

AN OVERVIEW OF THE COMA RECOVERY SCALE-REVISED (CRS-R)

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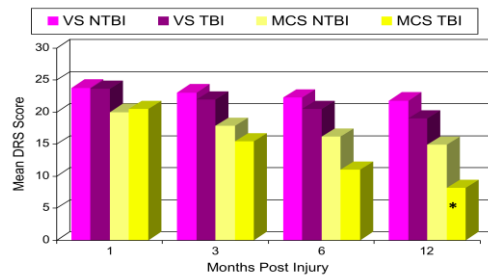
Why is accurate diagnostic assessment important?

Incidence of diagnostic error

- 37% (Childs et al, *Neurol*, 1993)
 - 43% (Andrews et al, *BMJ*, 1996)
- ↓
- 41% (Schnakers et al, *Brain Injury*, 2008)

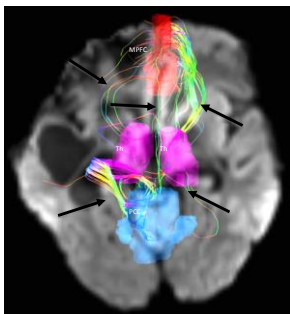
Outcome from VS and MCS at 1 Year

VS = 54; MCS = 49; Mixed etiology; Mean time post-injury = 9 wks



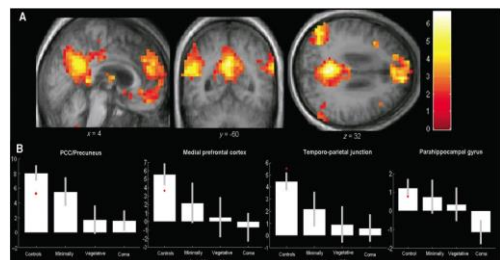
(Giacino & Kalmar, *J Head Trauma Rehabil*, 1997)

Structural connectivity: MCS > VS



Edlow, et al., *Neurocrit Care*, 2013

Functional connectivity: MCS > VS and Coma



Vanhaudenhuyse, et al., *Brain*, 2010

Coma Recovery Scale- Revised

JFK COMA RECOVERY SCALE - REVISED													
Brief Form													
This form should only be used in assessment of patients who have a diagnosis of persistent and profound COMA. It should not be used for patients with other diagnoses.													
Name:	Date of Admission:												
Date of Onset:	Date of Assessment:												
1. Auditory Function Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
2. Visual Function Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
3. Motor Function Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
4. Verbal Function Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
5. Arousal Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
6. Reflex Function Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
7. Communication Scale	1	2	3	4	5	6	7	8	9	10	11	12	13
8. Total Score	1	2	3	4	5	6	7	8	9	10	11	12	13

Indications

- Differential diagnosis
- Establish prognosis
- Monitor rate of recovery
- Promote inter-rater reliability/ Facilitate multidisciplinary treatment planning
- Evaluate efficacy of treatment interventions
- Alert to sub-clinical changes
- Project disposition needs

(Giaccino, et al Arch Phys Med Rehabil, 2004.)

CRS-R: Descriptive Characteristics

- | | |
|---------------------------|--|
| Scale Type: | Interval |
| Target Population: | Coma, VS, MCS |
| Assessment Areas: | Auditory (4)
Visual (5)
Motor (6)
Oromotor/Verbal (3)
Communication (2)
Arousal (3) |
| Organizational Structure: | Lowest Item – Reflexive
Highest Item – Cognitively-Based |
| Administration Time: | 15-30 mins |

CRS-R Psychometric Characteristics

The JFK Coma Recovery Scale-Revised: Measurement Characteristics and Diagnostic Utility
Joseph T. Giacino, PhD, Barbara Baker, PhD, John Wray, MD, PhD

This study was designed to evaluate the measurement characteristics and diagnostic utility of the JFK Coma Recovery Scale-Revised (CRS-R) in a sample of patients with persistent and profound coma. The study included 100 patients who were assessed on the CRS-R and other measures of consciousness and brain function. The results of the study are presented below.

Measurement Characteristics: The CRS-R demonstrated excellent reliability and validity. The internal consistency reliability of the CRS-R was 0.92. The test-retest reliability of the CRS-R was 0.88. The construct validity of the CRS-R was supported by the results of the study. The CRS-R was found to be a valid measure of consciousness and brain function.

Diagnostic Utility: The CRS-R was found to be a useful tool for the diagnosis of persistent and profound coma. The CRS-R was found to be a valid measure of consciousness and brain function. The CRS-R was found to be a useful tool for the diagnosis of persistent and profound coma.

ACRM Archives of Physical Medicine and Rehabilitation

CRS-R: Can We Scientifically and Reliably Measure the Level of Consciousness in Vegetative and Minimally Conscious States? Back Analysis of the Coma Recovery Scale-Revised

Table 1. Results of the Back Analysis of the CRS-R

The results of the back analysis of the CRS-R are presented in Table 1. The table shows the results of the back analysis for each item on the CRS-R. The results show that the CRS-R is a valid measure of consciousness and brain function.

General CRS-R Administration and Scoring Guidelines

CRS-R Protocol

Pre-Assessment

1. Chart Review/Consultation with Treating MD
2. Baseline Observation
3. Arousal Facilitation Protocol
4. Brainstem Reflex Assessment

Primary Assessment

5. CRS-R Subscales

Chart Review/Consultation with Treating MD

Purpose

- Ensure examination is not medically contraindicated (eg, elevated ICP, fever).
- Identify and document use of sedative and paralytic agents.
- Recognize local trauma (e.g. fractures, contusions, lacerations, and decubiti), internal lines, implanted devices or other injury sequelae that may necessitate modification of examination procedures.

Baseline Observation

Purpose

- Determine level of arousal.
- Facilitate selection of appropriate commands.
- Help differentiate volitional from random/incidental movement.

Baseline Observation & Command-Following Protocol

1 minute baseline observation period

- Observe:
- Eye opening status.
 - Presence or absence of spontaneous visual fixation or tracking.
 - Type and frequency of spontaneous movement.
 - Resting posture of the extremities.

Commands	Baseline	1	2	3	4
		1	2	3	4
I. Object Related Commands					
A. Eye Movement Commands					
Look at the object (R)					
Look at the object (L)					
B. Limb Movement Commands					
Touch the nose (upper R)					
Touch the nose (upper L)					
Touch the nose (lower R)					
Touch the nose (lower L)					
Touch the hand (upper R)					
Touch the hand (upper L)					
Touch the hand (lower R)					
Touch the hand (lower L)					
Touch your nose from your right/shoulder point					
II. Non-Object Related Commands					
A. Eye Movement Commands					
Look back from me					
Look out of window					
Look down (at feet)					
B. Limb Movement Commands					
Touch to head					
Touch your nose from your right/shoulder point					
C. Object Movement/Verbalization Commands					
Bring out your tongue					
Open your mouth					
Close your mouth					
Say "Hi"					
Spontaneous Eye Opening: Yes No					
Spontaneous Head Turning: Yes No					
Resting Posture					
None					
R/L/E					
L/R/E					
L/R/E					

Arousal Facilitation Protocol

GUIDELINES
1) The goal of this intervention is to prolong the length of time the patient maintains arousal (i.e. eye opening)
2) The protocol is administered anytime the patient is observed to: - Exhibit sustained eyelid closure AND/OR - Steps following commands for a period of at least one minute
3) Readminister the arousal facilitation protocol when: - Sustained eye closure re-occurs OR - Behavioral responsiveness ceases despite sustained eye opening

INTERVENTIONS
Deep Pressure:
1) Present deep pressure stimulation unilaterally to the face, neck, shoulder, arm, hand, chest, back, leg, foot, and toes. The muscle should be firmly grasped at its base between the thumb and forefinger. While squeezing the muscle firmly, it should be "rolled" back and forth through the finger tips three to four times. This procedure should be repeated sequentially working from the facial musculature to the toes. The examiner should assure that there are no internal lines, focal injuries (e.g., fractures, contusions, decubiti) or systemic complications (e.g., heterotopic ossification) before administering deep pressure.
2) Administer same on contralateral side.

Brain Stem Reflex Assessment

- Purpose
 - Determine level of brain dysfunction to assist with prognosis
 - Assist with interpretation of CRS-R findings

Patient	Date				
Pupillary Light	Reactive				
	Eq:ax				
	Constricted				
	Accommodation				
Corneal Reflex	Asympt				
	Present Unilateral				
	Present Bilateral				
Spontaneous Eye Movements	None				
	Sluggish Deviation				
	Conjugate Gaze Deviation				
	Roving				
Oculocephalic Reflex	None				
	Anocving				
	Full				
Focustar Postures (Indicate Limb)	Abnorm Extension				
	Abnorm Flexion				

CRS-R Primary Assessment

Auditory Function Subscale

Score	Item	Method	Response
1	Cane frequency administered monaurally for 10 seconds. Visual feedback provided on compliance. (Passive/Probe on page 7)	None	Clear, consistent and purposeful response to the sound in the presence of the probe.
		Minimal	This item is intended only when the response is purposeful and consistent.
		None	None
2	Cane frequency administered monaurally for 10 seconds. Visual feedback provided on compliance. (Passive/Probe on page 7)	None	Clear, consistent and purposeful response to the sound in the presence of the probe.
		Minimal	This item is intended only when the response is purposeful and consistent.
		None	None
3	Cane frequency administered monaurally for 10 seconds. Visual feedback provided on compliance. (Passive/Probe on page 7)	None	Clear, consistent and purposeful response to the sound in the presence of the probe.
		Minimal	This item is intended only when the response is purposeful and consistent.
		None	None

Score	Item	Method	Response
1	Auditory device	None	Clear, consistent and purposeful response to the sound in the presence of the probe.
		Minimal	This item is intended only when the response is purposeful and consistent.
		None	None
2	None	None	Clear, consistent and purposeful response to the sound in the presence of the probe.
		Minimal	This item is intended only when the response is purposeful and consistent.
		None	None

Visual Function Subscale

Score	Item	Method	Response
4	Object Recognition	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object.
3	Object Location	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's location.
2	Object Identification	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's name.
1	Object Description	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly describes the object's features.
0	None	See above	No response or an incorrect response.

Motor Function Subscale

Score	Item	Method	Response
4	Functional Object Use	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly uses the object for its intended purpose.
3	Object Manipulation	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly manipulates the object.
2	Object Identification	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's name.
1	Object Description	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly describes the object's features.
0	None	See above	No response or an incorrect response.

Score	Item	Method	Response
4	Object Manipulation	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly manipulates the object.
3	Object Identification	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's name.
2	Object Description	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly describes the object's features.
1	Object Manipulation	Present the examinee with a functional object (e.g., a pencil) and observe the examinee's response. Record the response as correct or incorrect.	Correctly manipulates the object.
0	None	See above	No response or an incorrect response.

Oromotor/Verbal Function Subscale

Score	Item	Method	Response
4	Object Recognition	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object.
3	Object Location	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's location.
2	Object Identification	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly identifies the object's name.
1	Object Description	Place an object on a table in front of the examinee or hold it in the examinee's hand. Observe the examinee's response. Record the response as correct or incorrect.	Correctly describes the object's features.
0	None	See above	No response or an incorrect response.

Communication Subscale

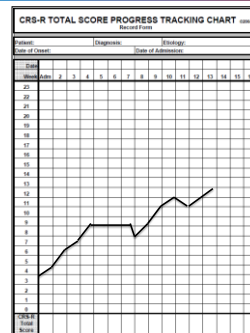
Score	Item	Method	Response
4	Functional Accurate	Administer the Situational Orientation Protocol and the Communication Assessment Protocol. Record the response as correct or incorrect.	Correctly communicates information.
3	Functional Inaccurate	Administer the Situational Orientation Protocol and the Communication Assessment Protocol. Record the response as correct or incorrect.	Incorrectly communicates information.
2	Non-Functional: Intentional	Administer the Situational Orientation Protocol and the Communication Assessment Protocol. Record the response as correct or incorrect.	Intentionally communicates incorrect information.
1	Non-Functional: Unintentional	Administer the Situational Orientation Protocol and the Communication Assessment Protocol. Record the response as correct or incorrect.	Unintentionally communicates incorrect information.
0	None	See above	No response or an incorrect response.

COMMUNICATION ASSESSMENT PROTOCOL						
Situational Orientation			Aural Ability			
Visual Based						
Am I touching my ear right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Am I touching my nose right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Am I touching my nose right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Am I touching my ear right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Am I touching my nose right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Am I touching my ear right now? (DO NOT SAY)			Am I clapping my hands right now? (DO NOT SAY)			
Date			Date			
Score			Score			
0 of 6	0 of 6	0 of 6	0 of 6	0 of 6	0 of 6	0 of 6
Date			Date			
Score			Score			
0 of 6	0 of 6	0 of 6	0 of 6	0 of 6	0 of 6	0 of 6

Arousal Subscale

Score	Item	Method	Response
3	Attention	Observe the examinee's response to the attention protocol. Record the response as correct or incorrect.	Correctly responds to the attention protocol.
2	Eye-Opening with Distraction	Observe the examinee's response to the eye-opening protocol with distraction. Record the response as correct or incorrect.	Correctly responds to the eye-opening protocol with distraction.
1	Eye-Opening with Distraction	Observe the examinee's response to the eye-opening protocol with distraction. Record the response as correct or incorrect.	Incorrectly responds to the eye-opening protocol with distraction.
0	Unresponsive	See above	No response or an incorrect response.

CRS-R Progress Tracking Chart



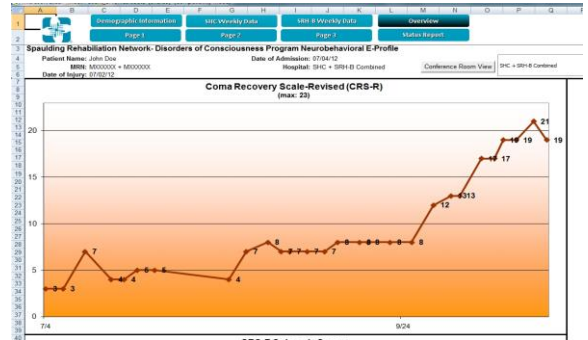
Scoring Guidelines

- Scoring criteria for each item outlined in CRS-R Administration and Scoring Manual
- Responses scored as present/absent
- Only *elicited* responses are scored (spontaneous behavior can be noted but not scored unless otherwise indicated)
- Responses that occur after a 10 second interval has elapsed are not scored.
- Best response scored within each subscale
- Equivocal responses are not credited

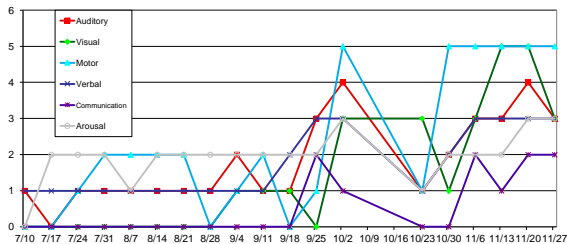
CRS-R Discontinuation Criteria

- Three consecutive examinations on which the following subscale profile is obtained:
 - *Auditory subscale score = 5*
(Consistent command-following)
 - *Communication subscale score = 2*
(Reliable communication)
 - *Arousal subscale score = 3*
(Sustained attention)

CRS-R Total Score and Subscale Analysis



CRS-R Subscale Scores



Sensitivity and Specificity of the Coma Recovery Scale-Revised Total Score in Detection of Conscious Awareness

Bodien Y. C. Carlowicz, Chastelle C. Giacino, J. Arch Phys Med Rehabil, in press

Background

Patients emerging from coma after severe traumatic brain injury (TBI) often remain unaware of their surroundings. The Coma Recovery Scale-Revised (CRS-R) is a standardized assessment of consciousness. This study aimed to determine the sensitivity and specificity of the CRS-R total score in detecting consciousness in patients with TBI.

Results

CRS-R Total Score	Sensitivity	Specificity
3	0.57	0.53
4	0.58	0.78
5	0.80	0.93
6	0.91	0.94
7	0.92	0.97
8	0.93	0.97
9	0.93	0.97
10	0.93	0.97
11	0.93	0.97
12	0.93	0.97
13	0.93	0.97
14	0.93	0.97
15	0.93	0.97
16	0.93	0.97
17	0.93	0.97
18	0.93	0.97
19	0.93	0.97
20	0.93	0.97
21	0.93	0.97

Conclusions

A total CRS-R score of 10 or higher provides strong evidence of conscious awareness but resulted in a false-negative diagnosis score in 20% of cases. A cut-off score of 8 provides the best balance between sensitivity and specificity, accurately classifying 92% of cases. The "optimal" total score cut-off will vary depending on the user's objectives.

Methods

Data were retrospectively extracted from the medical records of patients enrolled in a specialized Unit of Consciousness (UoC) program. Sensitivity and specificity analyses were conducted using CRS-R-derived diagnoses of Minimum Conscious State (MCS) or Emergent from Minimal Conscious State (EMCS) as the reference standard for conscious awareness and the total CRS-R score as the "test criterion".

References

(Bodien Y, C Carlowicz, Chastelle C, Giacino J, Arch Phys Med Rehabil, in press)

08/12/98

5

Detection and interpretation of impossible and improbable CRS-R scores

Aims:

1. To provide clinicians and researchers with an empirically-derived tool for assessment of CRS-R data quality.
2. To detect differential involvement of specific neural circuits (eg, M5-A2) for use in prognostic assessment and treatment planning.

(Chatelle C, Bodien Y, Carlowicz C, Laureys S, Seel R, Giacino J. Arch Phys Med Rehabil, in press)

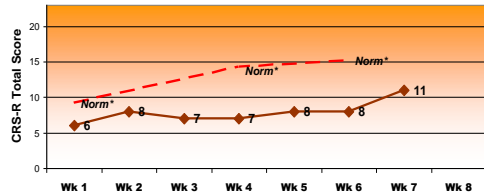
Differential Diagnosis

JFK COMA RECOVERY SCALE - REVISED <small>©2004</small>	
This form should only be used in conjunction with the "CRS-R ADMINISTRATION AND SCORING GUIDELINES" which provide instructions for standardized administration of the scale.	
Patient:	Diagnosis:
Date of Onset:	Date of Admission:
Site:	Week:
Week:	2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
REGISTRY FUNCTION SCALE	
1) Conscious Movement to Command *	
2) Responsiveness to Command *	
3) Localization to Sound *	
4) Auditory Verbal *	
VISION FUNCTION SCALE	
1) Object Recognition *	
2) Object Location Recognition *	
3) Visual Tracking *	
4) Visual Form *	
5) Visual Size *	
6) Color *	
HEARING FUNCTION SCALE	
1) Functional Object Use *	
2) Auditory Motor Programs *	
3) Object Manipulation *	
4) Localization to Acoustic Stimulation *	
5) Verbal Response *	
6) Place on Worksheet *	
ORBITAL/UNIVERSAL FUNCTION SCALE	
1) Single Object Location *	
2) Identification of Movement *	
3) Object Location Recognition *	
COMMUNICATION SCALE	
1) Functional Awareness *	
2) Oral Functional/Behavioral *	
AROUSAL SCALE	
1) Arousal *	
2) Eye Opening with Stimulation *	
3) Eye Opening with Stimulation *	
4) Spontaneous Eye Opening *	
TOTAL SCORE	
Score: _____	
Denote impossible item(s): _____	
Denote score: _____	

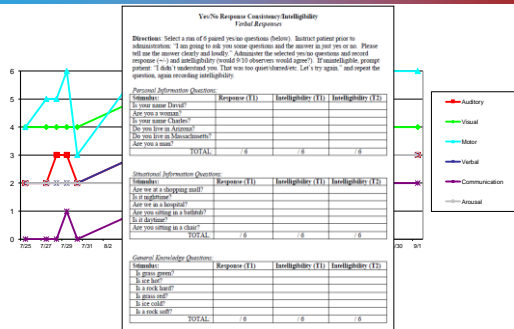
CRS-R Applications in Clinical Practice

Prognosis (Rate of recovery)

Coma Recovery Scale Revised (CRS-R) (max: 23)

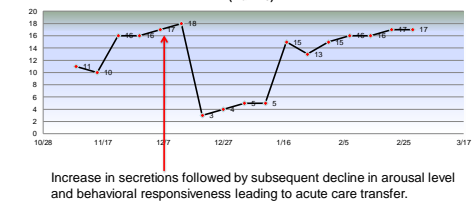


Facilitate Rehab Treatment Planning



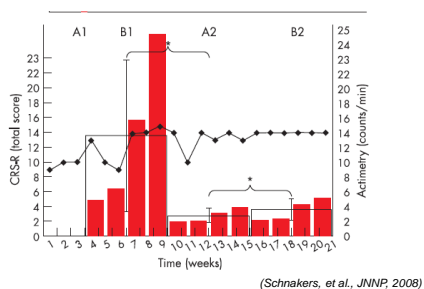
Alert to complications

Coma Recovery Scale-Revised (CRS-R) (max: 23)



Increase in secretions followed by subsequent decline in arousal level and behavioral responsiveness leading to acute care transfer.

Monitor response to treatment



Website addresses for the CRS-R

NINDS: <http://www.commondataelements.ninds.nih.gov/CDE.aspx>

COMBI: <http://www.tbims.org/combi/crs/index.html>

Spaulding-Harvard TBI Model System: www.SH-TBIMS.org