Coma and Disorders of Consciousness

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To medical teams and families we see every day and who inspire us.

Foreword I

Consciousness is synonymous with human existence. Rene Descarte's bold proclamation, "Cogito ergo sum" (I think therefore I am), elegantly captures this premise. The clear inference here is that self-doubt about one's own existence establishes proof of one's existence. We exist because we know we exist. But how does one come to know that someone else is aware of his existence? Without direct access to knowledge of the self, it is impossible to prove (or disprove) the awareness of another. In normal consciousness, this problem is obviated by the multitude of behavioral expressions of conscious awareness manifested by living beings nearly every waking moment. Words, gestures and actions, the "stuff" of consciousness, provide compelling evidence of the inner life of another.

A small but significant percentage (5–10%) of those who sustain severe acquired brain injury experience prolonged disturbance in consciousness. Most will eventually recover at least basic capacity for self and environmental awareness, but this may not occur for many months and, in some cases, years. During this period of severely altered consciousness, one's existence may be stripped of the usual harbingers of an active inner life. Sensory, motor, language, perceptual and drive systems may all be compromised in the aftermath of severe brain injury. Consequently, the repertoire of behaviors available to signal retention of conscious awareness may be dramatically narrowed or lost altogether. This predicament presents one of humankind's greatest existential dilemmas – is consciousness lost, or simply no longer apparent? This question is at the heart of, *Coma and Disorders of Consciousness* edited by Caroline Schnakers and Steven Laureys of the Coma Science Group based at the University of Liège. The Coma Science Group is one of the most prolific and accomplished research teams currently engaged in the study of patients with disorders of consciousness (DoC). Laureys and Schnakers, specifically, are responsible for many seminal papers in this rapidly advancing field. Together, they have assembled an outstanding list of authors, most associated with the Coma Science Group, and have compiled a comprehensive volume that aptly depicts the state of the science in assessment and treatment of patients with DoC. The first half of the book is devoted to technological advances in diagnostic and prognostic assessment, appropriately reflecting the most important developments over the last 5 years. Novel

applications of functional neuroimaging (i.e., fMRI) and electrophysiologic (i.e., EEG, ERP) methods of detecting conscious awareness in behaviourally non-responsive patients are addressed, as are imaging techniques that index brain metabolites (i.e., spectroscopy), white matter tracts (i.e., diffusion tensor imaging) and patterns of neural activation (i.e., transcranial magnetic stimulation), which may be of prognostic significance. The second half of the book focuses largely on treatment interventions ranging from sensory stimulation to neuromodulation strategies (i.e., pharmacotherapy, deep brain stimulation, brain computer interface). Two important but understudied areas, sleep and oral feeding, are also covered. The book concludes with a discussion of the ethical conundrums associated with clinical management of patients with DoC and a forward look at this pivotal area of discovery, located at the crossroads of philosophy and science. This book continues the search for the "seat of consciousness" begun more than two millennia ago – a quest that, by virtue of the human condition, we are compelled to undertake. For this reason, no reader will turn away from this book disappointed.

Harvard Medical School, Boston, MA, USA Joseph T. Giacino

Foreword II

The definition of "*the persistent vegetative state*" by Jennett and Plum in 1972 constituted an important step in the understanding and the monitoring of patients presenting a disorder of consciousness after a period of coma. However, for years, the scientific work on this topic remained insignificant. The merit of the Coma Science Group is to have been interested in these patients with a new perspective, at a clinical but also scientific and ethical level. These researchers are using tools of modern neuroscience, particularly, functional neuroimaging and electrophysiology, in order to better understand the brain functioning of patients recovering from coma. They showed, for instance, that patients diagnosed as being in a "*vegetative*" state could present conscious activity unsuspected at a clinical level. Their approach did not remain only theoretical, as they were also interested in clinical assessment and, particularly, in the risk of diagnostic errors, in the care and in the complex ethical problems associated with these vulnerable patients. This team, in parallel with British researchers, significantly contributed to the progress of knowledge in this field. This book coordinated by Steven Laureys and Caroline Schnakers presents a complete review of the main clinical and scientific advances on the disorders of consciousness, including a synthesis of their own work. It also tackles questions about the future, such as pharmacological treatment or deep brain stimulation. Ethical questions are also discussed. I am sure that this book, coordinated by two of the best experts in the field, will meet the success it deserves and will quickly become a classic for all clinicians and researchers working with these patients.

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Philippe Azouvi

Preface

Consciousness is a word worn smooth by a million tongues. Depending upon the figure of speech chosen it is a state of being, a substance, a process, a place, an epiphenomenon, an emergent aspect of matter, or the only true reality.

George Armitage Miller

Fifty years ago, the field of disorders of consciousness was a very limited research domain. Severely brain-injured patients, who are most likely to present impaired consciousness during recovery, often died. In the 1950s, the introduction of artificial breathing changed everything. The life of these patients could be extended even in cases of severe lesions to brain areas supporting the control of vital functions. The clinician started to face patients who were alive but not reactive to their surroundings. In this context, a new field was called to emerge. In the 1960s, Plum and Posner defined for the first time a clinical entity called the coma. Slightly later, Jennett and Teasdale developed the well-known Glasgow Coma Scale for assessing the progress of comatose patients in intensive care units. The 1980s were characterized by the development of a new kind of treatment, the sensory stimulation programs. In the late 1990s, the emergence of neuroimaging techniques opened new opportunities to study brain reactivity in patients with disorders of consciousness.

However, in spite of the medical advances and the increasing number of severely brain-injured patients, the assessment and treatment of patients recovering from coma represents a very difficult and delicate task even today. The detection of signs of consciousness is complicated by the frequent motor and cognitive limitations of these patients. Treatment options are nearly absent, leaving the clinician often with a situation of palliative rather than restorative care. Even in an experimental setting, the study of patients in a coma or related disorders of consciousness is a real challenge. These patients are easily exhausted, limiting the assessment window, and spontaneous motor reactions have to be controlled for. The development of a research environment adapted to the scientific investigation of these patients is time consuming and requests important clinical and scientific expertise. For over 10 years now, the Coma Science Group (http://www.coma.ulg.ac.be) has been working on the scientific exploration of disorders of consciousness, with both scientific and

clinical research agendas. This research team, bridging various medical (neurology, neurosurgery, intensive care, anesthesia, physical medicine, otorhinolaryngology) and paramedical disciplines (psychology, speech therapy, physical therapy) as well as engineering and biological disciplines, has been a major player in the development of new assessment, communication, and treatment techniques for disorders of consciousness, and this at both the behavioral and the neuroimaging level. We decided to write this book in order to offer clinicians as well as researchers an overview of the most recent advancements in this domain.

By focusing on both clinicians and researchers as potential readers of this book, we decided to include well-established findings about diagnostic/prognostic criteria, ethical issues, assessment techniques (i.e., behavioral scales, electrophysiological explorations, and structural/functional neuroimaging), and treatment procedures, but also techniques under development (i.e., the use of classifiers, brain-computer interfaces, transcranial magnetic stimulation, or deep brain stimulation) which, we hope, will stimulate ideas for future research.

In conclusion, we hope to have reached our aim by offering a comprehensive and reader-friendly book to readers both familiar or not with the difficult but intriguing field of disorders of consciousness.

We hope you enjoy reading this book.

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Steven Laureys

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