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The Utility of Electroencephalogram in Intensive Care Unit Patients at King Abdul-Aziz University Hospital

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ABSTRACT

EEG is a diagnostic tool that is commonly ordered in ICU, it is argued that EEG role is overestimated in critically ill patient, our study included 141 patients from ICU who had an EEG during their admission. The most common reason for ordering EEG is an unexplained impairment of consciousness. The majority of the patients EEG are reported as abnormal, and they represented about (90.8%) out of total patients, while the study showed that the most important specific EEG abnormality are diffuse slowing in 36.9%. However EEG neither helps in changing patient management nor it improves patients outcome.

Key words: EEG, critically ill, non-convulsive seizures.

1. INTRODUCTION

EEG is a frequently ordered investigation in ICU patient especially in cases of unexplained impairment of consciousness. The EEG can be helpful in discovering that the underlying cause of an abnormal clinical presentation is a diffuse or a focal central nervous system (CNS) disorder, or ongoing seizure activity either with a motor manifestations or without such as non-convulsive seizures (Richard et al. 2009). Furthermore, the EEG can help to improve patient outcome by detecting acute brain injury such as cerebral ischemia or seizures and preventing secondary injury by early treatment. Although EEG is a valuable tool that aids in diagnosing and managing some critical cases with diffuse cortical dysfunction for example non-convulsive status epileptics and other encephalopathies. It is argued that many EEGs are ordered for patient in the critical care are of no useful impact on the patient management and outcome. The main purpose of this study was to view the clinical indication of ordering EEG for patient in the ICU from the ordering physician prospective and correlation between the EEG finding and the clinical impression. We also planned to investigate the utility of the EEG result on patient management; weather it changes the management or not.

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Table 1

Definitions for EEG finding

Epileptiform activity	Presence of sharp wave, spikes, with or not preceded by slow wave
Focal epileptiform activity	Epileptiform activity well localized in a hemisphere or lobe
Generalized epileptiform activity	Epileptiformactive`ity generalized, symmetric and synchronous
Triphasic waves	Delta waves, positive wave preceded and followed by negative waves
PLED/BiPLED	Periodic lateralized epileptiform discharge and bilateral independent PLED
Diffuse slowing	Delta or theta waves diffusely distributed
Focal slowing	Delta or theta waves localized in a hemisphere or lobe
Low voltage	Slow waves with amplitude less than 20 microvolts
Burst–suppression	Paroxysmal activity alternating with periods of suppression of EEG
Electrocerebral inactivity	Isoelectric EEG recording

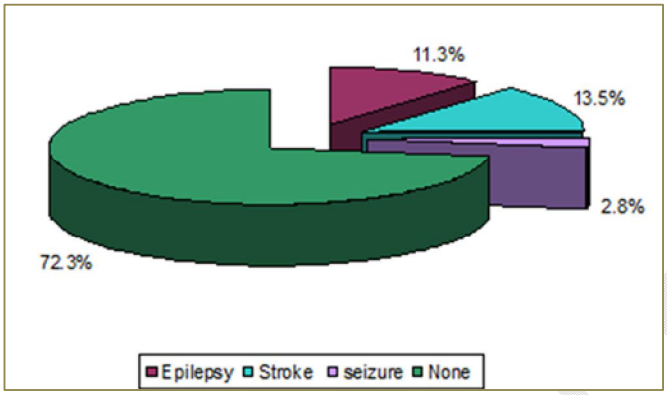

Figure 1

Patients with prior history of neurological diseases

2. METHOD

We included all patients from ICU whom an EEG was requested and performed at the neurophysiology lab of King Abdul-Aziz University Hospital (KAUH). Patients were enrolled retrospectively between January 2009 and march 2013. KAUH is a multispecialty hospital providing secondary and tertiary care for population of western region of Saudi Arabia. KAUH is linked to King Abdul-Aziz University Medical School. The medical records were reviewed and a focused questioner was filled that include the following variables: patient demographic data, reason of ICU admission and Glasgow coma scale at time of admission, any previous neurological event such as, Epilepsy or stroke. The time of the EEG performance in relation to ICU admission was recorded as either within 24 hour of admission or after 24 hour. In addition, the impact of the EEG result on patient management was reviewed regarding any change in antiepileptic drug or requesting a further workup.

All EEGs were reviewed by a certified Neurologist for the reason of request and the presence of any abnormality. These abnormality were classified as either epileptiform activity or non-epileptic abnormality. Epileptiform activity was defined as spike or sharp waves with asymmetrical transient having a fast rising phase and a slower descending phase followed or not by a slow wave (João et al. 2012) (Niedermeyer et al. 1999). Nonepileptic abnormality is defined as any EEG abnormality that doesn't fulfill the definition of Epileptiform activity. Electrographic seizures were defined as an abnormal paroxysmal event that was different from the background lasting longer than 10 seconds (Abend et al. 2011). Furthermore the epileptic abnormalities were localized as generalized, hemispheric, regional orfocal (Jan, 2002). Status epileptics was defined as any seizure events greater than 5 to 10 minutes in length, as supported by the American Academy of Neurology (AAN), the American Epilepsy Society, and other international organizations (Mirski et al. 2008; Rijckevorsel et al. 2005). Status epileptics is divided into convulsive status epileptics when the classic motor manifestations are seen or non-convulsive status when there is impairment of consciousness and electrographic seizures or abnormal EEG without any overt motor manifestations (Panayiotis et al. 2004). Moreover, the abnormal EEG activity was described according to the following definitions in order to have standardized criteria (Table 1), (Niedermeyer, 1999; Duffy et al. 1989), also the number of EEG performed for each patient during the ICU admission was recorded. Descriptive statistics methods were employed to interpret the data, Chi-Square test was used to find if there is a significant correlation between the EEG finding and the clinical indication. The magnitude of significant associations is presented as P-values, a P-value less than 0.05 was considered statistically significant. The study was approved by the ethical committee of King Abdul-Aziz University.

3. RESULTS

141 cases were included; all EEGs were performed using the international 10-20 System of electrode placement. The patients mean age is (50.6) with standard deviation equal to (21.89). Glasgow Coma Scale of the patient at the time of ICU admission showed equal distribution as 50% were reported as less than 8 and 50% were reported as 8 or more. Most of the patients at 72.3% had no prior history of any neurological diseases as presented in Figure 1. CNS infection was the main reason of ICU admission at 15.6% of the cases, whereas status epileptics and sepsis were the second

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Table 2

Etiology of ICU admission

Diagnosis	Frequency	Percent
Arterial ischemic stroke	14	9.9
Heamoragic stroke	11	7.8
CNS infection	22	15.6
CNS vascuilities	1	0.7
Brain tumor	3	2.1
Head trauma	6	4.3
Status epileptics	15	10.6
Anoxic encephalopathy	9	6.4
Cerebral venous thrombosis	2	1.4
Alcohol withdrawal	1	0.7
Acute myocardial infarction	6	4.3
Congestive heart failure	2	1.4
Chronic liver disease	4	2.8
Sepsis	15	10.6
Renal failure	3	2.1
Systemic malignancy	2	1.4
Electrolyte disturbance	10	7.1
Respiratory	6	4.3
Other	9	6.4
Total	141	100.0%

most common reason of admission at 10.6% for each of them. Table 2 lists the patients' etiology of admission. Only 5.7% of the patients had an EEG within the 1st 24 hours of admission and the majority of the patients 86.3% had only one EEG during their admission Table 3 illustrates the number of EEGs performed for each case. Overall, EEG had no effect on management as 76.3% of the EEGs performed on the patient did not change the management. Change in antiepileptic medications occurred in 21.4% of the patients while a follow up EEG was requested in only 5% of the patients. Testing if there is a significant association between the time of EEG performance and impact of EEG on management reveals no significant association, the chi-Square Test value (3.176) at a significant level (0.075) which is greater than (0.05). That means timing of EEG performance has no significant relationship with the impact of EEG on management in our study.

The patient outcome in the examined sample was as following: 40.4% of the sample died at some point of time regardless the cause of death, 31.2% improved while 28.4% have been static with nor improvement neither deterioration. Testing if there is a significant association between the impact of EEG on management and patient outcome result in a chi-Square Test value (2.771) at a P-value of (0.25) which is greater than (0.05) ,so no significant association between the impact of EEG on management and patient outcome (Table 4). The most common reasons for ordering EEG in ICU patient as mentioned by the ordering physician is unexplained impairment of consciousness 34% followed by convulsive status epileptics 26.9%, while non-convulsive status epileptics constitute 9.2% of all EEG requests. In concern of EEG findings, the results showed that for the majority of the patients EEG finding is considered as abnormal, and they represented about (90.8%) out of total patients, while the study showed that, the most important specific EEG abnormality are diffuse slowing in 36.9% of the patients, focal slowing in 12.8% of the patients, and focal epileptiform activity, generalized epileptiform in 9.9% and 9.2% of the patients respectively.

4. DISCUSSION

EEG is non-invasive, low risk tool for investigation in patient with acute brain dysfunction for the purpose of diagnosis and prognosis. However, it is thought that with the advancing neuroimaging techniques EEG uses have been limited to specific indications such as monitoring treatment response in status epilepticus and to diagnose non-convulsive epilepsy. There is no clear recommendation for EEG monitoring in ICU patients and evidence supporting the best method of monitoring are not well established (Claassen et al. 2013). In our study the most common reason for ordering EEG was unexplained impairment of consciousness 30.4%, to evaluate convulsive status epileptics 26.2% and non-convulsive status epileptics 9.2%, which is compatible with the finding in other study (João et al. 2012). EEG is considered the gold standard for diagnosis in the last two conditions (Praline et al. 2007; Varelas et al. 2003; Claassen et al. 2004). Although generalized convulsive status epileptics is a clinical diagnosis that does not need EEG for

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Table 3
Number of EEG performed for each patient

No. of EEG	Frequency	Percent	Valid percent
One	120	85.1	86.3
Two	14	9.9	10.1
Three	4	2.8	2.9
More than three	1	0.7	0.7
Total	139	98.4	100.0%
missing	2	1.4	
Total	141	100.0%	

Table 4
Correlation between impact of EEG on management and patient outcome

Impact of EEG on management	Patient outcome			Total	Chi-Squire	Sig
	Death	Improved	Static			
No change	46 (33.1)	33 (23.7)	27 (19.4)	106 (76.3)	2.771	**0.250**
Change	10 (7.2)	10 (7.2)	13 (9.4)	33 (23.7)		
Total	**56 (40.3)**	**43 (30.9)**	**40 (28.8)**	**139 (100.0)**		

diagnosis, it is commonly followed bynon-convulsive seizures and non- convulsivestatus epileptics at a frequency (48 % and 14 %, respectively) (DeLorenzo et al. 1998). Differentiating ongoing seizure activity in non-convulsive seizures from postictal confusion or drug-induced encephalopathy is not straight forward. Usually no clinical symptoms are present and EEG is necessary to diagnose ongoing non-convulsive seizure activity (Drislane, 2000; Privitera, 1994). A systematic review of 42 studies was performed to establish consensus recommendations on the use of EEG in the ICU patients recommended urgent EEG in patients with SE that do not return to functional baseline within 60 min after administration of seizure medication (strong recommendation, low quality of evidence—grade 1C) (Claassen et al. 2013). In addition , not all abnormal movement in critically ill patients are due to seizures some abnormal movement mimic sizeures such as tremor or multifocal myoclonus .In a study that used video-EEG monitoring for 52 patient in ICU with abnormal motor phenomena labeled as possible seizures revealed that 73% had non-epileptic events (Benbadis et al. 2010). The distinction between true seizure and non-epileptic event is an important issue in critically ill patient as using antiepileptic drug in that vulnerable patient is not without side effect. For example Lorazepam which is commonly used to abort seizure is an independent risk factor for delirium in ICU patient (Pandharipande et al. 2006). Subsequently delirium leads to increased morbidity and mortality (Ouimet et al. 2007). Therefore ordering EEG for patient with suspected seizure or to exclude non-convulsive seizures in ICU patient is a justified reason.

Another important point worth noticing in this study is that the vast majority of ordered EEGs in critically ill patients were abnormal 90.8%, which is higher in comparison with other studies almost half of the patient had abnormal EEG (Kilbride et al. 2009). Although with the high number of abnormal finding in the EEG interpretation should be made with caution and with clinical correlation of the patient history. As not all abnormality encountered in EEG are specific for certain diagnosis and can be found in non-convulsive seizures and other pathologies such as toxic-metabolic encephalopathies, degenerative disorder, CNS infections and following anoxia (Richard et al. 2009). Furthermore, most of the patient in ICU are sedated this is known to interfere with EEG interpretation.

In our study EEG did not change the management in the majority of the patients; antiepileptic drugs were added or changed only in 21.4% of the cases in contrast to another study were 52% of studied cases had some changes in antiepileptic prescriptions. This may be explained by the fact that a large number of the studied cases had multiple comorbidities for example sepsis, electrolyte disturbance and other causes of metabolic or toxic encephalopathy that need management and the review of medical records focused only on antiepileptic prescription. A small number of patients had EEG in the first 24 hours of admission in our study, although EEG service for emergent recording is available there is often delay in the interpretation of the finding which subsequently lead to delay in the management, this problem is not limited to our hospital as this problem is obvious in a lot of hospital worldwide due to limitation of resources and number of neurophysiologist (Trevathan et al. 2006). This may be one of the reasons for high ICU mortality; It is proven that delay in recognition of non-convulsive status epilepsy is an independent risk factor for mortality (Young et al. 1996). The prevalence of non-convulsive seizures in comatose patient in general ICU is around 8% (Towne et al. 2000). Unfortunately not all patients with non-convulsive seizures are detected in routine EEG.In a retrospective study that reviews the usage of routine EEG in a general ICU showed a lower than expected rate of electrographic seizure detection 2% of the patients (McHugh et al. 2009). Continuous or prolonged EEG monitoring is some time required in order to detect non-convulsive seizures, in a study of 570 critically ill patients

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who underwent a continuous EEG monitor, non-convulsive seizures were present in 18% of the patient, 12% of the patients required longer than 24 hour EEG monitoring to detect seizures (Claassen et al. 2004). EEG did not have a significant impact on outcomes of ICU patient in this study which is expected as EEG did not help in changing the management. The main limitation of our study was the nature of data collection from medical records to complete our database and the possibility of over or underestimating the data from records and EEG requests.

5. CONCLUSION

In conclusion, EEG is non-expensive, non-invasive and low risk technique that is helpful in confirming or excluding some conditions especially seizure disorders either convulsive or non-convulsive seizures. However, interpretation of abnormal finding in critically ill patient should be done with cautions as not all abnormality is due to seizures. In addition, the need for emergent EEG and continuous monitoring cannot be denied as it can help in improving outcome by early detection of seizures and avoiding blind treatment for suspected seizures without any evidence. On the other hand, routine EEG did not prove to be helpful in management or predicting outcome of ICU patients and utilization of alternative method for treatment and prognosis in critically ill patients should be encouraged.

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