, and almost as badly as patients do who have had severe TBIs.
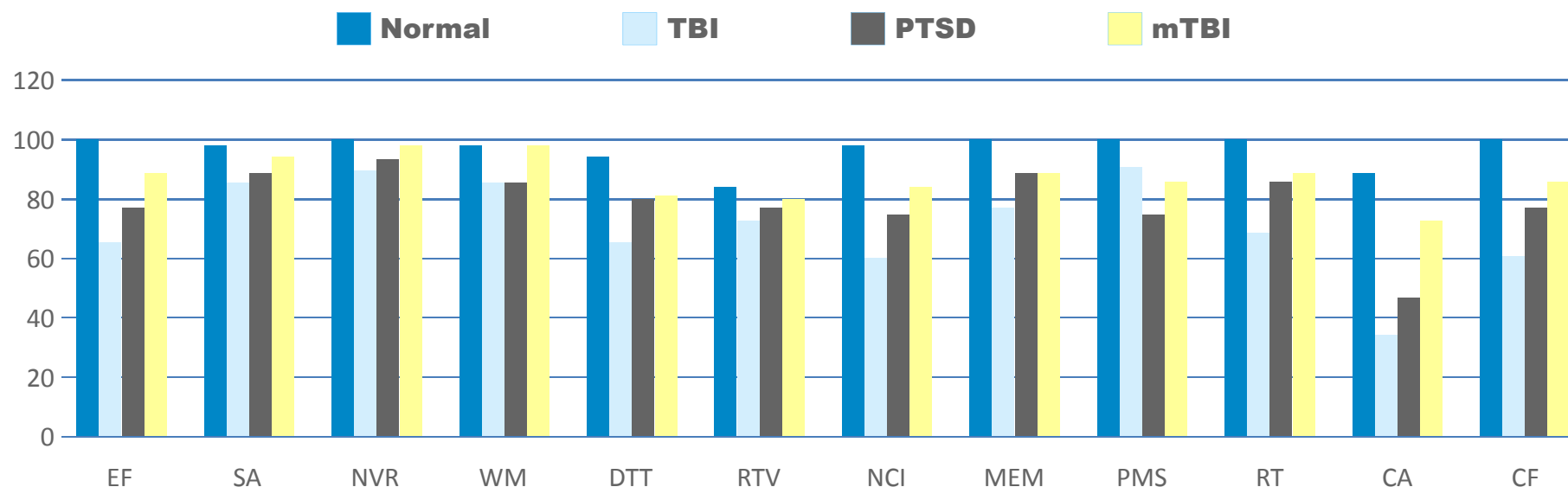
Legend: ■ Normal   ■ TBI   ■ PTSD   ■ mTBI

Categories: EF, SA, NVR, WM, DTT, RTV, NCI, MEM, PMS, RT, CA, CF

Source: ISCTM 2009; NEUROCOGNITIVE EVALUATION OF PATIENTS WITH TRAUMATIC BRAIN INJURIES; C Thomas Gualtieri MD, Sandeep Vaishnavi MD PhD; North Carolina Neuropsychiatry Clinics, Chapel Hill, Charlotte & Raleigh

CNS Vital Signs: TBI and PTSD

A NEURCOGNITIVE BATTERY FOR MBI: Logistic regression indicates that a model including measures of reaction time, executive function, psychomotor speed, memory and multitasking (dual task test) correctly classify 93% of the subjects (compared to normals). An appropriate MBI battery, therefore, might include tests of verbal and visual memory, finger tapping and coding, shifting attention and the Stroop test, and the dual task test. All of these tests are appropriate, as well, for the evaluation of patients with severe TBI.

NORMALS v MBI	Area	Asymptotic Sig	Effect Size
REACTION TIME	0.699	0.0169	0.48
PSYCHOMOTOR SPEED	0.676	0.0345	0.36
DUAL TASK TEST	0.673	0.0378	0.49
MEMORY	0.665	0.0480	0.50
WORKING MEMORY	0.664	0.0500	0.09
REACTION TIME VARIABILITY	0.655	0.0628	0.13
DUAL TASK %	0.653	0.0661	0.01
EXECUTIVE FUNCTION	0.646	0.0802	0.38
COGNITIVE FLEXIBILITY	0.642	0.0900	0.29
COMPLEX ATTENTION	0.610	0.1878	0.20
DUAL TASK CORRECT	0.595	0.2539	0.28
SOCIAL ACUITY	0.547	0.5732	0.12
NONVERBAL REASONING	0.495	0.9501	0.12

NMLS v PTSD	Area	Asymptotic Sig	Effect Size
PSYCHOMOTOR SPEED	0.787	0.0000	0.78
COGNITIVE FLEXIBILITY	0.730	0.0001	0.64
COMPLEX ATTENTION	0.729	0.0001	0.50
EXECUTIVE FUNCTION	0.729	0.0001	0.65
WORKING MEMORY	0.683	0.0017	0.62
DUAL TASK %	0.665	0.0047	0.56
DUAL TASK TEST	0.663	0.0052	0.52
MEMORY	0.646	0.0125	0.50
SOCIAL ACUITY	0.636	0.0196	0.46
REACTION TIME	0.626	0.0313	0.47
NONVERBAL REASONING	0.626	0.0313	0.45
DUAL TASK CORRECT	0.592	0.1164	0.35
REACTION TIME VARIABILITY	0.514	0.8154	0.35

The cognitive differences between normal Ss and patients with PTSD were more dramatic, and involved a wider number of tests and variables, suggesting a broader, non-specific effect on cognitive function.

MBI v PTSD	F	Sig.	Effect Size
WORKING MEMORY	6.93	0.0033	0.53
DUAL TASK TEST	5.16	0.0069	0.03
SOCIAL ACUITY	5.13	0.0119	0.35
NONVERBAL REASONING	4.13	0.0256	0.35
DUAL TASK %	3.08	0.0603	0.55
EXECUTIVE FUNCTION	2.48	0.1000	0.27
COGNITIVE FLEXIBILITY	1.77	0.1878	0.29
REACTION TIME	1.57	0.2247	0.03
PSYCHOMOTOR SPEED	1.40	0.2620	0.42
REACTION TIME VARIABILITY	1.23	0.3061	0.22
DUAL TASK CORRECT	0.79	0.4635	0.15
COMPLEX ATTENTION	0.64	0.5338	0.29
MEMORY	0.31	0.7385	0.02

When MBI patients are compared to PTSD patients, there are significant differences, for example in working memory, multitasking and social acuity, but the effect sizes are small.

Source: ISCTM 2009; NEUROCOGNITIVE EVALUATION OF PATIENTS WITH TRAUMATIC BRAIN INJURIES; C Thomas Gualtieri MD, Sandeep Vaishnavi MD PhD; North Carolina Neuropsychiatry Clinics, Chapel Hill, Charlotte & Raleigh

CNS Vital Signs: TBI and PTSD

DRUG SENSITIVITY: TBI patients are often treated with psycho-stimulant drugs for cognitive problems including inattention and cognitive slowing. A subset of 32 TBI patients who had sustained moderate or severe TBI were administered a test dose of psycho-stimulant, methylphenidate 0.3 mgm/kgm (max, 20 mgm). The "test dose" paradigm has been described (Psychiatry2005, 2, 44-53, 2005). Improvement tends to be seen in most domains.

The areas where improvement was likeliest to seen are measures of impulsive responding, executive function, complex attention, psychomotor speed and reaction time variability.

CONCLUSIONS:

1. The same broad-spectrum neurocognitive battery can be used to assess patients with mild and severe TBI or PTSD.
2. An appropriate battery, therefore, might include tests of verbal and visual memory, finger tapping and coding, shifting attention and the Stroop test, and the dual task test. Tests of attention and working memory might also be included in a long battery. An abbreviated battery should include the finger tapping and shifting attention tests.
3. Patients with PTSD score lower than MBI patients on virtually all cognitive tests (save memory) and almost as poorly as patients who have had moderate-to-severe TBIs.
4. It is not possible to reliably distinguish between MBI and PTSD patients simply on the basis of neurocognitive testing at a point in time. One would expect the former to improve over time, however, while the latter may not.
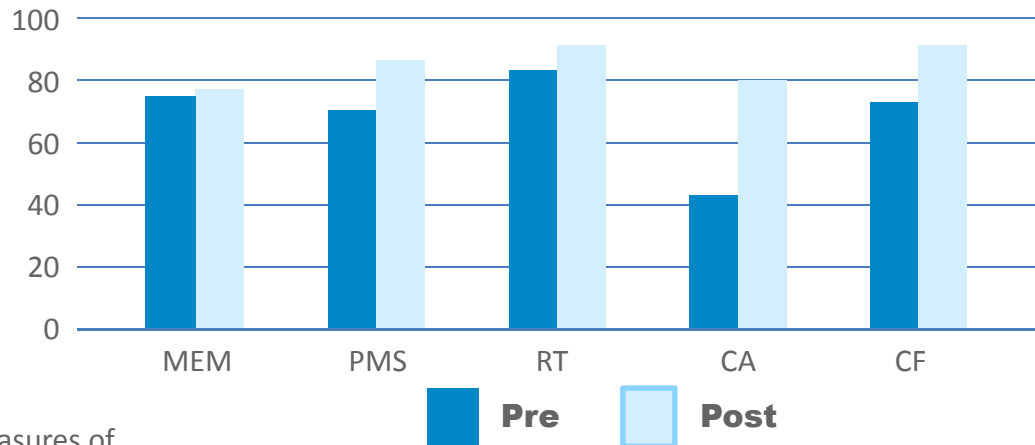
	d	F	
SATerr	0.62	4.29	impulsive responding
CF	0.58	5.69	executive function
PMS	0.56	5.19	psychomotor speed
STstERR	0.53	2.83	impulsive responding
STcRTsd	0.52	1.77	RT variability
CPTc	0.52	2.86	impulsive responding
STcERR	0.51	2.69	impulsive responding
CPTcomm	0.51	2.80	impulsive responding

Source: ISCTM 2009; NEUROCOGNITIVE EVALUATION OF PATIENTS WITH TRAUMATIC BRAIN INJURIES; C Thomas Gualtieri MD, Sandeep Vaishnavi MD PhD; North Carolina Neuropsychiatry Clinics, Chapel Hill, Charlotte & Raleigh

CNS Vital Signs Assessment

Brain injury / Stroke In-take, Neurocognitive Test Procedure, Evidence-Based Rating Scales

Establish a Baseline	Retest(s)	Surveillance
■ Rehab Intake ■ Concussion Program	■ Measure Progress ■ Document for Outcomes and/or Research	■ Measure Progress ■ Document for Outcomes and/or Research
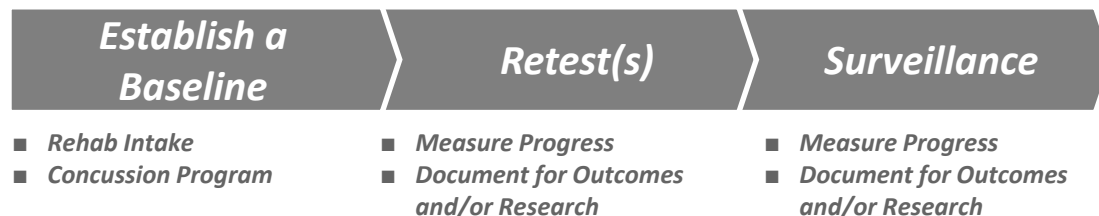
The CNS Vital Signs ADHD neurocognitive testing procedure takes 15 to 45 minutes depending on the number of neurocognitive tests that are selected. The assessment platform collects objective data on the patients neurocognitive performance e.g., executive function, complex attention, cognitive flexibility, etc. The testing results are immediately auto-scored and presented in easy to read and interpret reports.

Key Advantage

A key advantage to the VSX assessment platform is the autoscoring of embedded indicators of patient testing effort. As with all psychological and neuropsychological testing neuropsychiatric patients can feign their responses due to incentives such as academic accommodations. When analyzing test data, either in research, or in clinical practice, it is important to know whether a test result is valid or not. Clinicians need to know if testing subjects are generating "dubious results" or a "non-credible response pattern." CNS Vital Signs has developed "validity indicators" for its tests and domains that indicate whether the patient gave poor effort or generated invalid results. The Validity Indicator alerts the clinician to the possibility of an invalid test allowing the clinician, examiner or testing technician to question the testing subject: Do the testing results reflect an understanding of the test and the instructions? Did the testing subject put forth their best effort? Did they get a good night's sleep? Does the subject have poor vision and need their glasses?

Should a subject test abnormally low triggering an "invalid" test (NO as displayed in the Validity Indicator section of the report) then that would be a reason for retesting the individual, unless your clinical judgment makes you believe that is the best score the patient can achieve. Like any suspicious lab, the test should be re-administered, and it can be done with CNS Vital Signs through the RETEST function. Before Retesting, the test examiner or technician should reinforce the need for the subject to give a good testing effort and use the "Validity Indicator" as a tool to help with the reinforcement. To RETEST a subject go to MENU > RETEST SUBJECT > and select the appropriate subject and retest the subject. Upon retest, should a subject test abnormally low again triggering yet another "invalid" test (NO as displayed in the Validity Indicator section of the report) and the clinician believes it was the patient's best effort further evaluation or referrals should be considered.

CNS Vital Signs Assessment

Brain injury / Stroke In-take, Neurocognitive Test Procedure, Evidence-Based Rating Scales

The clinician generally integrates the VSX Test report with information from other in-take - assessment tools and the clinical evaluation to help guide the discussion on the level of impairment and the possible treatment strategies and plan. Longitudinal assessments can help tailor/optimize medications and track the patients condition and outcomes according to the chronic care model.

In-Take

The VSX TBI - Concussion Toolbox contains valid and reliable neurocognitive testing to rapidly assess individuals. These instruments can either be done remotely via CNSVS Online web-based assessment platform or in the clinic using a handheld e.g., iPad, Android or laptop computer.

NOTE: Brain and Behavioral Specialists – *CNS Vital Signs supports the specialist "Team Management" or "Center of Excellence" practice strategy. This is a way for specialist to provide support services to brain injury care practices. The CNS Vital Signs platform helps enable a seamless continuum of care.*

Neurocognitive Testing & TBI Rating Scales

The VSX TBI Toolbox/Test may be administered at the initial visit to help quantify the severity of deficits related to neurocognition. Objective neurocognitive testing data from the VSX report supplements information gathered through the CNS Vital Signs rating scales from parents, teachers and self-reports. The baseline VSX Test provides a foundation of objective information about the patients neurocognitive status and helps to guide the conversation about an individualized treatment plan and outcomes assessment

Follow-up Testing

Clinicians can use the CNSVS Online web-based assessment platform to collect follow-up rating scales to track symptoms and behaviors. Clinicians can also run a series of CNS Vital Signs neurocognitive assessments to help tailor (maximize neurocognition while minimizing dosage) or inform medication management to achieve greater clinical efficacy. The CNS Vital Signs assessment platform is used to evaluate progress toward goals and to help guide treatment planning.

About Computerized Neurocognitive Testing

The Benefits of Computerized Assessment of Neurocognition

CONCLUSIONS: *Beyond **ease of administration** and **data collection**, computer-based assessment offers benefits over paper-and-pencil measures in the **form of millisecond timing accuracy, reliable and randomized presentation of stimuli over multiple trials and repeat administrations**, and **unobtrusive measurement of cognitive skills and response times during all aspects of the assessment process**.*

Journal of Head Trauma Rehabilitation 2002 Oct;17(5):395-410

Computerized neurocognitive assessments have increasingly received recognition for use in the research and clinical setting. The American Psychological Association-APA recognized the value of computerized psychological testing and published guidelines in 1987, to assist in the development and interpretation of computerized test results. The APA identified six major benefits of computerized assessment including: (1) automated data collection and storage, (2) greater efficiency of use, (3) release of the clinician from test administration to focus on treatment, (4) greater sense of mastery and control for the client, (5) reduced negative self-evaluation among clients that experience difficulty on the computer and (6) greater ability to measure aspects of performance not possible through traditional means, such as latency, strength and variability in response patterns.

Source: APA (1987). Guidelines for computer based tests and interpretations. American Psychological Association.

Why Sports Concussion Management?

Second Impact Syndrome Case Study
E:60 explores Preston Plevretes' life after tragedy

- Public Health issue
- The Right Thing "To Do"
- State Legislation
- Athletic Mandates e.g. NCAA
- Tort Protection (Do You Have a PLAN? Did you Follow It?)

What is Needed?

- Valid & Reliable Tools
- Systematic Documentation
- Made Easier
- Made Affordable

Solutions for Measuring , Monitoring, and
Managing Neurocognitive and Behavioral Health
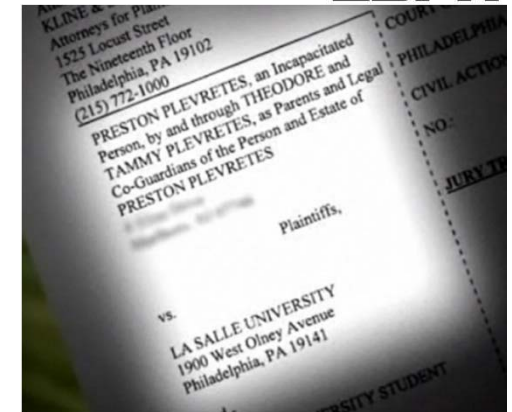
Why Concussion Vital Signs?

- **Athlete Health:** Concussions are sometimes referred to as the invisible injury and are not always easy to assess (like a sprained ankle or broken bone). Returning-to-play to soon after a first concussion can have devastating consequences e.g. second impact syndrome. *Concussion Vital Signs provides scientifically Valid & Reliable tools that can help assess a athletes status e.g., neurocognitive, symptoms, history, and sideline.*

- **New Advances:** Advancing medical knowledge has led to consensus guidelines supporting the proper management of sports related concussions (e.g., SCAT 2). *Concussion Vital Signs is optimized to assist every school and clinical practice in the longitudinal management of sports concussion.*

- **Risk Management:** Many state legislatures and sports governing bodies (e.g. NCAA) have passed mandates or guidelines related to the proper management of sports related concussions. *Concussion Vital Signs is optimized to assist every school and clinical practice in the compliance of sports concussion mandates, policies, and plans e.g. flexible and efficient assessment platform that enables a systematic documentation.*

- **The Right Thing To-Do:** *"…the new program is integral to protecting athlete safety… the online test measures verbal, visual, memory and psycho-motor speed. There is also a 5-minute response test that measures how quickly athletes respond to stimuli. Every athlete is tested before their seasons begin to establish a baseline… We had a student who suffered a head injury this year… I went through the sideline test with them and they did fine. Later, they took the online test and it revealed that reaction times were seriously affected. Without the test, a doctor may have cleared the athlete to play again immediately. With the test, the athlete's health was protected." Adapted from concussion article; Kansas ATC interview.*

- **Affordable:** *Concussion Vital Signs Un-Limited Testing (Baselines and Post-Injury) is included with each years affordable subscription.*

Helping to Assemble the Concussion Puzzle

Symptoms and History

Pocket SCAT2

The Pocket SCAT2 is a standardized method of evaluating injured athletes for concussion and can be used in athletes aged from 10 years and older.

Concussion should be suspected in the presence of **anyone or more** of the following: symptoms (such as headache), or physical signs (such as unsteadiness), or impaired brain function (e.g. confusion) or abnormal behavior.

Any athlete with a suspected concussion should be IMMEDIATELY REMOVED FROM PLAY, urgently assessed medically, should not be left alone and should not drive a motor vehicle.

Sideline

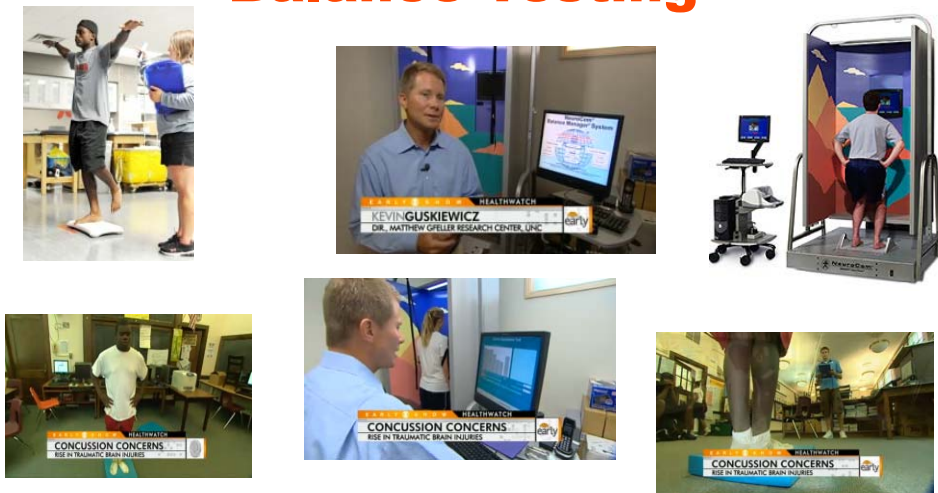*Baseline /Post-Injury*

Brain Function

Computerized Neuropsychological Tests
e.g. Concussion Vital Signs
Paper and Pencil
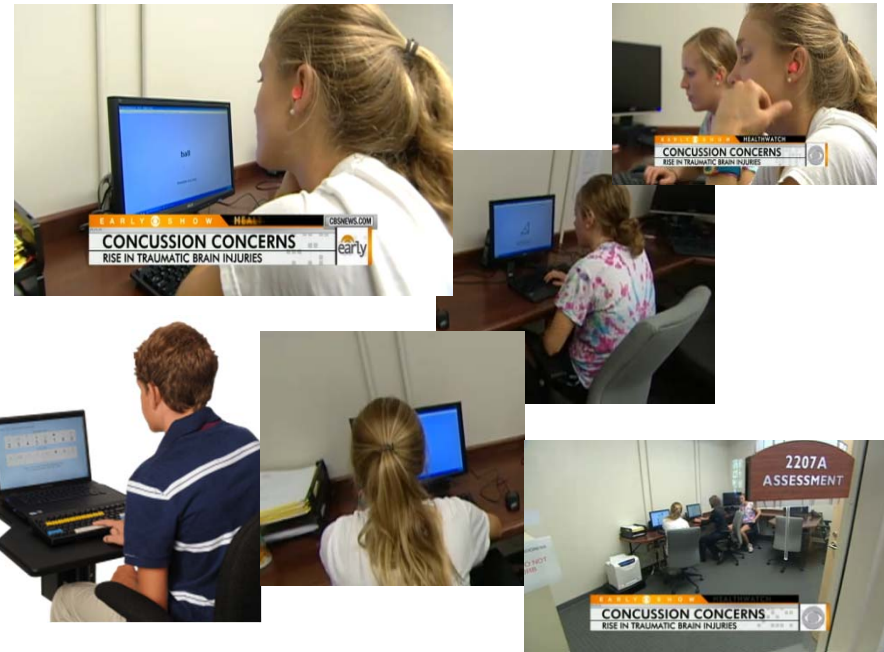
Balance Testing

Brain Structure
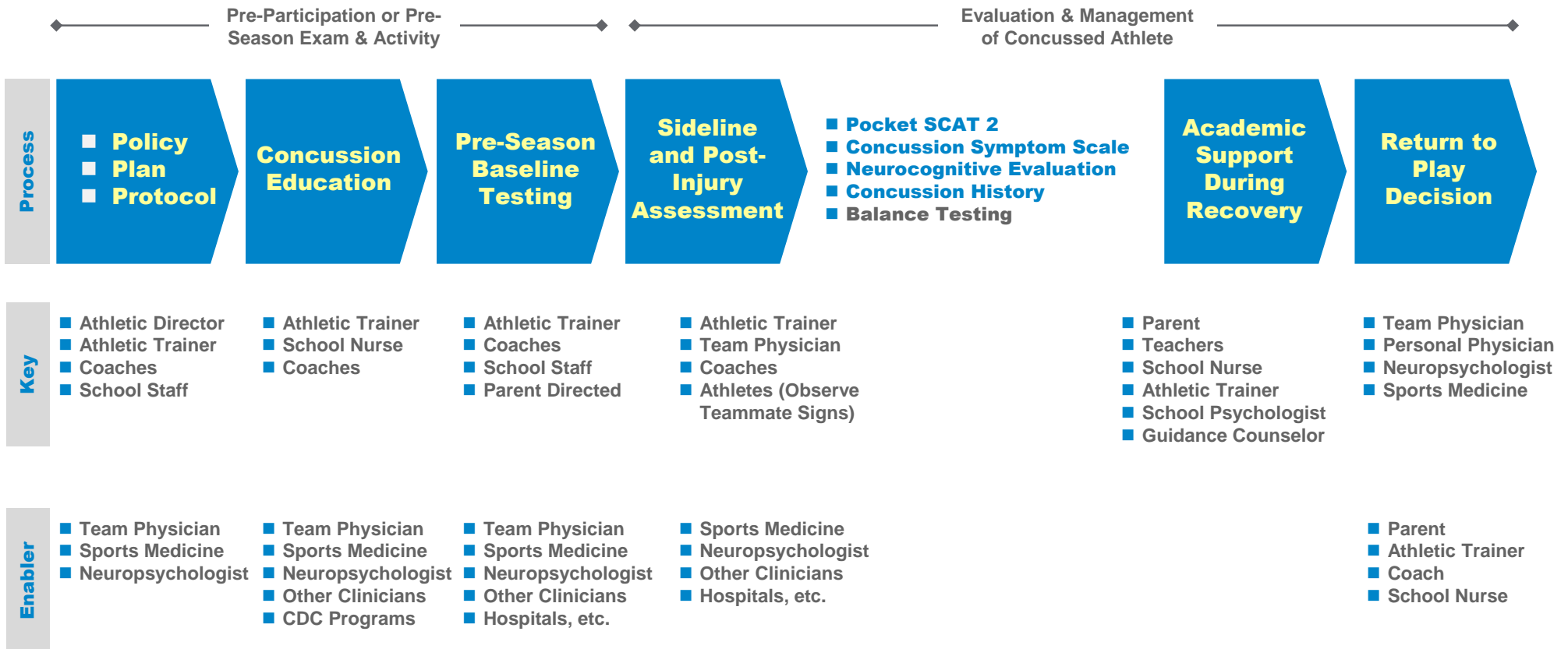
MRI - CT Scan

Lab Values

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

What is the Concussion Vital Signs Platform?

Student-Athlete Concussion Management

Pre-Participation or Pre-Season Exam & Activity → Evaluation & Management of Concussed Athlete

Process

| Policy · Plan · Protocol | Concussion Education | Pre-Season Baseline Testing | Sideline and Post-Injury Assessment | ■ Pocket SCAT 2 ■ Concussion Symptom Scale ■ Neurocognitive Evaluation ■ Concussion History ■ Balance Testing | Academic Support During Recovery | Return to Play Decision |

Key

■ Athletic Director ■ Athletic Trainer ■ Coaches ■ School Staff	■ Athletic Trainer ■ School Nurse ■ Coaches	■ Athletic Trainer ■ Coaches ■ School Staff ■ Parent Directed	■ Athletic Trainer ■ Team Physician ■ Coaches ■ Athletes (Observe Teammate Signs)		■ Parent ■ Teachers ■ School Nurse ■ Athletic Trainer ■ School Psychologist ■ Guidance Counselor	■ Team Physician ■ Personal Physician ■ Neuropsychologist ■ Sports Medicine

Enabler

■ Team Physician ■ Sports Medicine ■ Neuropsychologist	■ Team Physician ■ Sports Medicine ■ Neuropsychologist ■ Other Clinicians ■ CDC Programs	■ Team Physician ■ Sports Medicine ■ Neuropsychologist ■ Other Clinicians ■ Hospitals, etc.	■ Sports Medicine ■ Neuropsychologist ■ Other Clinicians ■ Hospitals, etc.			■ Parent ■ Athletic Trainer ■ Coach ■ School Nurse

Systematic Documentation of Relevant Clinical Endpoints to Help Make an Improved Return-to-Play Decision

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

Systematic Collection and Documentation of Relevant Clinical Endpoints
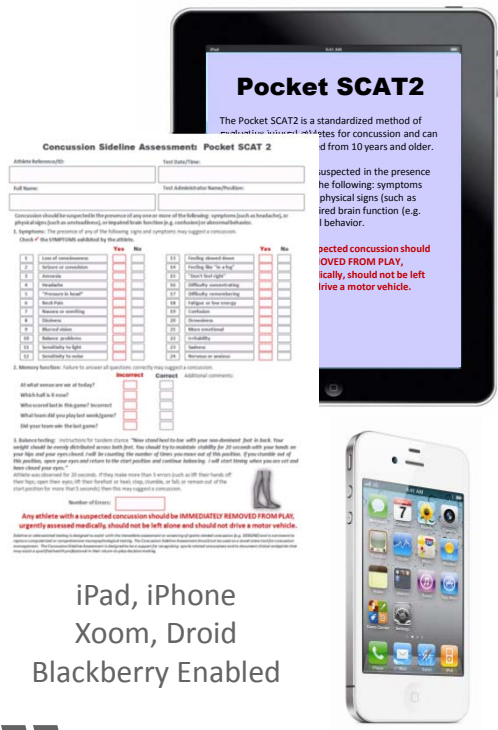
Pre-Season Baseline Testing

- **Neurocognitive Evaluation**
- **Concussion History**
- **Concussion Symptom Scale**
- Balance Testing

Sideline Assessment

- **Pocket SCAT 2**
- **Emergency Procedures e.g., Call 911**

iPad, iPhone
Xoom, Droid
Blackberry Enabled

Post-Injury Assessment

- **Rest Brain Until Concussion Symptom Free Using Concussion Symptom Scale**
- **After Symptom Free with Graduated Exercise then Re-administer the Neurocognitive Test**
- **Update Concussion History**
- Balance Testing

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

Concussion Vital Signs Test Report

Post-Concussion Example:
Second Retest
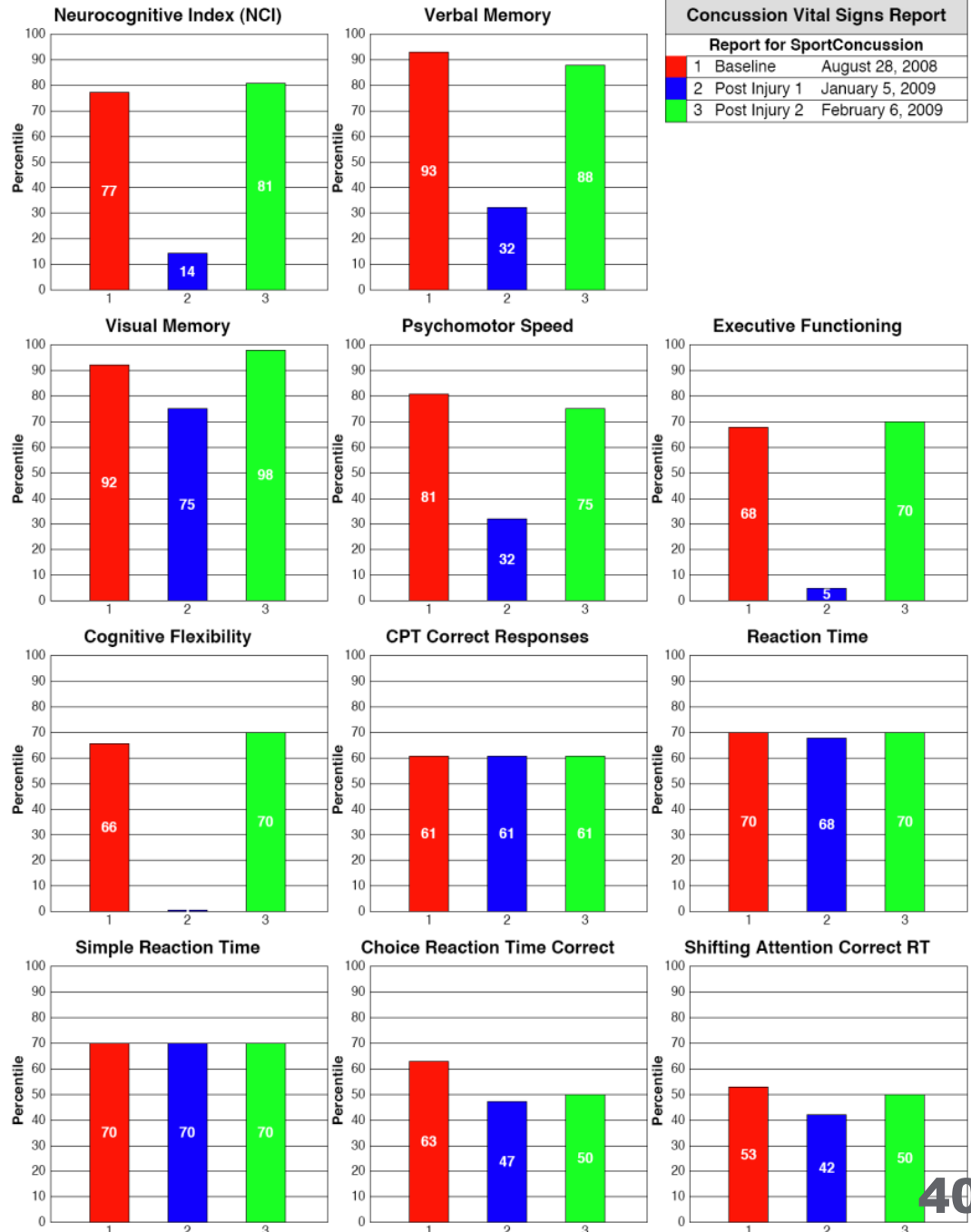
What is the Concussion Symptom Scale?

Post-Injury Concussion Symptom Scale	
Athlete Reference/ID: Symptom Scale Example	Test Date GMT: January 28, 2011 17:40:29
Full Name:	Age: 16
Administrator: Athletic Trainer	Language: English (United States)
Total Test Time: 2:14 (min:secs) for all tests in this report	Test Date Local: January 28, 2011 12:40:29
Testing Supervision: Unsupervised Testing	Testing Environment: Alone
This scale was administered using Concussion Vital Signs	

Rates how this symptom is currently experienced, Absent (0 - None) or Present (1 - Mild to 6 - Severe).

CSI - Symptoms*		Baseline (Jan 18, 2011)		Post-Injury	
		Absent	Present	Absent	Present
1	Headache	0			3
3	Nausea	0			1
5	Poor balance	0			2
6	Dizziness	0		0	
7	Fatigue or loss of energy	0			3
9	Drowsiness or feeling sleepy	0		0	
14	Feeling like "In-a-fog"	0		0	
15	Difficulty concentrating		3		2
16	Difficulty remembering		1		2
10	Sensitivity to light	0		0	
11	Sensitivity to noise	0		0	
17	Blurred vision		1		1
24	Feeling slowed down	0			0

Additional Concussion Symptoms**		Baseline (Jan 18, 2011)		Post-Injury	
		Absent	Present	Absent	Present
8	Difficulty falling or staying asleep	0		0	
12	Irritability, easily annoyed or frustrated	0			2
13	Sadness		2		1
2	Feeling numbness or tingling	0			4
18	Ringing in the ear	0		0	
19	Neck pain	0		0	
20	More Emotional	0		0	
21	Feeling Nervous	0		0	
22	Feeling anxious or tense		1	0	
23	Feeling Confused	0			1
4	Vomiting	0		0	

Do Symptoms get worse with Physical Activity: No
Do Symptoms get worse with Mental or Academic Activity: No

Acknowledgements: Concussion Vital Signs Symptom Scale contains a representative sample of well recognized sports concussion symptoms similar to those found in the CSI - Concussion Symptom Inventory, SCAT2, and the Neurobehavioral Symptom Inventory.
* (CSI) Concussion Symptom Inventory: An Empirically Derived Scale for Monitoring Resolution of Symptoms Following Sport-Related Concussion; Christopher Randolph, Scott Millis, William B. Barr, Michael McCrea, Kevin M. Guskiewicz, Thomas A. Hammeke, James P. Kelly; Archives of Clinical Neuropsychology 24 (2009) 219-229; Public Domain
** SCAT2 - Sport Concussion Assessment Tool 2: This tool has been developed by a group of international experts at the 3rd International Consensus meeting on Concussion in Sport held in Zurich, Switzerland in November 2008. British Journal of Sports Medicine, 2009, volume 43, supplement 1.
*** Neurobehavioral Symptom Inventory: Cicerone, KD: J Head Tr Rehabil 1995;10(3):1-17

Most Important?

- **Used in all Phases**
- **Graded** (1-Mild to 6- Severe)
- **CSI - Concussion Symptom Inventory**
- **SCAT 2**
- **Neurobehavioral Symptom Inventory**

What is the Concussion History?

CNSVS Concussion History (page 1 of 2)

Subject Reference/ID: athletetest	Test Date: October 29, 2010 14:33:19
Lastname, Firstname, MI: Public, John Q	Age: 27
Administrator: Athletic Trainer	Language: English (United States)
Total Test Time: 5:07 (min:secs) for all tests in this report	Test Date GMT: October 29, 2010 18:33:13
Testing Supervision: Supervised by athletic trainer or school personnel	Testing Environment: Group 2-5

This scale was administered using CNS Vital Signs

Demographic and Background Information - General Information

Height: 6 ft 5 in	Weight: 280 lbs
Sport Setting: High School	
Academic Year: Senior	Eligibility Year: 2011
Race: Caucasian	
Handedness: Right	Gender: Male
Native Language: English	
Second Language: Spanish	How Long? 2yrs

Demographic and Background Information - Education

Years of Education Completed (e.g. high school senior is 11 years): 11yrs

SAT (total): 1600 out of 2400

Received speech therapy:	No
Attended special education classes:	No
Repeated one or more years of school:	No
Diagnosed attention deficit disorder (ADD) or hyperactivity (ADHD):	Yes
Diagnosed learning disability:	Yes

Demographic and Background Information - Sports

Primary Sport: Football
Primary Sport Position: Defensive Lineman
Years you have played this primary sport at current level: 6
Total number of years you have played this primary sport: 8
Secondary Sport: Basketball
Secondary Sport Position: Center
Years you have played this secondary sport at current level: 8
Total number of years you have played this secondary sport: 10

Concussion & Medical History

Number of times diagnosed with a concussion: 2

Injury 1	
Approximate Date of Injury: October/1995	Days Lost: 6

Was this concussion sports related?	Yes
Did this concussion result in a loss of consciousness?	Yes
Did this concussion result in confusion?	No
Difficulty remembering events immediately before injury?	No
Difficulty remembering events immediately after injury?	Yes

Injury 2	
Approximate Date of Injury: September/1998	Days Lost: 8

Was this concussion sports related?	Yes
Did this concussion result in a loss of consciousness?	Yes
Did this concussion result in confusion?	Yes
Difficulty remembering events immediately before injury?	No
Difficulty remembering events immediately after injury?	Yes

Injury 3	
Approximate Date of Injury: /	Days Lost:

Was this concussion sports related?	
Did this concussion result in a loss of consciousness?	
Did this concussion result in confusion?	
Difficulty remembering events immediately before injury?	
Difficulty remembering events immediately after injury?	

Indicate whether you have experienced the following:

Treatment for headaches by physician:	No
Treatment for migraine headaches by physician:	No
Treatment for epilepsy/seizures:	No
History of brain surgery:	No
History of meningitis:	No
Treatment for Substance/alcohol abuse:	No
Treatment for psychiatric condition (depression, anxiety etc.):	Yes

Current Medications: adderall

Demographic and Background Information - Education
- Years of Education Completed (e.g. high school senior is 11 years):
- SAT - ACT (total):
- Received Speech Therapy:
- Attended Special Education Classes:
- Repeated One or More Years of School:
- Diagnosed Attention Deficit Disorder (ADD) or (ADHD):
- Diagnosed Learning Disability:

Demographic and Background Information - Sports
- Primary Sport:
- Primary Sport Position:
- Years you have played this primary sport at current level:
- Total number of years you have played this primary sport:
- Secondary Sport:
- Secondary Sport Position:
- Years you have played this secondary sport at current level:
- Total number of years you have played this secondary sport:

Concussion & Medical History
- Number of times diagnosed with a concussion:
- Injury 1 *(Up to 3 Injury's can be reported)*
- Approximate Date of Injury:
- Days Lost:
- Was this concussion sports related?
- Did this concussion result in a loss of consciousness?
- Did this concussion result in confusion?
- Difficulty remembering events immediately before injury?
- Difficulty remembering events immediately after injury?

Indicate whether you have experienced the following:
- Treatment for Headaches by Physician:
- Treatment for Migraine Headaches by Physician:
- Treatment for Epilepsy / Seizures:
- History of Brain Surgery:
- History of Meningitis:
- Treatment for Substance / Alcohol abuse:
- Treatment for Psychiatric Condition (depression / anxiety etc.):
- Current Medications:

Solutions for Measuring , Monitoring, and Managing Neurocognitive and Behavioral Health

NEXT STEPS:

Contact Us...

Getting Started

Step One: Register at www.CNSVS.com

After registering download the VSX 'Brief-Core' Assessment Software with 5 FREE Test Sessions... Take it for a test drive.

Step Two: *Schedule a FREE One-on-One In-Service Webinar...* Contact CNS Vital Signs Support support@cnsvs.com with dates and times that you will be available.

After the webinar the total CNS Vital Signs Assessment platform (Web & Local) can be configured to meet your practice needs.

Learn More

Contact me to receive report examples, case studies, administration guides etc.

- **Website: www.CNSVS.com**

- **Phone: 888.750.6941**

- **Email: support@cnsvs.com**

- **Address:**
  598 Airport Blvd.
  Suite 1400
  Morrisville, NC 27560

"The webinar training was terrific... it covered the Validity & Reliability of the platform, the interpretation of results, billing and coding, testing protocol, and the integration of the CNS Vital Signs platform into our practice." *Practice Administrator*