Continuous EEG monitoring in the Intensive Care Unit: Beta Scientific and Management Scientific aspects

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Abstract— **Due to various technological advances, it is now possible to continuously monitor critically ill patients using EEG, including the extraction of various quantitative features. In this study, several beta scientific and management scientific aspects of the implementation and use of cEEG on the ICU will be discussed.**

Keywords— **Continuous EEG, quantitative EEG, patient groups, cost, labour intensity**

I. Introduction

Continuous EEG (cEEG) monitoring provides a non-invasive and rather inexpensive method to continuously assess important aspects of the neurologic status of a patient. Because this technique can monitor brain function for long periods of time, even when patients are comatose or sedated, it can be of great use in the intensive care unit (ICU). For instance, Jordan [1] monitored 124 patients in a neuro ICU, and in 51% of these patients cEEG made an essential contribution for decisions that were taken by the physician. Another positive aspect of cEEG is that it can result in a declined length of stay on the ICU, shown in a study by Vespa *et al* [2]. It can also result in a reduced need for CT scans. However, there are various practical and logistical problems that have to be overcome before cEEG can be implemented in the ICU. For instance, analysis of the raw EEG signal has to be performed by a specialist, who is not always present in the ICU. This problem can be overcome by the accessibility of a network, so the physician can view the EEG from his office or from home, although this would be rather labour intensive. Quantitative EEG (qEEG) analysis methods and automated signalling can simplify interpretation for nursing staff of the ICU and reduce labour intensity as well [3,4].

In this study, we analyze the aspects that are involved in implementation and use of cEEG in the ICU. The beta scientific aspects that are analyzed are for instance the relevant patient groups that can be monitored and the suitability of the different qEEG features, including automated signalling. The management scientific aspects that are determined are the costs and labour intensity. Based on our own experience and literature about this subject, it is likely that a combination of qEEG features is needed to optimally monitor different types of injury. Analysis of the aspects involved in implementation and use of cEEG in the ICU will reveal the points of interest and will contribute to a successful implementation in the ICU.

II. Materials and methods

For this study, the experiences described in existing literature are reviewed. By means of information obtained from these studies, relevant patient groups will be established. All eligible patients will be monitored for 24 hours or up. EEGs are recorded according to the International 10-20 system with Ag/AgCl electrodes. Recording is performed using a NeuroCenter EEG System (Clinical Science Systems, Netherlands), with a. sampling frequency set to 256 Hz. Various quantitative features will be evaluated, as well, including the Brain Symmetry Index [5], mean spectral power coherence, and Nearest Neighbor Phase Synchronization [3]. Firstly, various of these features are evaluated off-line, using EEG recordings from our digital EEG database. Promising features will be implemented in NeuroCenter EEG for real-time analysis. Before actual long-term EEG recordings will start, several teaching courses for the intensive care physicians and nursing staff will be given.

III. Results

Several presentations were given to the ICU-staff, and long-term EEG recordings will soon be started. At the time of the congress, we expect to have included 10 to 15 patients. In Figure 1 we show an example of a potential qEEG feature, that may serve to detect seizure activity in ICU patients. This feature is based on the nearest neighbor coherence, and may serve to detect seizure activity.

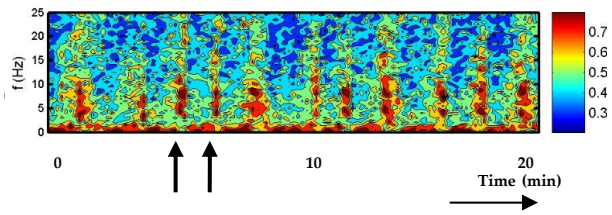

Fig. 1. Illustration of a qEEG feature that can assist in the detection of seizure activity. Arrows point to bursts of epileptiform discharges.

IV. Discussion and conclusions

Literature, and our own experience, strongly suggest that cEEG monitoring should be more commonplace. Various neurological derangements are very difficult, if not impossible, to detect in ICU patients, without the use of cEEG, in particular in sedated patients. This includes the presence of a non-convulsive status epilepticus or the occurrence of vasospasms. cEEG may assist in the detection of derangement in brain function in a still-reversible state, allowing a therapeutic window.

Various conditions need to be satisfied in order to successfully implement cEEG recording in the ICU. This includes teaching the ICU-staff about the various logistic and technical challenges.

We expect to have included 10-15 patients at the time of the congress. These data will allow us to draw our first conclusions about the beta and management scientific aspects of cEEG monitoring in the ICU.

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