

An EEG-Based Scale for Comatose Patients' Vigilance State

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Abstract : Understanding the condition of comatose patients can be difficult, but it is crucial to their optimal treatment. Consequently, numerous scoring systems have been developed around the world to categorize patient states based on physiological assessments. Although validated and widely adopted by medical communities, these scores still present numerous limitations and obstacles. Even with the addition of additional tests and extensions, these scoring systems have not been able to overcome certain limitations, and it appears unlikely that they will be able to do so in the future. On the other hand, physiological tests are not the only way to extract ideas about comatose patients. EEG signal analysis has helped extensively to understand the human brain and human consciousness and has been used by researchers in the classification of different levels of disease. The use of EEG in the ICU has become an urgent matter in several cases and has been recommended by medical organizations. In this field, the EEG is used to investigate epilepsy, dementia, brain injuries, and many other neurological disorders. It has recently also been used to detect pain activity in some regions of the brain, for the detection of stress levels, and to evaluate sleep quality. In our recent findings, our aim was to use multifractal analysis, a very successful method of handling multifractal signals and feature extraction, to establish a state of awareness scale for comatose patients based on their electrical brain activity. The results show that this score could be instantaneous and could overcome many limitations with which the physiological scales stock. On the contrary, multifractal analysis stands out as a highly effective tool for characterizing non-stationary and self-similar signals. It demonstrates strong performance in extracting the properties of fractal and multifractal data, including signals and images. As such, we leverage this method, along with other features derived from EEG signal recordings from comatose patients, to develop a scale. This scale aims to accurately depict the vigilance state of patients in intensive care units and to address many of the limitations inherent in physiological scales such as the Glasgow Coma Scale (GCS) and the FOUR score. The results of applying version V0 of this approach to 30 patients with known GCS showed that the EEG-based score similarly describes the states of vigilance but distinguishes between the states of 8 sedated patients where the GCS could not be applied. Therefore, our approach could show promising results with patients with disabilities, injected with painkillers, and other categories where physiological scores could not be applied.

Keywords : coma, vigilance state, EEG, multifractal analysis, feature extraction

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