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ELECTROENCEPHALOGRAPHY PATTERN IN CRITICAL ILL PATIENT WITH DECREASED LEVEL OF CONSCIOUSNESS AT HIGH CARE UNIT

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ABSTRACT

***Background*:** Brain dysfunction is associated with increased mortality in high care unit. Brain dysfunction due to convulsive seizures, nonconvulsive seizures or ischemia, may be difficult to identify by neurological examination. EEG examination can identify brain dysfunction.The aim of this study is to describe the most EEG pattern in critical ill patient with decreased level of consciousness at high care unit

***Methods*:** This is a retrospective study. All patients who were treated in the high care unit and underwent an EEG examination in January-December 2019 was conducted in this study. The outcome of this study such as the sociodemographic patient characteristics (like age, sex and history of seizure during treatment in high care unit, past medical history of seizure), etiology diagnosis and EEG pattern. All data were analyzed using SPSS 25.

***Conclusion*:**Continous Slow Activity (CSA) was most commonly abnormal EEG features in critical ill patient with decreased level of consciousness at high care unit.

Keywords: Electroencephalography, high care unit, seizures

Introduction

The incidence of seizures in the general population is about 40/100,000[1]. Risk of seizure as a main reason or complication of admission in Intensive Care Unit(ICU) is 3.3%, although the actual incidence is likely to be significantly higher. Seizures occurs in 28,1% patient and as second cause of neurologic complication after metabolic encephalopathy according in prospective clinical evaluation of all medical ICU admissions for over 2 years2. Risk of neurologic complication in critically ill patients was very high, including seizures, ischemia, edema, infection, and increased intracranial pressure, which can cause permanent neurologic disability if untreated[3].

Recognition of seizures in high care units is important to explore morbidity, mortality and the risk of developing epilepsy. The use of electroencephalography (EEG) in high care unit population not only focuses on the high incidence of seizures but also helps in assessing cerebral function due to ischemia monitoring, prognosis, and evaluate the degree of encephalopathy[4].

Status epilepticus (SE) is one of the most serious manifestations in epilepsy and defined as recurrent epileptic seizures without complete recovery between seizures. Generalized convulsive status epilepticus (GCSE) is the most common and most life-threatening form of SE and the mortality risk increases with aging. Non-convulsive SE is a term that used to include complex partial SE and absence SE – both of which present as an "epileptic twilight state" – and SE in comatose patients. Diagnosis of non-convulsive SE can be difficult, especially in the elderly, clinical features can be overlapping, electroencephalogram patterns can be seen in SE and in a variety of encephalopathic conditions[5].

Non-convulsive seizures cause coma and mental changes in 18 to 45% of patients admitted to high care units. Non-convulsive seizures can be suspected in patients with impaired consciousness with unclear causes and no motor symptoms. Although clinical manifestation of seizure is the best evident to define the type of seizure. Correct diagnosis of seizure requires EEG) examination[6,7]. Approximately 30% patients with decreased of consciousness that admitted to high care units have non-convulsive status epilepticus. EEG

monitoring can be recommended in patients with decreased of consciousness in high care units to obtain early detection of non-convulsive status epilepticus followed by appropriate interventions[8].

*Electroencephalography*is a clinical neurophysiological tool used to evaluate the activity of cerebral cortex[5]. The change of EEG pattern can be observed at the onset of neurological complications. EEG examination provides diagnosis, therapeutic monitoring, and seizure monitoring in high care units. EEG is particularly useful in detecting subclinical seizures and nonconvulsive status epilepticus in critically ill patients, including those under sedation treatment. In addition, EEG is involved in the differential diagnosis of epilepsy, non-epileptic abnormal movements, and motor deficits due to focal seizures in high care units[9].

Methods

This is a retrospective and record-based study. The patients were identified from the medical records, starting from January 2019 to June 2019.The inclusion criteria of our study was patients with seizure and altered mental status who performed *electroencephalography* (EEG) examination and treated in high care unit DR. Soetomo General Hospital Surabaya. Consent was sought for accessing the medical records. Patients who inclompleted medical records were excluded. The following information was noted such as the sociodemographic patient characteristics (like age, sex and history of seizure during treatment in high care unit, past medical history of seizure), etiology diagnosis and EEG pattern. All data were analyzed using SPSS 25.

Results

We obtained data on 63 participants in the high care unit who had decreased of consciousness and performed an EEG examination. A total of 18 patients were excluded due to incomplete medical record data. We identified 45 patients who met inclusion and exclusion criteria. We got 45 EEG records, and 3 types of EEG pattern abnormalities. We found 29 (65,8%) was male and 16 (34,1%) was female. The ratio of men and women was 1.8:1. The mean of age was 50.9 years old. Seizure was recorded during in 27(60%) of participant during EEG examination and there are 40(88,9%) participant with no past medical history of seizure as shown in Table 1. Convulsive status epilepticus occurs among 23(51,1%). The mean of days interval since motor seizure onset to performed EEG examination was 2,4.

We identified 6 diagnoses of patients treated in high care units, including stroke, encephalitis, encephalopathy, intracranial tumour, Traumatic Brain Injury (TBI) and epilepsy. Stroke was the most etiology diagnosis that found in patient with altered mental state treated at high care unit. Abnormal EEG pattern found in 77(92,7%) patient as shown in Table 2.Most EEG waves were abnormal slowing activity 60(77,9%)based on Table 3. Nine patients with generalized slowing activity had unilateral abnormal brain imaging and 1 patient with focal slowing activity had bilateral abnormal brain imaging. We found 2 patients with encephalitis and stroke with focal epileptogenic discharge and bilateral abnormal brain imaging. We got 1(2,22%) patient with non-convulsive seizure.

Discussion

Convulsive status epilepticus occurs among 23(51,1%) based on Table 1. High incidence of status epilepticus is not accompanied by the findings of an eeg seizure. Occurrence of EEG seizure was very low 1(11,1%) because EEG examination can not be performed immediately in high care unit. EEG examination performed in outpatient unit due our facilities limitations. The mean of days interval since motor seizure onset to performed EEG examination was 2,4 days. There was limited facility to assess the brain function at our high care unit recently. The use of EEG in the Intensive Care Unit(ICU) is not widely discussed or evaluated even in advanced countries. Electroencephalographic monitoring gives dynamic information about the brain function that permits early detection of changes in neurologic status, which is especially useful when the clinical examination is limited. Identification of ongoing electrographic seizures, Non-Convulsive Status Epilepticus (NCSE), Periodic Epileptogenic Discharges (PED), irreversible cerebral dysfunction would help the physician in rapid and appropriate diagnosis and therapy[10].

Loss of consciousness due to non-convulsive seizures occurs in 18 to 45% in intensive care unit patients[3]. The incidence rate of non-convulsive seizures is 8.5% and is associated with a poor outcome (86.7%) with an odds ratio (OR) of 5.1 (95% confidence interval [CI] 1.09 - 23.8)[7]. Based on 1123 consecutive patients monitored on EEG, incidence seizure of awake patients was 10% and comatose was 30%8. Hantus Study 2019 showed that of 215 patient with seizure, EEG monitoring performed about 19.1%. In total, 89.3% of these seizures occurred without clinical signs. Patients who were in a coma were more likely to have seizures (OR 3.64; 95% confidence interval, 2.23-5.95) than patients in aware condition[1].

Decreased of consciousness was assumed caused by non-convulsive seizures because high incidence of non-convulsive seizures in patients with decreased of consciousness. We got 1(2,22%) patient with nonconvulsive seizures. This incidence was lower than prior studies might because continousEEG(cEEG) can not be performed in our hospital facilities. Epilepsy is the most frequent epileptic seizures with a prevalence of

convulsive type was 78% and non-convulsive type was 18%, the other was mixed type[9]. Meanwhile, patients with seizure-free still need regular follow up because the brain waves not returned to normal condition yet and there was possibility of reccurent epilepsy if there is sufficient stimulation[10]. cEEG for at least 48 h in comatose patients was recommend by the recent Neurocritical Care Society's guidelines to evaluate for NCS[11]. Patient with critically ill perform continuous EEG monitoring (cEEG) to detect non-convulsive seizures (NCS) and status epilepticus (NCSE)[12].

Slowing activity was the most abnormal EEG pattern found in critically ill patient at our high care unit 60(77,9%) and general CSA in 22(73,3%). Abnormal EEG findings consist of ictal patterns (observed during an epileptic ictal event), interictalepileptiform activity and non-epileptiform abnormalities. General CSA can be found in conditions that affect both cortical as subcortical structures, as well as the presence of several toxic-metabolic encephalopathies, early stages of coma and deep midline lesions. This type of abnormality is related to disease states that affect neurons at cortical and subcortical levels and they are not specific to deep midline pathology or increased intracranial pressure[13]. The EEG in CNS infections consist of variable abnormalities such as generalized slowing, focal slowing, and epileptiform discharges[14]. Generalized CSA also can be found in viral encephalitis as seen in Figure 1.

A total of 7.6% of patients with diagnosis of encephalitis had *Periodic Lateralized Epileptiform Discharges* (PLEDs). This finding is appropriate with study performed by Azabou et al. who also found PLEDs wave in patients with encephalitis[9]. High-risk epileptiform patterns such as PLEDs are common in patients with encephalitis and suggest a high risk for seizure of 60%–71%[1]. PLEDs are common in patients with encephalitis and represent 60% to 71% risk for seizures[1]. The EEG is an easy, non-invasive test and its sensitivity can help confirm early brain pathological processes, even before MRI abnormalities are seen[15].

There was 22,2% patient in our study diagnosed as encephalopathy. Triphasic wave (TW) was found in 10% patient with encephalopathy. Triphasic wave generally reflect metabolic encephalopathy[9]. TW is moderate to high amplitude complexes with three (but sometimes two or four) negative-positive-negative phases and common occurring in runs at 1.5–3 per second. TW specific to severe hepatic encephalopathy, but TW also found in encephalopathies caused by renal failure, electrolyte imbalance, anoxia and other intoxications such as lithium, metrizamide, and levodopa[16]. The EEG features of acute encephalopathy generally show non epileptiform disorders, such as slowing in background activity with or without triphasic waves and reflect underlying structural or metabolic problems[17]. Burst suppression may be observed in severe post-anoxic encephalopathy and in cases of deep sedation[9].

Among 17(37,8%) patients were diagnosed with stroke. We found slow wave activity 15(88,2%) and normal waves 2(11,8%) patients respectively. Slow wave activity that accompanied by sharp waves was found in 6,7% patients of stroke. Incidence of seizure in ischemic stroke was 17.7%, consist of 9.8% were acute strokes and 7.9% were chronic strokes4. EEG monitoring in ischemic stroke detecting epileptic activity in 44% patients which is consist of nonconvulsive status epilepticus (12%) and periodic discharges showed epileptogenic activity(21%)[18].

Background suppression, BSA and CSA were found as EEG features in TBI according to our study. TBI is often associated with acute symptomatic seizures within the first 14 days of injury. Seizures are more common in patients with temporal or frontal lobes damage. EEG seizures found in 22% of acute TBI in a study of 94 patients. Early EEG seizure common seen in acute TBI and often became chronic epilepsy[4].

In our study there were 3(6,7%) patients with brain tumors and which 2(66,7%) had performed tumor resection. Epileptogenic discharge that found in patient who had performed tumor resection can be related to the size of the tumor mass and the extent of cerebral edema. Another study in 100 patients showed that seizure activity on EEG recordings within 24 hours after surgery found in 7 patients and late seizure occur in two patients (2%)[19].

Two of our patients with comorbid epilepsy and altered consciousness showed EEG features of normal PLEDs and waves. In patients with normal waves, epileptogenic discharge may not appear during recording but may appear outside the recording time. Background EEG can be normal in patient with epilepsy and abnormal interictal EEG waveforms may appear include nonepileptiform abnormalities and interictalepileptiform discharge (IED). Patients with epilepsy may exhibit generalized or focal slowing of the background, but the presence of a focal or generalized IED supports the diagnosis of epilepsy[17].

EEG examination is an important support in the management of patients in high care units because it can help in early detection of seizures and monitor treatment response. The EEG device used should be able to be attached in patients with decreased consciousness with or without seizure manifestations during treatment in the high care unit. This study shows the importance of anticipating the appearance of abnormal EEG waves in patients with altered mental status so that clinicians can make an immediate decision to start therapy according to the results of EEG wave abnormalities.

COMPETING INTERESTS

The authors state no conflict of interest.

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STATEMENT OF ETHICS
This study was evaluated and approved by the Research Ethics Committee ofDR.Soetomo General Hospital, East Java, Indonesia, number: 2031 / KEPK / VIII / 2020 .

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Tabel 1. Demographic and Clinical Data

Population	**n(%)**	**Mean**
Sex		
Male	29(65,8)	
Female	16(34,1)	
Age (years old)		**50,9**
History of seizures during treatment in the high care unit		
Yes	27(60)	
No	18(40)	
Past medical history with seizures		
Yes	5(11,1)	
No	40(88,9)	
Convulsive status epilepticus in high care unit		
Yes	23(51,1)	
No	22(48,9)	
Days interval since motor seizure onset to performed EEG examination (day)		**2,4**

Table 2. Etiology Diagnosis and EEG Pattern Distribution

	n(%)
Etiology	
Stroke	17 (37,8)
Encephalitis	11 (24,4)
Enchephalopaty	10 (22,2)
Intracranial tumour	3 (6,7)
Traumatic Brain Injury	2 (4,4)
Epilepsy	2 (4,4)
EEG wave	**83 (100)**
Normal EEG	6 (7,2)
Abnormal EEG	77 (92,7)

Table 3. Abnormal EEG Pattern

	n(%)
Abnormal EEG (n=77)	
Slow wave activity	**60(77,9)**
BSA	23(38,3)
ISA	7(11,7)
General	2(28,5)
Focal	5(71,4)
CSA	30(50)
General	22(73,3)
Focal	8(26,7)
Epileptogenic pattern	**6(7,7)**
Focal Sharp Wave	4(44,4)
Focal SSWC	1(11,1)
Focal EEG seizure	1(11,1)
Other Type	**11(14,2)**
PLEDs	3(33,3)
General Periodic pattern	1(12,5)
General Triphasic wave	1(12,5)
General Burst suppression	1(12,5)
GeneralBackground Suppresion	2(250
Asymetric Background Rhythm	3(37,5)

BSA: Background Slow Activity, **ISA:**Intermittent Slow Activity, **CSA:**Continous Slow Activity, **PLEDS:**Periodic Lateralized Epileptiform Discharges, **SSWC:**Slow Spike and Wave Complexes

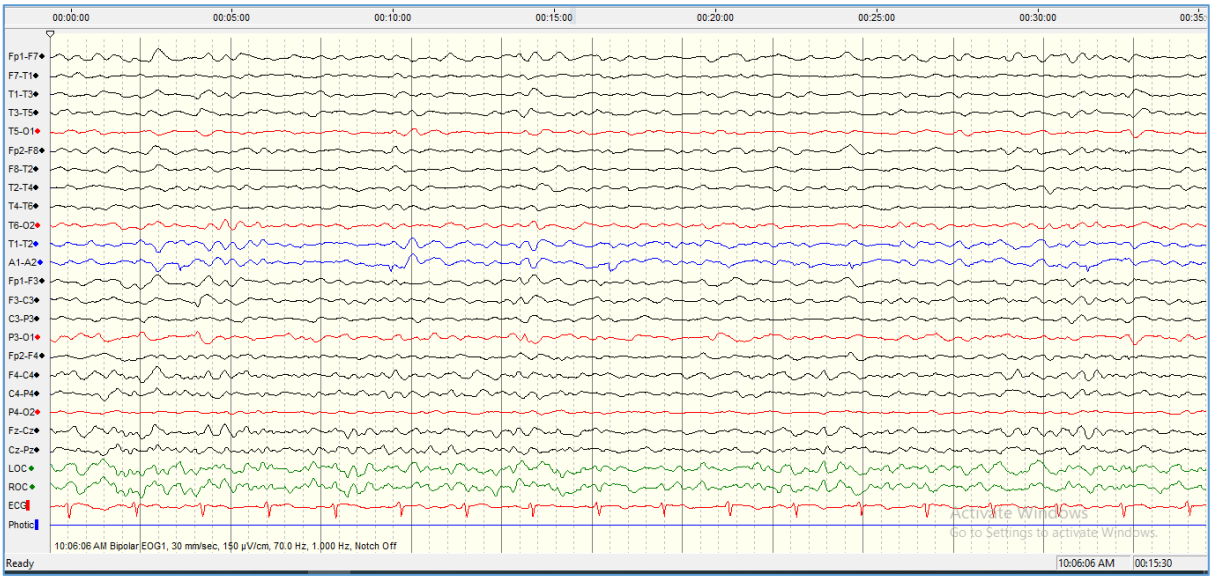

Figure 1.A 65-year-old woman came to the emergency department with a loss of consciousness. The history, physical examination, neurologic examinations suggest viral encephalitis. EEG was performed and a generalized continuous slow activity (CSA) was obtained.