

## The value of electroencephalography in differential diagnosis of altered mental status in emergency departments

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### Abstract

**Objective:** To evaluate the value of electroencephalography in patients with altered mental status in emergency departments.

**Methods:** Demographical characteristics, types and aetiologies of seizures, and clinical outcomes of the patients were recorded. Patients were divided into 4 groups according to the complaints of admission: findings and symptoms of seizure; stroke and symptoms of stroke-related seizures; syncope; and metabolic abnormalities and other causes of altered mental status. The electroencephalography findings were classified into 3 groups: epileptiform discharges; paroxysmal electroencephalography abnormalities; and background slowing. Electroencephalography abnormalities in each subgroup were evaluated. SPSS 21 was used for statistical analysis.

**Results:** Of the total 190 patients in the study, 117(61.6%) had pathological electroencephalography findings. The main reason for electroencephalography in the emergency department was the presence of seizure findings and symptoms in 98(51.6%) patients. The ratio of electroencephalography abnormality was higher in patients who were admitted with complaints of metabolic abnormality-related consciousness disturbances ( $p<0.001$ ). A total of 124(65.3%) patients had neuroimaging. Electroencephalography abnormalities were found to be significantly higher in patients with neuroimaging compared to those without neuroimaging ( $p<0.003$ ).

**Conclusion:** Despite advanced neuroimaging techniques, electroencephalography is still an important tool in the differential diagnosis of altered mental status such as epileptic seizures, metabolic abnormalities, pseudo-seizures and syncope.

**Keywords:** EEG, Altered mental status, Emergency department. (JPMA 64: 923; 2014)

### Introduction

Electroencephalography (EEG) is an inexpensive but useful diagnostic tool for revealing the functional status of the brain and reflecting the relation between a patient's alertness and functional disorders of the brain.<sup>1</sup> Although the use of EEG has been limited in the last 10 years because of the development of other neuroimaging techniques, like, magnetic resonance imaging (MRI), single photon emission computed tomography (SPECT) etc, EEG is still used to diagnose the cause of unexplained altered mental status (AMS) when routine screening tests do not determine the cause.<sup>2</sup>

AMS is a significant challenge to emergency department (ED) physicians because it is a manifestation of a wide range of medical syndromes and does not indicate a specific diagnosis.<sup>3</sup> Sudden onset diseases with AMS, such as epilepsy, metabolic disorders, encephalopathy and

encephalitis, consist of a large proportion of ED admissions (up to 10% of the patients).<sup>3,4</sup> The ED practitioner who is faced with a patient with AMS may find a quick EEG helpful in ensuring efficacious patient care.<sup>1</sup> EEG may have a great value in AMS patients with normal neuroimaging findings.<sup>4</sup> However, EEG is underused or often not available in EDs. Proposed reasons for this underuse include lack of availability and lack of awareness of the utility of EEG. There are only a few studies in literature about EEG usage in EDs, and its value on patient management.<sup>1</sup> In this study, we aimed at determining the value of EEG in patients with AMS in EDs.

### Patients and Methods

The retrospective study was conducted at the Emergency Department of a tertiary care university hospital of Ondokuz Mayıs University in Turkey, and comprised record of patients with AMS who had undergone EEG between 2005 and 2011.

The ED has an adult patient population and treats approximately 45000 patients per year. The study was approved by the institutional ethics committee. Adult patients older than 18 years who presented to the ED with AMS and had undergone EEG were included in the study.

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The presence of seizure, syncope, stroke, or metabolic abnormalities was determined by an ED physician and a neurologist. Patients with recent head trauma were not included in the study. AMS was defined as a new onset change in the level of arousal and quality of awareness.<sup>3</sup>

Historical features suggestive of a seizure, such as tongue biting, postictal confusion, incontinence, and presence of neurological deficits were noted. Seizure types were determined according to the anamnesis of the patients' relatives and the observations of the physicians. The parameters of metabolic status including glucose level, fever, electrolyte levels, and liver and kidney function tests were noted.

Patients were divided into 4 subgroups according to their complaints on admission: (1) seizure; (2) stroke-related seizures; (3) metabolic abnormality-related consciousness disturbances (MARCD); and (4) syncope. EEG abnormalities were investigated in all patient subgroups.

For EEG recordings, the standard EEGs consisted of a minimum 20 minutes recording with a 32-channel digital EEG machine (Micromed, Mogliano Veneto, Italy) using 20 hydrogen electrodes placed according to the international 10-20 system. EEG collection was at a low-frequency filter setting of 0.01Hz and a high-frequency filter setting of 70Hz. All EEGs were obtained within the first 12 hours after the patients' admission. Initially, EEG results were divided into 2 subgroups: normal or pathological. Pathological findings of EEG were classified as follows: (a) epileptiform discharges (focal spikes, multifocal spikes, generalised spike waves, spike-wave complexes, or presence of photoparoxysmal responses); (b) paroxysmal EEG abnormalities; and (c) background slowing (focal or diffuse).

Data was analysed using SPSS 21.0. Continuous data was presented as mean  $\pm$  standard deviation (SD), and categorical data as frequencies and percentage. Results were presented with descriptive statistical information. Chi-square test and Fisher's exact test were used. A p-value of less than 0.05 was considered statistically significant.

## Results

Initially, EEG records of 232 patients admitted to the ED were analysed, but subsequently 42(18%) had to be discarded: 32(14%) because of lack of medical records; 7(3%) because they related to patients below 18 years of age; 1(0.4%) because of the diagnosis of intoxication; and 2(0.8%) because they had received EEG because of headaches. The study sample, as such, comprised data of 190(81.9%) patients.

**Table-1:** Baseline demographic characteristics of the patients.

	n	(%)
<b>Gender</b>		
Male	101	53.16
Female	89	46.84
<b>Admission diagnosis</b>		
Epilepsy	98	51.6
Generalized tonic clonic	29	29.59
Simple partial	17	17.34
Complex partial	29	29.59
Focal	14	14.28
Status epilepticus	4	4.1
Others	5	5.1
Stroke related seizure	22	11.6
MARCD	41	21.6
Syncope	29	15.2
<b>Accompanying diseases</b>		
Epilepsy treatment history	65	34.21
Stroke	42	22.1
Metabolic disturbances	15	7.89
Epilepsy history in family	10	5.26
CNS infection	6	3.15
Cranial trauma history	6	3.15
Cerebral operation history	5	2.65
Cerebral tumor history	3	1.57
Undetermined	38	20.02
<b>Final status of the patients</b>		
Discharged	119	62.63
Hospitalised	70	36.84
Exitus	1	1.9

CNS: Central Nervous System.

MARCD: Metabolic abnormality-related consciousness disturbance.

Within the sample, 101(53.16%) were male and 89(46.84%) were female. The overall mean age of the patients was 47.6 $\pm$ 20.1 years (range: 18-87 years). All EEGs were performed within the first 12 hours of admission. Pathological findings were determined in 117(61.6%) EEGs, and the EEGs of 73(38.4%) patients were found to be normal. Clinical and demographical features of the patients were noted (Table-1).

The largest number of patients who underwent EEG was in the epilepsy group 98 (51.6%); 41(21.6%) underwent EEG because of MARCD; 29(15.2%) because of complaints of syncope; and 22(11.6) because of stroke-related seizure (Table-2).

Abnormal EEG findings were more common in patients with MARCD when compared to those with epileptic seizures, syncope, or stroke-related seizure ( $p < 0.002$ ,  $p < 0.001$ , and  $p < 0.001$ , respectively).

Among 41 patients with MARCD, the aetiological factors

**Table-2:** EEG abnormalities according to the admission complaints.

	Normal EEG	EEG findings n(%)			Total
		Epileptic discharges	Diffuse/focal slowing	Paroxysmal abnormality	
Epileptic seizure	40 (40.81%)	25(25.51%)	19(19.38%)	14 (14.28%)	98(51.6%)
Stroke related seizure	10 (45.45%)	3(13.63%)	4(18.18%)	5 (22.72%)	22(11.6%)
MARCD	7 (17.07%)	7(17.07%)	14(34.14%)	13 (31.70%)	41(21.6%)
Syncope	16 (55.17%)	5(17.24%)	3(10.34%)	5 (17.24%)	29(15.2%)
Total (n: patients)	73	40	40	37	190

MARCD: Metabolic abnormality-related consciousness disturbance

EEG: Electroencephalography.

**Table-3:** Neuroimaging findings in all patients.

	n	%
<b>Neuroimaging</b>		
Yes	124	65.3
No	66	34.7
Pathological findings	43	35.4
<b>CT</b>		
Yes	110	57.9
No	80	42.1
Pathological findings	30	27.2
<b>MRI</b>		
Yes	44	23.2
No	146	76.8
Pathological findings	11	25.0
<b>Diffusion MRI</b>		
Yes	15	31.0
No	175	69.0
Pathological findings	2	13.3
Total	190	

CT: Computed tomography.

MRI: Magnetic Resonance Imaging.

EEG: Electroencephalography.

found were one or more of the following: electrolyte imbalance in 17(41.5%) patients; uraemia 15(36.6%); systemic infection 8(19.5%); central nervous system (CNS) infection 6(14.6%); hepatic encephalopathy 2(4.87%); and malignancy 2(4.87%). In biochemical analyses on admission, hyperglycaemia was found in 15 (36.6%) patients, and hypoglycaemia in 5(12.19%).

Of the 58 patients with both the complaints of epileptic seizure and abnormal EEG findings, 44(75.86%) had interictal epileptiform discharges. Among the patients with complaints of epileptic seizures, the epileptiform abnormality was the most commonly seen EEG abnormality ( $p<0.05$ ).

Neuroimaging was performed in 124(65.3%) patients. Among them, 80(64.5%) only had computed tomography

**Table-4:** Distribution of EEG findings with neuroimaging in all patients.

	Patient with neuroimaging	Patient without neuroimaging	p
Normal EEG	38/124	35/66	0.003
Abnormal EEG	86/124	31/66	0.003
Epileptic discharges	29/124	11/66	0.259
Diffuse or focal slowing	35/124	5/66	0.000
Paroxysmal abnormality	22/124	15/66	0.421

EEG: Electroencephalography.

(CT) scans performed. In 14(11.3%) patients, only MRI was performed. In 30(24.2%) patients, both CT and MRI were performed. Pathological findings in CNS neuroimaging studies numbered 43(35.4%) (Table-3).

The rate of EEG abnormalities in patients with neuroimaging were found to be significantly higher when compared to those without neuroimaging ( $p=0.003$ ). This significance was due to the higher rates of focal and diffuse slowing in the EEGs of the patients with neuroimaging. A statistically significant difference was not determined for paroxysmal abnormalities and epileptic discharges between the patients with and without neuroimaging studies ( $p<0.256$ ,  $p<0.421$ , respectively) (Table-4).

While 119(62.63%) patients were discharged from the ED, 70(36.84%) were hospitalised in order to perform further examinations.

## Discussion

EEG is rarely used in EDs because it is not readily available. Due of delays in performing EEG, it can be difficult to make the correct diagnosis, and useless tests may be done.<sup>5</sup> The use of EEG has been limited in the last 10 years because of the development of other neuroimaging techniques. Neuroimaging methods are mostly used to diagnose structural lesions, but structural changes are not present in the majority of patients admitted with AMS to

EDs. Moreover, studies have revealed that structural neuroimaging findings were observed only in 7% to 21% of the patients admitted to EDs with AMS.<sup>6</sup> AMS conditions are frequently seen in EDs and are involved in the differential diagnosis of many diseases. Such a wide spectrum makes it harder for ED physicians to make an exact diagnosis in patients with AMS.

In a study investigating the factors of AMS, the following were identified: neurological 28%; toxicological 21%; traumatic 14%; psychiatric 14%; infectious 12%; endocrinological 5%; and metabolic 9%.<sup>7</sup> Aetiological factors may vary according to age groups. In older populations, the most common aetiological factors are stroke, hypoglycaemia, sepsis and hyperammonaemia.<sup>8,9</sup> In this study, we investigated the distribution of aetiological factors, and the value of EEG in the diagnosis and treatment of the patients presenting with AMS. The most common aetiological factor for performing EEG was found to be presentation with the symptoms of seizure, followed by MARCD (21.6%), syncope (15.2%), and stroke-related seizure (11.6%). The patients with AMS due to trauma were excluded from the study. In accordance with literature, structural changes of CNS were found in 21% of neuroimaging studies.

EEG is a tool that is used in the diagnosis of encephalopathy, and it facilitates making differential diagnosis. EEG is also important for the diagnosis of diseases such as non-convulsive status epilepticus, encephalitis, and hepatic encephalopathy.<sup>5,10,11</sup> In addition, it is a useful tool in the differentiation of pure psychogenic and psychiatric disorders that are frequently confused with AMS.<sup>5</sup> Moreover, EEG is cheap, easily available, and administered with a non-invasive instrument.<sup>1,4,11</sup>

A study evaluating AMS with EEG<sup>11</sup> investigated the utility of EEG in supporting the diagnosis. It reported that EEG supported the diagnosis in 36% of the patients, and did not support the diagnosis in 64%. It was also reported that EEG affected the treatment modality in 37.8% of the patients. In our study, pathological EEG findings were determined in 61.5% of the patients. EEG activity was higher in patients with MARCD, as compared to those with epilepsy (82.9% to 59.2%), whereas epileptiform activity was higher in patients with epilepsy (26.5% to 14.6%).

Basement-activity changes and paroxysmal EEG abnormalities were more common in patients with MARCD (34.14%). Ricardo et al.<sup>2</sup> reported abnormal EEG activity in 72.2% of the patients with acute impairment of consciousness. However, EEGs were obtained 24 hours

after admission in the majority of their patients (53.3%). In our study, EEG abnormalities were determined in 59.2% patients with clinical findings of epileptic seizures, and 44.8% of these patients had epileptiform discharges.

In 3 studies in which EEG was performed within 48 hours after the seizure, rates of abnormal EEG findings were 70.7%, 45%, and 69%, respectively.<sup>12-14</sup> A study<sup>5</sup> evaluated EEG findings of 50 patients with AMS. It reported epileptiform discharges in 9(18%) patients.

Another study<sup>15</sup> evaluated EEGs of 99 patients with syncope, and determined abnormality in 14% of EEGs. Moreover, it reported epileptiform discharge in only 1%. In our study, 44.8% of the 29 patients with syncope had EEG abnormality. Among these, 4(13.8%) had epileptiform discharges. One study<sup>16</sup> investigated the EEG findings of 1094 patients with syncope, and determined a high rate of EEG abnormality (29%). However, it determined epileptiform discharges in only 1.5% of the EEGs.<sup>16</sup> Their results show that prolonged syncope may cause changes such as EEG slowing and paroxysmal discharges, but epileptiform abnormalities are rarely seen.

In a review,<sup>17</sup> stroke-related seizures were evaluated, and the prevalence of seizures was found to be between 2% and 33%. In our study, we determined EEG abnormalities in 12(54.5%) of 22 patients with stroke-related seizure, and found that only 3(25%) of them had epileptiform discharges. A study<sup>10</sup> reported that EEG is an important tool in determining the prognosis of the patients with encephalopathy.

## Conclusion

Despite advanced neuroimaging techniques, EEG is still important in the differential diagnosis of AMS in patients without structural brain involvement, such as epileptic seizure, metabolic abnormalities, pseudo-seizure, and syncope.

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