World Federation of Neurology Teaching course:

HOW TO EXAMINE A COMATOSE PATIENT

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Belgium

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Marrakesh, November 14, 2011
Open Access: slides & papers

www.comascience.org

http://orbi.ulg.ac.be
Acute & chronic impaired consciousness

NORMAL CONSCIOUSNESS

COMA

“VEGETATIVE” UNRESPONSIVE WAKEFULNESS

MINIMALLY RESPONSIVE

LOCKED-IN SYNDROME

Laureys, Owen and Schiff, Lancet Neurology, 2005

www.comascience.org
Assessing arousal

E - eye opening

C. Not assessable

4. Spontaneous

3. To speech

2. To pain

1. None

www.comascience.org

Assessing consciousness in critically ill patients
Laureys et al 2002 Yearbook of Intensive Care & Emergency Medicine
Assessing awareness

V - verbal response

1. None
2. Incomprehensible sounds
3. Inappropriate words
4. Confused speech
5. Oriented conversation

Not assessable

AWARENESS
Assessing awareness

M - motor response

6. Obey simple commands
5. Localizes pain
4. Withdraws (normal flexion)
3. Stereotyped flexion
2. Stereotyped extension
1. None
Stereotyped motor response

A Metabolic encephalopathy

B Upper midbrain damage

C Upper pontine damage
Noxious stimulation

Supraorbital ridge

Nail beds of fingers/toes

Sternum

Temporomandibular joints

"COMA NAILS"
Quantifying consciousness

Assessing consciousness in critically ill patients
Laureys et al 2002 Yearbook of Intensive Care & Emergency Medicine

www.comascience.org
Glasgow-Liège Scale

R – brainstem reflexes

5. Fronto-orbicular

4. Vertical oculovestibular

3. Pupillary light

2. Horizontal oculovestibular

1. Oculocardiac

0. None

BRAINDEAD

Assessing consciousness in critically ill patients
Laureys et al 2002 Yearbook of Intensive Care & Emergency Medicine
Brainstem reflexes

AFFERENT (in)
EFFERENT (out)

1. No pupillary response to light
2. No blinking on corneal touch
3. No eye movement on caloric testing
4. No grimacing on painful stimuli
5. No cough or gag reflex

optic oculomotor
trigeminal facial
vestibulocochlear oculomotor & abducens
trigeminal facial
glossopharyngeal vagus
Pupillary light-reflex

Plum and Posner's
Diagnosis of Stupor and Coma

www.comascience.org
Other “coma” scales

**Edinburgh-2 Coma Scale (E2CS)**

<table>
<thead>
<tr>
<th>Stimulation (maximal)</th>
<th>Response (best)</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two sets of questions:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Month?</td>
<td>Answers correctly to both</td>
<td>0</td>
</tr>
<tr>
<td>2. Age?</td>
<td>Answers correctly to either</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Incorrect for both</td>
<td>2</td>
</tr>
<tr>
<td>Two sets of commands:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Close and open hands</td>
<td>Obeys correctly to both</td>
<td>3</td>
</tr>
<tr>
<td>2. Close and open eyes</td>
<td>Obeys correctly to either</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Neither correct</td>
<td>5</td>
</tr>
<tr>
<td>Strong pain</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Localizing</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Flexion</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Extension</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>9</td>
</tr>
</tbody>
</table>

Other "coma" scales

**Reaction Level Scale (RLS85)**

<table>
<thead>
<tr>
<th>Clinical descriptor</th>
<th>Responsiveness</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alert</td>
<td>No delay in response</td>
<td>1</td>
</tr>
<tr>
<td>Drowsy or confused</td>
<td>Responsive to light stimulation</td>
<td>2</td>
</tr>
<tr>
<td>Very drowsy or confused</td>
<td>Responsive to strong stimulation</td>
<td>3</td>
</tr>
<tr>
<td>Unconscious</td>
<td>Localizes but does not wade of pain</td>
<td>4</td>
</tr>
<tr>
<td>Unconscious</td>
<td>Withdrawing movements on pain stimulation</td>
<td>5</td>
</tr>
<tr>
<td>Unconscious</td>
<td>Stereotype flexion movements on pain stimulation</td>
<td>6</td>
</tr>
<tr>
<td>Unconscious</td>
<td>Stereotype extension movements on pain stimulation</td>
<td>7</td>
</tr>
<tr>
<td>Unconscious</td>
<td>No response on pain stimulation</td>
<td>8</td>
</tr>
</tbody>
</table>

Starmark et al
*Acta Neurochir (Wien)* 1988 91:12-20
Other “coma” scales

Innsbruck Coma Scale (ICS)

Max score 23

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eye opening</td>
<td>Spontaneous</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>To acoustic stimuli</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>To painful stimuli</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Reaction to acoustic stimuli</td>
<td>Turning towards stimuli</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Better-than-extension movements</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Extension movements</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Reaction to pain</td>
<td>Defensive movements</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Better-than-extension movements</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Extension movements</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Body posture</td>
<td>Normal</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Better-than-extension movements</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Extension movements</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Pupil size</td>
<td>Normal</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Narrow</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Dilated</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Completely dilated</td>
<td>0</td>
</tr>
<tr>
<td>Pupil response to light</td>
<td>Sufficient</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Reduced</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Minimum</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
<tr>
<td>Position and movements of the</td>
<td>Fixing of the eyes</td>
<td>3</td>
</tr>
<tr>
<td>eyeballs</td>
<td>Sway of eyeballs</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Divergent</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Divergent fixed</td>
<td>0</td>
</tr>
<tr>
<td>Oral automatisms</td>
<td>Spontaneous</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>To external stimuli</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>None</td>
<td>0</td>
</tr>
</tbody>
</table>
Standardized assessment

Inter-examiner consistency
Diagnosis
Serially recorded: reflects clinical course
Prognosis

Glasgow Coma Scale

Figure: Ever-increasing number of papers making reference to the Glasgow coma scale. MEDLINE search done in October 2005.

Laureys et al, Quantifying consciousness. *Lancet Neurology* 2005
FOUR / GCS

Wijdicks et al., Ann Neurol (2005)
Eye response

Grade the best possible response after at least 3 trials in an attempt to elicit the best level of alertness. A score of E4 indicates at least 3 voluntary excursions. If eyes are closed, the examiner should open them and examine tracking of a finger or object. Tracking with the opening of 1 eyelid will suffice in cases of eyelid edema or facial trauma. If tracking is absent horizontally, examine vertical tracking. Alternatively, 2 blinks on command should be documented. This will recognize a locked-in syndrome (patient is fully aware). A score of E3 indicates the absence of voluntary tracking with open eyes. A score of E2 indicates eyelids opening to loud voice. A score of E1 indicates eyelids open to pain stimulus. A score of E0 indicates no eyelids opening to pain.

4 Eyelids open or opened, tracking or blinking to command
3 Eyelids open but not tracking
2 Eyelids closed but opens to loud voice
1 Eyelids closed but opens to pain
0 Eyelids remain closed with pain
Motor response

Grade the best possible response of the arms. A score of M4 indicates that the patient demonstrated at least 1 of 3 hand positions (thumbs-up, fist, or peace sign) with either hand. A score of M3 indicates that the patient touched the examiner’s hand after a painful stimulus compressing the temporomandibular joint or supraorbital nerve (localization). A score of M2 indicates any flexion movement of the upper limbs. A score of M1 indicates extensor posturing. A score of M0 indicates no motor response or myoclonus status epilepticus.

- 4 Thumbs up, fist, or peace sign to command
- 3 Localizing to pain
- 2 Flexion response to pain
- 1 Extensor posturing
- 0 No response to pain or generalized myoclonus status epilepticus
Brainstem reflexes

Grade the best possible response. Examine pupillary and corneal reflexes. Preferably, corneal reflexes are tested by instilling 2-3 drops of sterile saline on the cornea from a distance of 4-6 inches (this minimizes corneal trauma from repeated examinations). Cotton swabs can also be used. The cough reflex to tracheal suctioning is tested only when both of these reflexes are absent. A score of B4 indicates pupil and cornea reflexes are present. A score of B3 indicates one pupil wide and fixed. A score of B2 indicates either pupil or cornea reflexes are absent, B1 indicates both pupil and cornea reflexes are absent and a score of B0 indicates pupil, cornea and cough reflex (using tracheal suctioning) are absent.
**Respiration**

Determine spontaneous breathing pattern in a nonintubated patient, and grade simply as regular **R4**, irregular **R2**, or Cheyne-Stokes **R3** breathing. In mechanically ventilated patients, assess the pressure waveform of spontaneous respiratory pattern or the patient triggering of the ventilator **R1**. The ventilator monitor displaying respiratory patterns is used to identify the patient generated breaths on the ventilator. No adjustments are made to the ventilator while the patient is graded, but grading is done preferably with PaCO2 within normal limits. A standard apnea (oxygen-diffusion) test may be needed when patient breathes at ventilator rate **R0**.
How to examine brain death

**Diagnostic criteria (AAN 1995)**
- Demonstration of coma
- Evidence for the cause of coma
- Absence of confounding factors, including hypothermia, drugs, electrolyte, and endocrine disturbances
- Absence of brainstem reflexes
- Absent motor responses
- Apnea
- A repeat evaluation in 6h is advised, but the time period is considered arbitrary
- Confirmatory laboratory tests are only required when specific components of the clinical testing cannot be reliably evaluated

**APNEA test:**
Preoxygenation: inspired O2 1.0 for 10 min
PO2>200 mm Hg, PCO2>40 mm Hg
disconnect, apneic diffusion oxygenation 6l/min O2
observe >8 min, PCO2>60 mm Hg

**Bedside diagnosis**
- No response to pain
- No brainstem reflexes
- No spontaneous breathing

Adapted from Wijdicks, NEJM 2001
Motor activity in brain death

VIDEO

Spinal reflexes 75%
extension-pronation
plantar responses
muscle stretch reflexes
abdominal reflexes
undulating toe flexion sign
“Lazarus’ sign

Bueri et al Mov Disord. 2000, 15:583-6

Laureys, Nature Reviews Neuroscience, 2005
IRREVERSIBLE COMA

Majority of deaths related to physicians’ decision to withhold or withdraw treatment

( Laureys, Nature Reviews Neurosci 2005)

POST-ANOXIC COMA

exclude confounding factors
including hypothermia, drugs, electrolyte disturbances...

brainstem reflexes
(pupillary, cornea, oculocephalic, cough)

absent and GCS 3/15

apnea testing

positive

BRAIN DEATH

confirmatory tests: isoelectrical EEG or transcranial Doppler or angiography or SPECT

ORGAN PROCUREMENT ORGANIZATION

D1-3: somatosensory EPs

N20 present

MMN on auditory EPs

(95% IC NA)

FP 0%

GOOD OUTCOME

N20 absent

FP 0.7%

(95% IC 0-3.7%)

FP 3%

(95% IC 0.9-11%)

FP 0%

(95% IC 0-8.8%)

FP 0%

(95% IC 0-3%)

FP 0%

(95% IC 0-3%)

POOR OUTCOME

ORGAN PROCUREMENT ORGANIZATION

Pittsburgh Protocol non-heart-beating donor

generalized suppression (<20 μV)
or ‘burst suppression’ EEG

or

d1: myoclonus status epilepticus

or

D3: M1 or M2 or no pupillary or cornea reflex

or

D1-3: serum NSE > 33 μg/l

Adapted from Wijdicks et al, Neurology, 2006
Boveroux et al, Réanimation, 2008 (French)
GCS, GLS or FOUR?

n=146 prospectively enrolled @ ICU
131 intubated (74%)  
Inter-rater reliability  
- GCS (κ 0.65), GLS (κ 0.66), FOUR (κ 0.75)
Outcome prediction  
- GCS ≈ GLS ≈ FOUR
GCS considered 71 “vegetative”/unresponsive
FOUR identified 8 MCS- (eye tracking) (11%)

Bruno et al, Neurocritical Care, 2011
Chronic disorders of consciousness

Acute Brain Injury → Coma

- Fast Recovery
- Vegetative State
  - 1972 Jennett (Glasgow) & Plum (NY)
  - Locked-In Syndrome
    - 1966 Plum & Posner (NY)
- Permanent Vegetative State
  - 1994, Multi-Society Task Force on PVS
    - >1 year (traumatic)
    - >3 months (non-traumatic; anoxic)
- Brain Death
  - 1952, artificial respirator (Ibsen, Copenhagen)
    - Redefinition of death based on neurological criteria

Recovery of Consciousness

Permanent Minimally Conscious State

2002, Aspen Workgroup

Laureys, Scientific American 2007

www.comascience.org
A new name for «vegetative»

Unresponsive wakefulness syndrome: a new name for the vegetative state or apalllic syndrome

“There’s nothing we can do... he’ll always be a vegetable.”

Laureys et al, BMC Medicine 2011
Chronic disorders of consciousness

- **Emergence**: functional communication
- **Minimally Conscious State**: Response to command (MCS+) or non-reflex movement (MCS-)
- **PVS/Unresponsive Wakefulness Syndrome**: eye opening only reflex movements
- **Coma**: loss of brainstem reflexes
- **Brain Death**

Terry Schiavo: °1963, vegetative 1990, † 2005

Laureys et al, Nature Clinical Medicine, 2008
Bruno et al, J Neurology, 2011

www.comascience.org
FOUR diagnosis of PVS/UWS

n=60 post-comatose

GCS : 29 diagnosed “vegetative”/unresponsive
FOUR : 24 PVS/UWS
CRS-R : 17 PVS/UWS

use an adapted validated scale (e.g., CRS-R) (not GCS or FOUR) to disentangle “vegetative”/unresponsive from minimally conscious (MCS)!

Schnakers et al, Annals of Neurology, 2006
Diagnostic error

n=103 post-comatose patients
- 45 clinical consensus diagnosis 'vegetative state'
- 18 signs of awareness (Coma Recovery Scale-Revised)

40% potential misdiagnosis of VS/UWS if no adapted scale is used

Schnakers et al, BMC Neurology 2009
Assessing pain

overestimation

agreement

underestimation

Kappesser and Williams, *Pain* 2010
Nociception and pain

Demertzi et al, Prog Brain Res, 2009

Nociception Coma Scale

Schnakers et al, Pain, 2010

Total score > 7 / 12 = analgesic treatment
Nociception coma scale

Schnakers et al, *Pain* 2010
Pain in minimally conscious state


http://neurology.thelancet.com

www.comascience.org
Quantifying consciousness

Laureys et al., Current Opinion in Neurology, 2005
<table>
<thead>
<tr>
<th>Scale</th>
<th>Free access</th>
<th>Guidelines of administration &amp; scoring procedures</th>
<th>Content validity (i.e., enclosing diagnostic criteria)</th>
<th>Internal consistency</th>
<th>Inter-rater reliability</th>
<th>Test-retest reliability</th>
<th>Diagnostic validity</th>
<th>Outcome prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coma Recovery Scale-Revised (CRS-R, [45])</td>
<td>Yes</td>
<td>Present</td>
<td>Excellent</td>
<td>Good</td>
<td>Good</td>
<td>Excellent</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Sensory Stimulation Assessment Measure (SSAM, [46])</td>
<td>Yes</td>
<td>Present</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Wessex Head Injury Matrix (WHIM, [47])</td>
<td>No</td>
<td>Present</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Western Neuro Sensory Stimulation Profile (WNSSP, [48])</td>
<td>Yes</td>
<td>Present</td>
<td>Good</td>
<td>Excellent</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Sensory Modality Assessment and Rehabilitation Technique (SMART, [49])</td>
<td>No</td>
<td>Present</td>
<td>NA</td>
<td>Excellent</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Disorders of Consciousness (DOC, [50])</td>
<td>Yes</td>
<td>Present</td>
<td>Acceptable</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Coma Near Coma (CNC, [51])</td>
<td>Yes</td>
<td>Present</td>
<td>Acceptable</td>
<td>Unacceptable</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Full Outline of Unresponsiveness scale (FOUR, [52])</td>
<td>Yes</td>
<td>Absent</td>
<td>Poor</td>
<td>Excellent</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Yes</td>
</tr>
<tr>
<td>Comprehensive Level of Consciousness Scale (CLOCS, [53])</td>
<td>Yes</td>
<td>Absent</td>
<td>Acceptable</td>
<td>Good</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
</tr>
<tr>
<td>Innsbruck Coma Scale (INNS, [54])</td>
<td>Yes</td>
<td>Absent</td>
<td>Poor</td>
<td>Acceptable</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>No</td>
</tr>
<tr>
<td>Glasgow Liège Scale (GLS, [55])</td>
<td>Yes</td>
<td>Absent</td>
<td>Poor</td>
<td>Unproven</td>
<td>Unacceptable</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Yes</td>
</tr>
<tr>
<td>Loewenstein Communication Scale (LOEW, [56])</td>
<td>Yes</td>
<td>Absent</td>
<td>Acceptable</td>
<td>Unproven</td>
<td>Excellent</td>
<td>Unproven</td>
<td>Unproven</td>
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</tr>
<tr>
<td>Reaction Level Scale (RLS85, [57])</td>
<td>Yes</td>
<td>Absent</td>
<td>Acceptable</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
<td>Unproven</td>
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</tr>
</tbody>
</table>
## JFK COMA RECOVERY SCALE - REVISED

**Record Form**

<table>
<thead>
<tr>
<th>Patient:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### AUDITORY FUNCTION SCALE
- 4 - Consistent Movement to Command *
- 3 - Reproducible Movement to Command *
- 2 - Localization to Sound
- 1 - Auditory Stare
- 0 - None

### VISUAL FUNCTION SCALE
- 5 - Object Recognition *
- 4 - Object Localization: Reaching *
- 3 - Visual Pursuit *
- 2 - Fixation *
- 1 - Visual Stare
- 0 - None

### MOTOR FUNCTION SCALE
- 6 - Functional Object Use *
- 5 - Automatic Motor Response *
- 4 - Object Manipulation *
- 3 - Localization to Noxious Stimulation *
- 2 - Flexion Withdrawal
- 1 - Abnormal Posturing
- 0 - None/Flaccid

### OROMOTOR/VERBAL FUNCTION SCALE
- 3 - Intelligible Verbalization *
- 2 - Vocalization/Oral Movement
- 1 - Oral Reflexive Movement
- 0 - None

### COMMUNICATION SCALE
- 2 - Functional: Accurate *
- 1 - Non-Functional: Intentional *
- 0 - None

### AROUSAL SCALE
- 3 - Attention
- 2 - Eye Opening w/o Stimulation
- 1 - Eye Opening with Stimulation
- 0 - Unarousable

### TOTAL SCORE

---

**VIDEO**

- simple command-following

---

**SELF- STUDY DVD OFFER**

**COMA RECOVERY SCALE - REVISED:**

GUIDELINES FOR ADMINISTRATION AND SCORING

ORDER VIDEO:
coma@chu.ulg.ac.be

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www.comascience.org
Visual function

1—Visual startle

Object-related eye or limbs movement commands

3/4 clearly discernible responses

Object localization: reaching

The patient is asked to touch an object with his/her arm or leg, 4 trials (2 left, 2 right presentations).

Movement must occur in the correct direction on 3/4 trials.

Pursuit eye movements

Move mirror 45° to the right, left, upper and lower directions. 2 trials in every direction (manually open eyes if necessary).

Eyes must follow the mirror for 45° without loss of fixation on 2 occasions in any direction.

Fixation

Present a brightly coloured object in front of the patient’s face and then rapidly move to upper, lower, right and left visual fields for a total of 4 trials (manually open eyes if necessary).

Eyes change from initial fixation point and then fixate on the new target location for more than 2 s. At least 2 fixations.

None

Quickly move a finger 1 inch in front of the patient’s eye, while avoiding contact with the eyelashes or inadvertent production of a breeze (manually open eyes if necessary). 4 trials per eye.

Blink promptly following presentation of visual threat on at least 2 trials with either eye.

No response to any of the above.

Visual startle = reflex

blinking to visual threat: reflex or sign of awareness?

REFLEX: Jennett et al BMJ 1997

AWARENESS: Royal College of Physicians 1996; Wade BMJ 1999;
Liu, J Clin Neuroophthalmol 1992

ATYPICAL: Multi-Society Task Force on PVS NEJM 1994;
Royal College of Physicians 2003; Australian Government National Health
and Medical Research Council 2003

91 patients with PVS/UWS (CRS-R diagnosis)
51% show blink to visual threat
37% recovered (24% no blink)
⇒ not atypical & no sign of consciousness

Vanhaudenhuyse et al, Neurology 2008

www.comascience.org
Visual fixation = reflex
Eye tracking: use a mirror!
Locked-in syndrome

Laureys et al., Progress in Brain Research, 2005
Locked-in syndrome

Cognitive function in classical LIS patients (in black) is comparable to age-matched healthy controls (in white).

Suggested reading

Schakers et al., J Neurology, 2008

www.comascience.org
Quality of life

A survey on self-assessed well-being in a cohort of chronic locked-in syndrome patients: happy majority, miserable minority

Signs of consciousness on fMRI

Yes-No communication with fMRI

HEALTHY SUBJECT

Answers « YES »

Answers « NO »

« VEGETATIVE STATE »

Monti & Vanhaudenhuyse, Coleman, Boly, Pickard, Tshibanda, Owen, Laureys
New England J Med 2010
EEG-based Brain Computer Interfaces

“MOVE YOUR FOOT”
HEATHY CONTROL SUBJECT

“MOVE YOUR HAND”

“VEGETATIVE” UNRESPONSIVE PATIENT

3/16 VS/UWS (19%)
- 2/5 traumatic (40%)
- 1/11 non-traumatic (9%)

www.thelancet.com Published online November 10, 2011

EEG-based Brain Computer Interfaces

www.decoderproject.eu

Coma or total locked-in syndrome?
21-y old woman
basilar artery thrombosis - day 49

Other names PASSIVE
Count TARGET (other name)
Own name PASSIVE
Count TARGET (own name)

Schnakers et al, Neurology, 2008
Schnakers et al, Neurocase, 2009

Fellinger et al Clin Neurophysiol, 2011

www.comascience.org
Aphasia as a confound!

The problem of aphasia in the assessment of consciousness in brain-damaged patients

Steve Majerus, Marie-Aurélie Bruno, Caroline Schnakers, Joseph T. Giacino, and Steven Laureys

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Bruno et al, J Neurology, in press

www.comascience.org
New knowledge, new nosology

Conclusion

Diagnosis
≈ 40% misdiagnosis

Prognosis
multimodal MRI

Treatment
pain treatment / deep brain stimulation thalamus

Ethical issues

Laureys & Boly, Nature Clinical Practice, 2008
Owen, Schiff & Laureys, Prog Brain Res, 2009
We need more research!

Laureys et al., Current Opinion in Neurology, 2006
THANK YOU

Fellows welcome

www.comascience.org