

Assessment and Rehabilitation of the Minimally Conscious Patient

Jay H. Rosenberg, MD

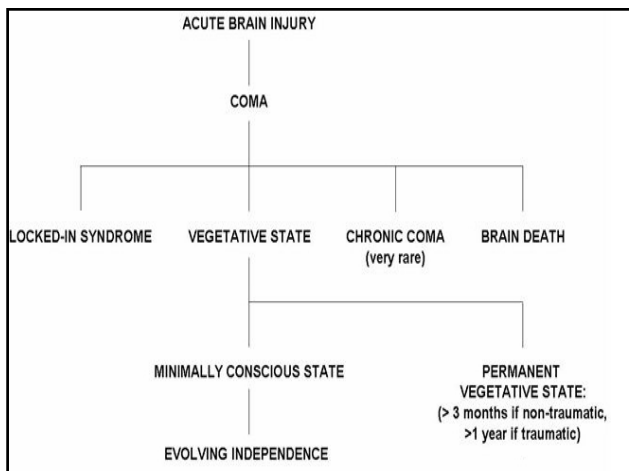
Coma and Altered States of Consciousness: Intervention Strategies For Health Professionals

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Acute Brain Injury

- Etiology of Acute Brain Injury
 - Traumatic
 - Metabolic
- Survivors of severe brain damage:
 - Progress through different clinical entities before partially or fully recovering consciousness



Definitions: Coma

- **Coma is a prolonged period of unconsciousness.** (>30-60 Minutes)
- Unconsciousness is the lack of appreciation of (or reaction to) a stimulus.
- Coma differs from sleep in that one cannot be aroused from a coma.

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Coma involves two different concepts:

1.) Reactivity

2.) Perceptivity

Reactivity:

- Reactivity refers to the innate (or inborn) functions of the brain:
 - The telereceptors (eyes and ears),
 - The nociceptors (responses to pain),
 - The arousal reaction (wakefulness),
 - The orienting response (turning one's head toward the source of sound or movement).

Perceptibility

Perceptivity refers to:

- The responses of the nervous system to stimuli, which have been learned or acquired:
 - language,
 - communication skills,
 - individual methods of movement such as gestures,
- To less complex learned or acquired reactions such as:
 - flinching when threatened
 - can also think of these as conscious movements.

COMA

A person in a coma does not exhibit reactivity or perceptivity. He/she can not be aroused by calling his/her name or in response to pain.

A comatose patient will never open the eyes even when intensively stimulated. The patient lacks the spontaneous periods of wakefulness and eye opening induced by Stimulation.

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Domains of GCS

- Best Eye Response
- Best Motor Response
- Best Verbal Response

GCS

Best Eye Response (4)

1. No eye opening
2. Eye opening to pain
3. Eye opening to verbal command
4. Eyes open spontaneously

GCS

Best Verbal Response (6)

1. No verbal response
2. Incomprehensible sounds
3. Inappropriate words
4. Confused
5. Orientated
6. Obeys commands

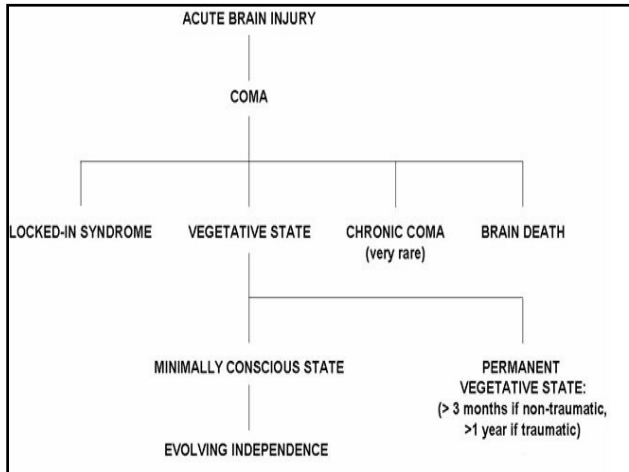
GCS

Best Motor Response (5)

1. No motor response
2. Stereotyped extension to pain
3. Stereotyped flexion to pain
4. Withdrawal from pain
5. Localizing pain

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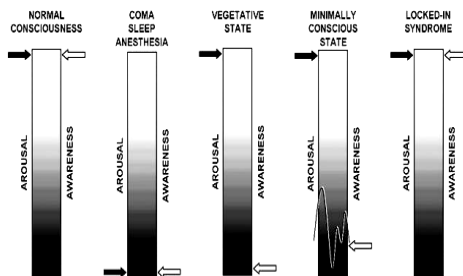


Brain death

The concept of brain death as defining death is largely accepted

- The clinical assessments for brain death are very uniform and based on the loss of all brainstem reflexes .
- The American Academy of Neurology guideline for the diagnosis of brain death represents a standard of care for the United States.
- There should be an evident cause of coma and confounding factors should be excluded.
- A repeat evaluation in 6h is advised (time period is considered arbitrary)

Two components of consciousness (arousal and awareness) and their alterations in coma, the vegetative state, the minimally conscious state and in the locked-in syndrome



Vegetative State (VS)

- After a period of 2 to 4 weeks, the patient develops sleep wake cycles with opening of the eyes.
- Patients in a vegetative state are awake but are unaware of self or of the environment

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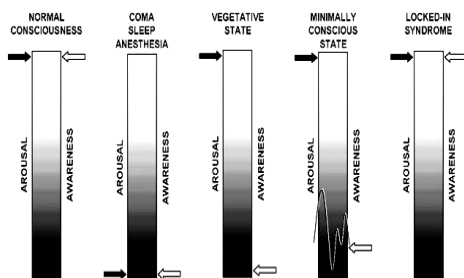
Criteria for the vegetative state (US Multi-Society Task Force on Persistent Vegetative State guidelines)

- No evidence of awareness of self or environment and an inability to interact with others
- No evidence of sustained, reproducible, purposeful, or voluntary behavioral responses to visual, auditory, tactile, or noxious stimuli
- No evidence of language comprehension or expression
- Intermittent wakefulness manifested by the presence of sleep-wake cycles
- Sufficiently preserved hypothalamic and brainstem autonomic functions to permit survival with medical and nursing care
- Bowel and bladder incontinence
- Variably preserved cranial-nerve and spinal reflexes (Eye blink is a reflex)

Prognosis of the VS

- Metabolic Causes:
 - VS > 3 months = **Permanent**
- Traumatic Causes:
 - If VS persists beyond 12 months it is highly unlikely that the patient will recover and the VS can be determined to be **Permanent**

Two components of consciousness (arousal and awareness) and their alterations in coma, the vegetative state, the minimally conscious state and in the locked-in syndrome



Minimally Conscious State (MCS)--
Patients above the vegetative state but unable to communicate consistently

Clearly discernible evidence of consciousness of self or environment, on an inconsistent but reproducible or sustained basis. Must demonstrate at least 1 of the following behaviors:

- (1) following simple commands,
- (2) gestural or verbal yes/no response (regardless of accuracy),
- (3) intelligible verbalization,
- (4) purposeful behavior (including movements or affective behavior that occur in contingent relation to relevant environment stimuli and are not due to reflexive activity—use of a comb).

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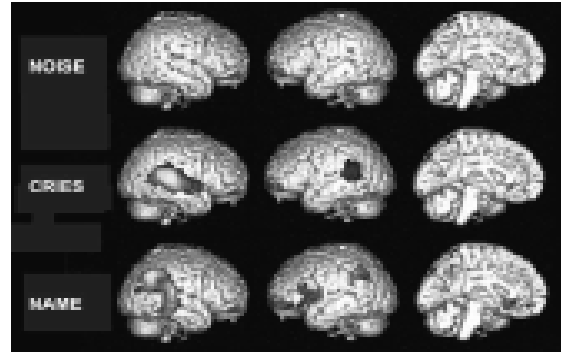
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Neuroimaging Regional Blood Flow Studies



1. (a): brain areas showing an increase in regional cerebral blood flow during auditory stimulation in controls. (b) and (c): areas of increase of rCBF during auditory stimulation that are common to controls and respectively MCS patients (b) and VS patients (c). Results are projected on a coronal section of a normalised brain MRI template, 28 mm posterior to the anterior commissural line

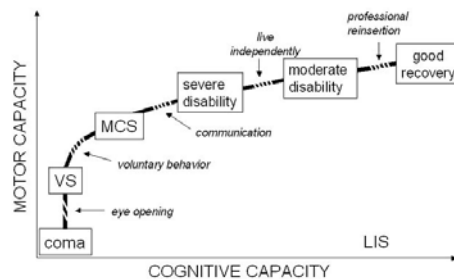
Pet Scanning in Response to Voice in MCS



Potential Treatments

- Amantadine
- Zolpidem (Ambien)
- Deep Brain Stimulation
- Acute and Subacute Rehabilitation with ST, OT, and PT

Emergence from the minimally conscious state--
defined by the ability to use functional interactive communication or functional use of objects consistently



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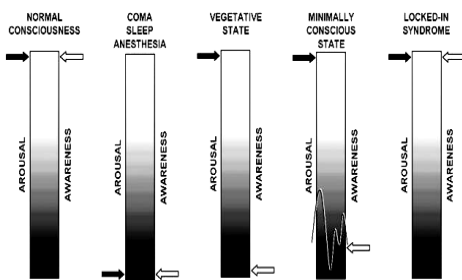
Glasgow Outcome Scale

- **Moderate disability**
 - Severely disabled until return of autonomy
- **Good recovery**
 - Return to work or school determines the transition to (clinical evaluation of cognition depends upon motor responsiveness).

Rancho Los Amigos Scale Outcome Scale

- I No response
- II Generalized response
- III Localized response
- IV Confused-Agitated
- V Confused-Inappropriate, Non-Agitated
- VI Confused-Appropriate
- VII Automatic-Appropriate
- VIII Purposeful-Appropriate

Two components of consciousness (arousal and awareness) and their alterations in coma, the vegetative state, the minimally conscious state and in the locked-in syndrome



Locked-in syndrome (LIS)

The extreme example of intact cognition with early complete motor deficit (only permitting eye-coded communication).

- Patients who are awake and conscious but have no means of producing speech, limb, or face movements.
- Eye-coded communication and evaluation of cognitive and emotional functioning is very limited because vigilance is fluctuating and eye movements may be inconsistent, very small, and easily exhausted

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Criteria for LIS as defined by Plum and Posner

- The presence of sustained eye opening (bilateral ptosis should be ruled out as a complicating factor)
- Preserved awareness of the environment
- Aphonia or hypophonia
- Quadriplegia or quadriparesis
- Primary mode of communication that uses vertical or lateral eye movement or blinking of the upper eyelid to signal **yes/no** responses

Classification of LIS

- The Locked-in syndrome can be divided into three categories
 - (a) **Classical LIS** is characterized by quadriplegia and anarthria with preserved consciousness and vertical eye movement or blinking;
 - (b) **Incomplete LIS** permits remnants of voluntary motion other than vertical eye movement; and
 - (c) **Total LIS** consists of complete immobility including all eye movements combined with preserved consciousness.

Diagnosis of severely brain-damaged patients

- An accurate and reliable evaluation of the level and content of consciousness
- Bedside evaluation of residual brain function in severely brain-damaged patients is difficult:
 - because motor responses may be very limited or inconsistent
 - consciousness is not an all-or-none phenomenon
 - its clinical assessment relies on inferences made from observed responses to external stimuli at the time of the examination

Scales of Evaluation—Pick one and stick with it for ongoing evaluation

- Rappaport Coma Scale

The Rappaport Coma Scale form includes fields for patient name, age, sex, and date. It also has sections for vital signs (T, P, R, BP, SpO2) and a large grid for recording observations. The grid has columns for 'Date' and 'Time' and rows for 'Glasgow Coma Scale', 'Pupils', 'Vital Signs', 'Reflexes', 'Motor Response', and 'Sensory Response'. To the right of the grid, there are instructions for how to use the scale and a legend for the symbols used in the grid.

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CRS-R

CRS-R
COMA RECOVERY SCALE-REVISED
Administration and Scoring Guidelines

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Center for Brain Injury
Edison, New Jersey

JFK
Johns Hopkins Rehabilitation Institute
Edmond and PDS Medical Center
SOLARIS

JFK COMA RECOVERY SCALE - REVISED <small>2003</small>											
<small>The items included in each of the subscales were selected by the JFK Administration and Coding Committee</small>											
<small>Additional instructions for clinicians administering the scale</small>											
Patient:		Diagnosis:		Site:		Date:		Time:		Observer:	
Date of Exam:		Date of Admission:		Bed:		Room:		Floor:		Ward:	
AWAKE / FUNCTION SCALE											
1. Consciousness in Context											
2. Purposeful Movement in Context*											
3. Language in Context											
4. Object Use											
VEGETATIVE FUNCTION SCALE											
1. Ocular Deviation											
2. Ocular Tracking*											
3. Head Deviation*											
4. Head Tracking*											
5. Oral Deviation*											
6. Oral Tracking*											
MINIMALLY CONSCIOUS FUNCTION SCALE											
1. Functional Object Use											
2. Audible Motor Response*											
3. Ocular Deviation*											
4. Localization to Pain Stimulation*											
5. Pain Withdrawal*											
6. Purposeful Grasping*											
VEGETATIVE / MINIMALLY CONSCIOUS FUNCTION SCALE											
1. Spontaneous Eye Deviation											
2. Spontaneous Eye Tracking											
3. Oral Deviation											
4. Oral Tracking											
COMA / VEGETATIVE / MINIMALLY CONSCIOUS FUNCTION SCALE											
1. Reflexive Eye Deviation											
2. Reflexive Eye Tracking											
3. Reflexive Head Deviation											
4. Reflexive Head Tracking											
5. Reflexive Oral Deviation											
6. Reflexive Oral Tracking											
VEGETATIVE SCALE											
1. Eye Opening with Stimulation											
2. Eye Tracking with Stimulation											
3. Head Deviation											
4. Head Tracking											
MINIMAL SCALE											
1. Eye Opening with Stimulation											
2. Eye Tracking with Stimulation											
3. Head Deviation											
4. Head Tracking											

Ethical Questions

- Do patients in a minimally conscious state perceive emotions and pain?
 - YES - neuroimaging studies show this is very likely the case, even if patients can not show or tell it (Schiff et al 2005; Boly et al 2005; Laureys et al 2004; Bekinschtein et al 2004)
- Do patients in a locked-in state feel anything?
 - YES - most patients feel, hear and see everything happening around them - Progress in Brain Research 2005
- Do patients in a vegetative state feel anything?
 - CLASSICALLY, AND IF CORRECTLY DIAGNOSED, PROBABLY NO - Neuroimage 2002

Journey from Injury to Recovery

From the time of injury, patients pass through four valleys and must climb significant mountain passes in order to reach the next valley:

1. *Valley of the Shadow of Death-- Will the loved one survive. Scale is GCS. Prognostic outcomes are unclear and should be communicated as such.*
2. *Valley of Limbo-- Climb the pass and drop into limbo entering the time of uncertainty. Will my love one wake up → Vegetative State, Minimally Conscious State, or full recovery. JFK Recovery Scale.*
3. *Valley of Enlightenment—Fully recovered consciousness and responsiveness, time of inpatient and outpatient rehabilitation. Rancho Coma Scale.*
4. *Valley of Reconciliation—Adjusting and adapting to recovery and level of full function or disability. Glasgow Coma Outcome Scale.*

Ethical issues

- What is the role of the family versus the patient in decision making of the patient with Locked-in syndrome?
 - ? Autonomy
 - ? Resource issue
- Would it be worse to be locked-in versus vegetative?
 - Providers 63% said yes
 - Patients when asked viewed their quality of life as satisfactory in about 30%. (I though the data was slightly skewed)

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Terry Wallace

- 1985—Arkansas (Appalachia) 19 y.o. Male Hillbilly
 - 19 y.o. wife
 - 3 month old daughter
 - Joy riding went through the guard rail truck fell 100 feet landing on its top in canyon below
 - Discovered next morning
 - Resuscitated with coma

Terry Wallace

- Vegetative vs MCS
- Nursing Home during the week and brought home for Saturday and Sunday and then back to SNF
- 2001→ Began to track more and seemed more “responsive” by family
- 2004→ Had returned from home to SNF and mother was in room. His Health Aid as she did many times asked “Terry, who is this?”
- HE RESPONDED WITH “MUM!”

Terry Wallace

- By 24 hours he was definitely and consistently communicating but had severe dysarthria, was slow, but family ultimately could interpret well.
- After several months the family petitioned for a in patient Acute Rehab Stay.
- This was granted and he spent three weeks in Rehab. This was cut off by the funding source because: “He would never return to work.”

Terry Wallace

- 11 Months after awakening the British Broadcasting Channel 4 wanted to do a documentary on his condition and contacted Joe Giacino, PhD world expert.
- Joe worked out an arrangement whereby he would consult but in lieu of his fee Terry and his family were to be brought to JFK in NJ for one week evaluation.
- Consisted of extensive neuropsychological evaluation by Dr. Giacino and fMRI at Columbia and PET and Diffusion Tensor MRI at Cornell.

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Terry Wallace

Clinically:

- After initial evaluation, communication was established through family translation of his severe dysarthria.
- He was oriented to date and person (He knew it was a Monday and he knew his name and family members.
- He was not oriented to place—He thought he was in Arkansas.
- In answer to who is the president he responded Regan (the president at the time of his injury

Terry Wallace

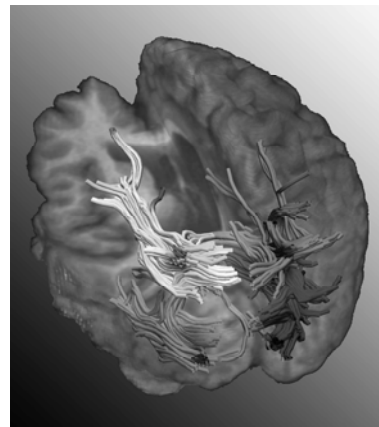
Clinically:

- Severe recent memory impairment with an amnesic syndrome
- He could follow first and second order commands but nothing complex.
- He was quadriplegic with spasticity and scissoring of his lower extremities with fixed contractures.

Terry Wallace

What is Diffusion Tensor Imaging?

- As diffusion is truly a three dimensional process, molecular mobility in tissues may be anisotropic, as in brain white matter.
- With diffusion tensor imaging (DTI), diffusion anisotropy effects can be fully extracted, characterized, and exploited, providing even more exquisite details on tissue microstructure in a three dimensional sense



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Terry Wallace

Neuroimaging:

- On the Diffusion Tensor Imaging he showed increase anisotropy of the occipital parietal area. This increased connections from occipital to frontal areas.
- Advised:
 - No idea as to how far his memory and cognition will recover.
 - Definitely he will have no improvement in his motor function.

Terry Wallace—18 months later

HBO wanted to do the documentary and same deal struck:

Clinically:

- Neuropsychologically unchanged but speech had improved
- His amnesic syndrome persisted
- He had voluntary movement of both lower extremities
- His prior an anisotropy in the occipital area had resolved but he had now a new area in cerebellum that was active.
- Neuroplasticity—23 years since event

