Sleep in Disorders of Consciousness

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INTRODUCTION

Consciousness consists of two components: arousal (wakefulness or level of consciousness) and awareness (contents of consciousness) (1).

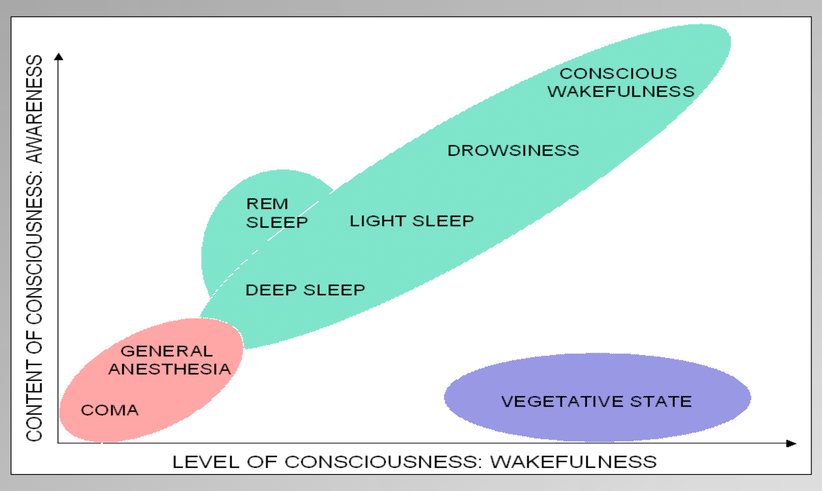

Fig. 1: *Graphical representation of the two components of consciousness the level of consciousness and content of consciousness (1)*

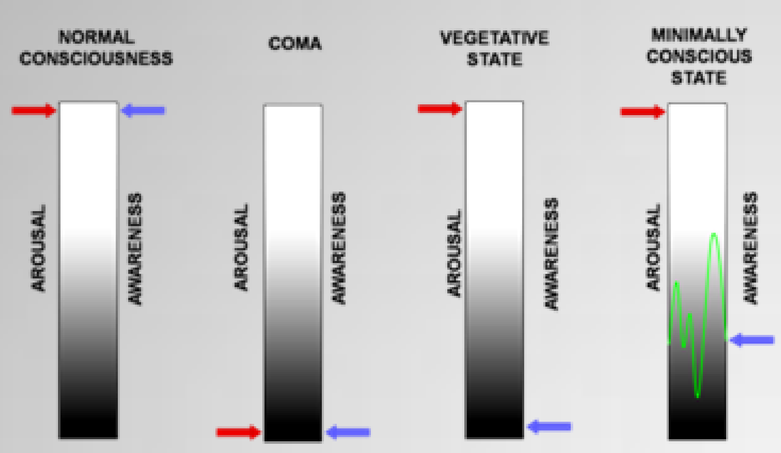

Fig. 2: *The two components of consciousness and their relation to "Disorders of Consciousness"*

Previous studies in patients suffering from clinical disorders of consciousness (DOC) have reported a wide spectrum of sleep disturbances ranging from almost normal patterns to severe loss and sleep architecture disorganisation (2). The sleep-wake system and consciousness appear intimately connected.

Disentangling the vegetative state (VS) from the minimally conscious state (MCS) is often difficult when relying only on purely behavioural clinical observation. The high rate of misdiagnosis might be counteracted (i) using active EEG paradigms which ask for instruction following in DOC (3) but as well by assessing sleep and specific sleep patterns which might carry important information regarding correct diagnosis and prognosis.

The working hypothesis can be stated as follows: The very existence of complex sleep patterns (NREM-REM cycling, sleep spindles, etc.) will only be evident in patients with relatively well preserved brain connectivity and will thus indicate (i) a higher level of "awareness" (relevance for diagnosis) and (ii) additionally might be predictive of better outcome (relevance for prognosis).

METHOD

24hr polysomnographies (PSG) were acquired in 18 VS and 16 MCS patients (at various rehabilitation clinics and hospitals in Austria and Belgium). Whole-head EEG was recorded using a 32-channel BrainAmp (BrainProducts) amplifier with cup-electrodes being mounted to the patients' head using Collodion.

"Abnormal spindles" (<10Hz), "Abnormal SWS" (<75μV) and "Cortical desynchronisation arousals" were only analyzed in a subsample (n_{MCS} = 10, n_{VS} =10) of the data so far. Additionally, a subsample of 8 VS and 6 MCS was analyzed for residual cognitive processing in "active" EEG paradigms.

Before and after the 24hr recordings patients were behaviourally tested with the Coma Recovery Scale-Revised (CRS-R) (4). After approximately one month the diagnosis was verified again using the CRS-R scales by two independent raters.

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RESULTS

Preliminary results indicate that especially (<10Hz) sleep spindles and cortical desynchronization arousals differ between the two clinical entities (i.e. ,more prevalent in MCS). Likewise, the amount of SWS and REM sleep appears to be higher in MCS patients (cf. Table).

	VS	MCS
Circadian	7/18	7/16
Cortical desynchro arousal	3/10	8/10
Spindles	2/18 (7/18)*	9/16 (15/16)*
Slow wave sleep	7/18 (14/18)**	13/16 (15/16)**
REM sleep	7/18	13/16

*with spindles <10Hz

** with SWS <75μV

Detection of sleep features:
Cortical desynchro arousals: Halasz et al. (2004) criteria (5)
Spindles/ slow wave & REM sleep: Rechtschaffen & Kales (1968) criteria (6).

Below we try to quantify sleep in a more data driven approach as classical staging criteria (6) are difficult to apply for pathological sleep recordings. Specifically, we plotted the 24hr recordings in the time-frequency domain (cf. Fig. 3-4).

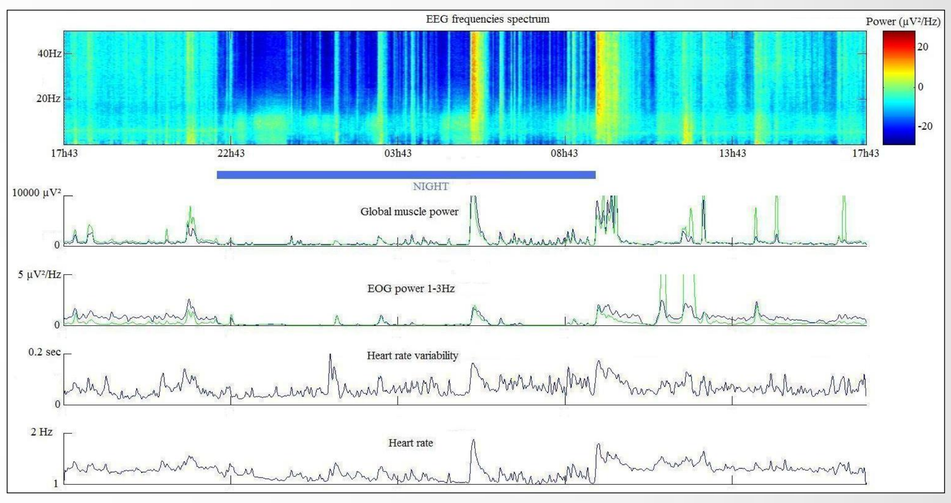

Fig. 3: *Cycled pattern of brain activity (VS patient). Note the change in higher EEG frequencies when entering the night period.*

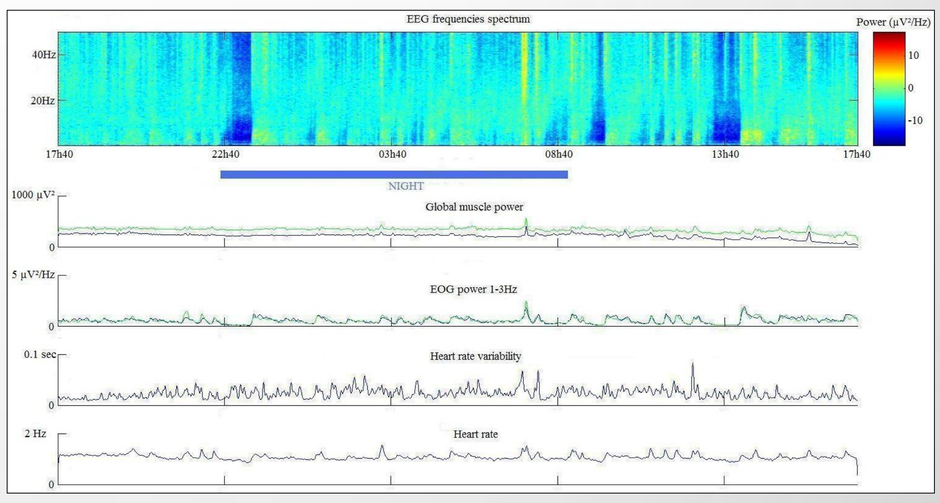

Fig. 4: "*Uncycled pattern" of brain activity (VS patient). Note the monotonous EEG plot as well as physiological recording traces (EMG, EOG, ECG)*

CONCLUSION

Preliminary results indicate that the complexity of sleep is higher in MCS than VS patients. Especially, sleep features such as REM sleep, SWS, and sleep spindles as well as cortical desynchronization arousals appear to distinguish between the two clinical entities.

It is suggested that this "complexity" of residual sleep patterns reflects more intact thalamo-cortically connected brains. Yet, results are to be interpreted with caution as classical R & K criteria are hard to apply in this DOC population. Especially, the general slowing of EEG frequencies make reliable SWS or spindle detection impossible. We therefore also consider more quantiative sleep analysis as depicted in Fig. 3-4.

Overall it is suggested that clinical diagnosis as well as prognosis of DOC patients can be refined using 24hr PSG recordings.

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