Case report

The practice of EEG monitoring in Neurointensive Care

Introduction

With the rapid spread of the concept of Neurointensive Care in recent years, intensivists and emergency physicians around the world have become more conscious of the importance of EEG monitoring. In order to provide information about EEG monitoring that will be useful in clinical practice, we will introduce reports from doctors representing each field on the practical implementation and challenges of EEG monitoring at facilities practicing Neurointensive Care.

The significance of EEG monitoring in ICU

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The purposes and applications of EEG monitoring in Neurointensive Care

The patient conditions for which EEG monitoring is used in our intensive care unit (ICU), listed in descending order, are altered mental status with unknown cause, neurological prognostication of post-cardiac arrest syndrome (PCAS), new-onset refractory resistant status epilepticus (NORSE) with suspected encephalitis, seizure after traumatic brain injury (TBI) and cerebrovascular accidents, status epilepticus in patients with known history of epilepsy, and myoclonus with unknown causes. The main purposes we use EEG monitoring for are detection of non-convulsive status epilepticus (NCSE), evaluation of response to anticonvulsive treatments and neurological prognostication. The most common reason to start EEG monitoring for possible NCSE in our hospital is a “Discrepancy between neurological findings and images such as CT / MRI or clinical history”. In such cases, EEG provides the most important diagnostic information, and may also prevent unfavorable neurological outcomes resulting from untreated NCSE. Although our ICU does not specialize only in Neurointensive Care, the use of EEG monitoring is increasing year by year with a current average of 5 to 10 cases per month in our 14-bed ICU.

The actual practice, workflow and challenges of EEG monitoring

Previously, we had to call the physiology lab and order EEG with a full montage, which was not designed for monitoring of ICU patients. As a result, there were many practical problems such as unavailability at night and interfering with nursing care due to the large number of electrodes. Therefore, we tried a simple form of EEG monitoring with 2 channels in which waveforms could be seen at bedside monitors. However, the clinical significance of this simple EEG monitoring was limited because it was not possible to exclude NCSE, as a result of low sensitivity due to too few electrodes. After the new 6 to 8-channel headband and wireless type headsets became commercially available, conducting EEG monitoring with decent enough sensitivity to rule out clinically significant NCSE has become much easier in our ICU (*1). In order to display and record EEG waveforms obtained by the headband and wireless type headsets, we have two choices; either a video-EEG device which is designed for full EEG monitoring, or a device to connect the bedside monitors (the EEG waveforms can be seen along with the other routine parameters and waveforms such as EKG, heart rate and arterial blood pressure) in case the only video-EEG device is being used somewhere else in the ICU. Although displaying and recording EEG waveforms on bedside monitors has disadvantages, such as the low waveform resolution and impossibility of completely distinguishing artifacts, especially those caused by nursing care, from true epileptic discharges simply by reviewing the recorded waveforms without use of a video camera, it is still useful for patients who “may be having NCSE right now”. Because it is not uncommon to have multiple patients with possible NCSE at the same time, the patients with higher probability of NCSE have priority on the full video-EEG monitoring in our ICU.

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The duration of EEG monitoring to rule out NCSE is around 24 hours, depending on the case. In order to detect NCSE, we pay attention not only to EEG waveforms but also to changes in heart rate, blood pressure, respiratory rate, and subtle movements of the facial muscles and limbs. The EEG monitoring may be continued for several days or even several weeks to monitor therapeutic responses to treatments and recurrence of NCSE, especially when sedatives are titrated down.

We do not expect nurses or junior residents to learn terminology for EEG-specialists to describe EEG waveforms. Instead, they are expected to use our simple algorithm sheet in which one of the instructions is “Call attending physicians or fellows if EEG waveforms look like sinus tachycardia” for example.

Because of the nature of an ICU, false epileptic EEG waveforms are very common due to frequent noise from various devices such as ventilators as well as from the provision of nursing care. The only way to solve the problem is using EEG-video monitoring to retrospectively confirm the patient environment synchronously. In addition to the expensive full video-EEG, EEG monitoring in Neurointensive Care would be further enhanced if the EEG waveforms recorded in the bedside monitors could be reviewed with a simultaneous video image.

(*1) : The headbands and headsets can be easily applied by nurses or physicians.

Case reports

<Case 1>

62 yo male was brought to the emergency room with altered mental status after sudden onset of headache. Head CT and MRA confirmed subarachnoid hemorrhage (SAH) of Fisher grade II and an aneurysm at anterior communicating artery. The patient underwent clipping of the aneurysm and was transferred to our ICU. However, he remained comatose with GCS of E1 VT M2 even on the next morning without any sedation. The “Discrepancy between the CT image and neurological findings” triggered us to start continuous EEG monitoring, which showed rhythmic delta activities interrupted by rhythmic sharp waves at 4 / sec in all the 6 channels. He was deeply sedated with propofol and was started on levetiracetam as NCSE. His mental status improved by gradually titrating down propofol while confirming that there were no significant epileptic discharges using EEG monitoring.

<Case 2>

67 yo male with a PMH of post-stroke epilepsy was hospitalized with fluctuating mental status and muscle jerks in the left upper extremity. The head CT was normal. He continued to have intermittent altered mental status even with increased antiepileptic medications for probable epilepsy in the general ward. He finally became comatose and was transferred to our ICU. We immediately started EEG monitoring and did not find any epileptic waves. Chart review revealed that he had anisocoria with dilated right pupil and relatively low blood pressure whenever he had an impaired level of consciousness as recorded by the ward nurses. MRI and MRA of the brain was obtained for possible “hemodynamic-dependent midbrain ischemia”, which showed significant narrowing of right vertebral artery in MRA and mild ischemia of the right cerebellum and midbrain in DWI. The patient underwent emergency endovascular treatment for the right vertebral artery. Unfortunately, the patient died because reperfusion of the right vertebral artery could not be obtained and the brain stem ischemia progressed.

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