

## Barriers to wider use of continuous EEG monitoring in ICU



Continuous electroencephalogram (EEG) monitoring is increasingly being used for brain monitoring in neurocritical care setting. This is mainly because of the proven effectiveness of continuous EEG in diagnosing nonconvulsive status epilepticus (NCSE) as a cause of unexplained consciousness disorder or mental deterioration. To date, however, no definitive diagnostic criteria exist for identifying EEG patterns suggestive of NCSE, according to a review paper in the *Journal of Intensive Care*.

"In particular, the ambiguous significance of PDs [periodic discharges] among EEG signals in the neurocritical care setting further complicates the diagnosis of NCSE. Although PDs are often associated with seizure, they can also be observed between seizures. Thus, analysing the change in EEG patterns over time is important for the correct diagnosis of NCSE," notes the report published by researchers mostly from the Department of Neurosurgery, Tokyo Women's Medical University in Japan.

NCSE is frequently encountered in the neurocritical care setting and is only accompanied by an altered EEG change without any clinically apparent manifestation, such as convulsion. Thus, it is considered a form of status epilepticus manifesting mainly with consciousness disorder. While NCSE poses diagnostic challenges, the report says, it should not be overlooked as NCSE is a curable condition.

NCSE is one of the brain responses associated with severe pathological conditions and is not a cause per se, the report authors explain, adding that most cases of NCSE are associated with acute brain disorders such as stroke, head trauma, and central nervous system (CNS) infection, while some cases also occur after neurosurgical craniotomy.

In addition to detection of NCSE, continuous EEG measurement in the ICU setting helps with assessment of sedative/anaesthetic state, early detection of delayed cerebral ischaemia associated with subarachnoid haemorrhage, and assessment of the outcome of patients with post-resuscitation encephalopathy or subsequent severe neurological disorders.

Especially useful for patients with NCSE, the report points out, continuous EEG can detect changes in EEG over time, thereby enabling the early initiation of treatment, and can evaluate response to treatment – if administered over time.

The report however cites some important factors which make it difficult to perform continuous EEG monitoring in the intensive care unit setting. These challenges include system-related problems, such as the preparation of mobile EEG devices and collodion-applied electrodes; human resource-related problems, such as staffing of EEG technicians and physicians who can respond flexibly to unscheduled needs; and EEG-specific difficulties in interpretation/diagnosis.

These issues preclude the widespread use of continuous EEG in daily practice, the authors note.

Since the numbers of EEG machines and technicians available are always limited, the report says, it is necessary to select patients who require continuous EEG. The standard portable EEG is sufficient for consciousness disorders of known cause (e.g., irreversible stroke due to brainstem haemorrhage or other causes, metabolic disorders such as hypoglycaemia, and drug intoxication). Moreover, digital EEG systems are required for continuous EEG monitoring. Current EEG systems have optional quantitative display functions, which allow detection of long-term changes in EEG signals at a glance and thus are useful for screening purposes.

For long-term EEG measurement, collodion-applied electrodes are usually used, instead of dish-type electrodes. Collodion-applied electrodes are preferred in the ICU setting because of possible electrode displacement during body repositioning, rehabilitation training, or other interventions performed by nurses, or due to sweating of the patient. Monitoring time is an important factor affecting the examination results.

Treatment for NCSE is based on the evaluation and management guidelines for status epilepticus proposed by the American Neurocritical Care Society. The first-line treatment consists of fosphenytoin at a loading dose of 22.5 mg/kg or 15 mg phenytoin equivalent (PE)/kg, followed by checking EEG patterns for any improvement 12 hours later, as well as measuring blood phenytoin concentration to check whether the concentration reaches the optimal level.

"Although the recommended phenytoin dose in the overseas literature is 20 mg PE/kg, we have used the 15 mg PE/kg dose and achieved a blood concentration of 10–15 µg/ml on the following day," the Japanese authors say, adding that further studies are needed to collect sufficient continuous EEG data and assess the outcome of patients who have undergone therapeutic interventions.

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