Unraveling disorders of consciousness: neuroimaging and interpretation

Nicholas D. Schiff, M.D.
Director, Laboratory of Cognitive Neuromodulation
Associate Professor of Neurology and Neuroscience
Department of Neurology and Neuroscience
Weill Medical College of Cornell University
New York, New York

Talk overview

• Definitions: global disorders of consciousness

• Evaluation of severely brain-injured patients using neuroimaging methods (positron emission tomography [PET], functional magnetic resonance imaging [fMRI], and diffusion tensor imaging [DTI]):
  – Vegetative state (VS)
  – Minimally conscious state (MCS)
  – and late emergence from the minimally conscious state (EMCS)

• Implications for evolving standards of evaluation of DOC:
  – Need for assessment of risk of misdiagnosis
  – Frameworks for longitudinal reassessments
  – Development of guidelines for use of neurodiagnostics
Definitions

Coma:

A condition in which the patient remains eyes closed and cannot be aroused or respond to stimuli.

A result of severe brain injury [or pharmacologic anesthesia].

Comas are invariably transient.

Vegetative state, VS (Jennett and Plum, 1972):

A condition characterize by total unresponsiveness with recovery of cyclic sleep and wake changes noted as periods of eye opening and eye closure.

A ‘wakeful’ appearing unconscious state associated with severe brain injury.
Minimally Conscious State, MCS (Giacino et al., 2002):

A condition of severely altered consciousness in which minimal but definite behavioral evidence of self or environmental awareness is demonstrated.

Locked-in State, LIS (Plum and Posner, 1966):

A condition in which the patient may remain eyes closed or open and may not appear to react to stimuli, yet is fully conscious. A result of selective brain injury involving the nerve fibers that control the skeletal muscle system.

Locked-in state is not a disorder of consciousness.


Conceptualizing global disorders of consciousness

Total functional loss → Cognitive function → Normal

Motor function

Functional Communication

Total functional loss

VS (PVS) → MCS → Severe to Moderate Cognitive Disability → Full Cognitive Recovery 

LIS*

Brain death → Coma


Diffusion Tensor Imaging (DTI)

Longitudinal measurements of regional fractional anisotropy over an 18 month interval following late recovery (20 years after injury) from MCS

Conceptual Models of the Spectrum of Vegetative and Minimally Conscious State Patients

Functional loss of cerebral integration beyond early cortical responses

Preservation of large-scale network responses with variation in quality of ongoing baseline brain activation

Conclusions

- Pathological and functional brain imaging studies support a model of widespread cerebral disconnection (functional +/- structural) in VS patients of all causes.

- Atypical behavioral findings in some chronic VS patients may reflect preservation of modular networks. Similarly, recovery of limited sensorimotor integration in low level MCS may also originate from limited network preservation.

- Some MCS patients, however, retain recruitable large-scale cerebral networks that overlap functionally with normal patterns of activation. These observations require further explanation in terms of mechanism.
Conclusions
(continued)

Implications for assessments of severe brain injury:

- A framework for longitudinal assessments of cerebral function in severely brain-injured patients should be developed.

- Neuroimaging evaluations of patients with severe brain injuries will be impractical until guidelines that are adjusted based on risk of missing clinical evolution can be developed.

- Guidelines for management of patients with severe brain injuries should be developed to identify risk of misdiagnosis or likelihood of significant clinical evolution outside of skilled facilities to reduce potential burden of isolation.

Conclusions
(continued)

- There is a need for rethinking professional standards and ethical obligations to the severely brain injured population:
  - preserving self-determination,
  - right-to-die and right-to-care, a
  - addressing unmet access needs to diagnostic and therapeutic advances,
  - defining proportionate palliative goals for patients and families


Collaborators:
Weill Medical College of Cornell University

Lab. Cognitive Neuromodulation
Nicholas D. Schiff, MD, Director
Erik Kobylarz, MD, PhD
Andrew Goldfine, MD
Sudhin Thomas, MA

Jonathan D. Victor, MD, PhD
Michael Repucci, PhD
Joseph J. Fins, MD
Fred Plum, MD
Daniel G. Herrera, MD, PhD
Douglas Ballon, PhD
Linda Heier, MD
Henning Voss, PhD
John Dyke, PhD
Shankar Vallabhajosula, PhD
Klaus Hamacher, PhD
Stanley Goldsmith, MD

Lab. Visually Guided Behavior
Keith P. Purpura, PhD, Director
Andrew E. Hudson, BA
David Menzer, BA
Steven F. Kalik, PhD

Partha Mitra, PhD (CSH Labor.)
Hemant Bokil, PhD(CSH Labor.)

Collaborators (continued)

JFK Johnson Rehabilitation Center:
Joseph T. Giacino, PhD
Carolyn McCagg, MD
Kathleen Kalmar, PhD

Memorial Sloan Kettering Cancer Center PET Imaging:
Ronald Blasberg, MD
Bradley Beattie, PhD

New York University School of Medicine Center for Neuromagnetism:
Urs Ribary, Ph.D.
Eugene Kronberg, PhD
Rodolfo Llinas, MD, PhD

Functional MRI Laboratory, Columbia University:
Joy Hirsch, PhD, Director
Constance Park, PhD
Diana Rodriguez-Moreno, BA

Cleveland Clinic Foundation, Center for Neurological Res.:
Ali Rezai, MD, Co-Chairman
Cameron McIntyre, PhD
Chris Butson, PhD
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