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EEG SIGNALS AND ITS RECORDING HELP IN DIFFERENT DISEASE

Mohd Atif Siddiqui[1], Mohd Maroof Siddiqui[2]

[1,2]*Department of ECE, Integral University, India*

ABSTRACT

This unit presents methods for recording and analysing the human electroencephalogram (EEG). Detailed protocols describe recorder calibration, electrode application, EEG recording, and computer EEG analysis. The electroencephalogram (EEG) is the most common source of information used to monitor, diagnose and manage neurological disorders related to sleep disorder, epileptically seizure, Alzheimer. With the help of EEG large amount of data are being produced and then visual inspection of these EEG is done, in order to find traces of epilepsy, Alzheimer and sleep disorder

KEYWORDS: Electroencephalogram, Epileptical Seizure, Alzheimer Disease.

I. INTRODUCTION

Electroencephalography is a medical imaging technique that read out scalp electrical activity generated by brain structures. The electroencephalogram (EEG) is defined as electrical activity of an alternating type which is recorded from the scalp surface after being picked up by metal electrodes and conductive media. If the EEG is measured using depth probes it is called electro gram and when measured directly from the cortical surface it is called electrocardiogram. We will referring EEG measured from the head surface. Thus electroencephalographic reading is a procedure which can be applied again and again to patients, normal adults, and children with virtually no risk or limitation. The local currents are produced by activation of brain cells. Cerebral Cortex contains many pyramidal neurons and the synaptic excitation of the dendrites of the pyramidal neurons causes the flow of current which is measured by EEG. Differences of electrical voltages are produced by summed postsynaptic graded potentials from pyramidal cells. The electrical dipole is being made between neural branches known as apical dendrites and body of neurons known as soma. The current in the mind consist of na+, ca++ and cl-. These ions are pumped through channels which are in the neuron membrane and the direction of these ions is governed by membrane potential. The detailed microscopic picture is more sophisticated, including different types of synapses involving range of neurotransmitters. The electrical activity recordable on the head surface is being generated by a large number of active neurons. Between electrode and neuronal layers current enters through skin, skull and several other layers. Weak signals amplification are done and then shown on paper or it can be stored to computer memory for further use. EEG has an ability and that ability is that it can reflect both the normal and abnormal electrical activity of the brain and thus EEG is a very powerful tool in the field of neurology and clinical neurophysiology. The EEG signals are in the range of .5 to 100 microvolts and

they are about 100 times lower than that of ECG signals.EEG signals are measured from peak to peak. Brain pattern have waveform and the wave form is sinusoidal. The Fourier transform power spectrum is used to drive the EEG signal. If the spectrum is continuous then the brain state of the individual may make certain frequencies more prevailing. Brain waves have been characterised into four basic groups: beta (>13 Hz), alpha (8-13 Hz), theta (4-8 Hz), delta (0.5-4 Hz).for spectrum to be continuous range has to be from 0 Hz up to one half of sampling frequency.

II. EEG RECORDING TECHNIQUES

Encephalographic measurements use recording system and it consists of

(a) Electrodes with conductive media

(b) Amplifiers with filters

(c) A/D converter

(d) Recording device.

Electrodes read the signal from the head surface and then the amplifiers amplifies the signals which are in microvolts into the range where they can be digitalized accurately, converter is used to change signals from analog to digital form, and storing devices are used to store obtained data. The recordings of neuronal action in the brain is called as the EEG and this EEG signal allows measurement of potential changes over time in basic electric circuit conducting between signal (active) electrode and reference electrode. Third electrode is called ground electrode, is needed for receiving differential voltage by subtracting the same voltages showing at active and reference points. Minimal configuration for mono- channel EEG measurement contains of one active electrode, one reference and one ground electrode. The multi-channel configurations may contain up to 128 or 256 active electrodes.

Recording electrodes

The electrodes used for EEG recording and their proper function are critical for acquiring suitably high quality data for understanding. Many types of electrodes exist, often with different characteristics. Basically there are following types of electrodes

(a)Disposable (gel-less, and pre-gelled types)

(b)Reusable disc electrodes (gold, silver, stainless steel or tin) headbands and electrode cap

(c) Saline based electrodes - needle electrodes.

For multichannel montages, electrode caps are chosen, with number of electrodes connected on its surface. Needle electrodes are used for long recordings and are intrusively inserted under the scalp. Skin preparation is different in this case, generally cleaning of the skin surface from oil and brushing from dried parts is suggested. Normally scalp electrodes are used. Scalp electrodes have a diameter of 1-3mm and they have along flexible leads which can be plugged into the amplifier. These scalp electrodes consist of silver-silver chloride disks. If there is very slow change of potential then that can be recorded easily by agcl electrode. In disposable and disc electrodes, a paste which can be removed by rubbing is used for slight skin abrasion. With cap systems, abutting needle at the end of injection is used for skin scratching, which can cause irritation, pain and infection. Especially when person's EEG is measured frequently and cap is mounted on the same electrode points, there is

a threat of certain bleeding and pain. So that's why the correct hygiene and safety practise should be done. Using the silver-silver chloride electrodes, the space between the electrode and skin should be filled with conductive paste which helps to stick. In cap systems, there is a small hole to inject conductive jelly. Conductive jelly and conductive paste serve as media to ensure lowering of contact impedance at electrode-skin interface. In 1958, International Federation in Electroencephalography and Clinical Neurophysiology accepted standardisation for electrode placement called 10-20 electrode placement system. This system standardized physical placement and descriptions of electrodes on the scalp. There is a proportional distances of head from prominent skull landmarks (nasion, preauricular points, inion) to provide sufficient coverage of all regions of the brain. The electrode are to be placed on head and they should be placed according to brain areas. The brain areas are: F (frontal), C (central), T (temporal), P (posterior), and O (occipital).

III. APPLICATIONS OF EEG

2.1 Sleep Disorder

Human disorders are largely affected by sleep and sleep corresponded complications. Roughly every medicine field suffers from sleep problem. Just in case, complications resembling troubles asthma and stoke disputes are likely to occur or we say that more frequently they occur during night and morning. Feasibly, because of differences in heart rate, hormones and another peculiarity affiliated with sleep. Different kinds of epilepsy are altered by sleep in manifold ways. A seizure that starts from one region of brain to another region is diagnosed by REM sleep, although the spread of seizures are supported by deep sleep. Sleep downfall also provoke seizures in many people suffering with different kinds of epilepsy. Immune system interacts with neuron which holds sleep. Anyone suffering from flu has the idea of this contaminating disease tending to feel sleepy a lot. The reason of this problem occurring is mainly because of cytokines. Cytokine is a chemical which helps our immune system to fight across an infection, then cytokine are proves to very helpful sleep-inducing chemicals. The immune system which needs another assets and energy are fulfilled by sleep. People who are suffering from brains problems counting with schizophrenia and depression are most likely affected by sleep disorder. Let's consider the case of a patient of depression, the problem of awakening in early hours of morning and found themselves to go back to sleep. Symptoms of mental disorders are largely influenced by volume of sleep required by normal person. Therapy of sleep deprivation is an active therapy that suffers with different kinds of depression, although it is the cause of depression in many people. Psychotic state of paranoia and hallucinations in healthy or fit people and mania episode is disrupted by sleep trigger in many people with depression state of mania. Alzheimer's, cancer, stroke, head injury are usual disorder including sleeping complications. These sleeping problems may arise from neurotransmitters and changes in brain regions which holds sleep or by the drugs which have control on symptoms of another disorder. Patients who are hospitalized or who have treat or round the clock care also suffers from disrupt sleep. Confusion, frustration is caused by sleeping problem or they can add to impairment of persons. The patient also notice pain and request the doctor for pain relief medicine. The quality of life and health of patient could be improved by better management. Insomnia is closely connected with disorders of stimulation such as anxiety and depression. The success of EEG training in implementation improved self-regulation of arousal should, therefore, be predicted to result in enhanced regulation of sleep in these cases. Sleep apnea is consist of a central, neurological component, and a somatic,

obstructive component. A somatic, obstructive component is due to the fact that the disorder closely relates with obesity. Obstructive sleep apnoea has historically been treated surgically and this sleep apnoea has rather poor consequences so that is why surgery is now slowly being abandoned in favour of a breathing aid device which provides continuous positive airway pressure (CPAP).

2.2 Epileptical Seizure

Epileptiform activity is specific, but not sensitive, for analysis of epilepsy as the cause of a transient loss of awareness or other paroxysmal event that is clinically possible to be epilepsy. EEG has moderately less sensitivity in epilepsy, ranging between 25–56%. Specificity is better, but again variable at 78–98%. These wide-ranging ranges can be explained partly by diverse case selection and differences in clinical requirements for diagnosis of epilepsy in population studies of EEG. Secondly, relationship between different EEG patterns and epilepsy changes, and only IED are related with seizure disorders at a sufficiently high rate to be of scientific use. Abnormalities of related cerebral rhythms, focal slow activity or regional attenuation are much less precise than epileptiform activity, while they can indicate localised structural pathology underlying the seizure disorder, or spread cortical dysfunction as in indicative generalised epilepsies. Here are some types of epileptiform phenomena and they are 3 per second spike wave discharge, hypsarrhythmia, and for clinical epilepsy generalised photo paroxysmal response is associated. While for active epilepsy focal sharp waves in Centro-temporal or occipital regions are considered. The children having Centro-temporal EEG discharges and out of them only about 40% have expressed seizures. There is low or zero predictive value for epilepsy in subclinical rhythmic epileptiform discharge in adults (SREDA), rhythmic mid temporal theta (θ), phantom spike and wave and Spikey or rhythmic phenomena have 14 and 6 Hz spike. Over interpretation of non-specific EEG abnormalities or Misunderstanding of such non-epileptogenic phenomena and spiky/paroxysmal options of normal cerebral rhythms, is the common reason for over-diagnosis of epilepsy. To determine seizure type and epilepsy syndrome in patients with epilepsy EEG is used, and thus choice of antiepileptic medication and prediction of prognosis. EEG results contribute to the multi-axial diagnosis of epilepsy, which tells whether the seizure disorder is generalised or focal, or part of a specific epilepsy syndrome, idiopathic or symptomatic. In Focal and generalised seizure disorders there are some overlap of both clinical and electrographic manifestations, and unihemispheric epilepsies blurs the boundaries more. However, there is conceptual division of partial and generalised seizures/epilepsy types are valid and clinically useful. However, with the help of EEG we can differentiate between a complex partial seizure with focal IED, and an absence type seizure with generalised IED

2.3 Alzheimer's Disease

EEG is used for Alzheimer's disease. As for clinical purposes it is less specific but still it is used because it has great potential as it is a cost effective screening tool. Thus to improve its specificity a new method for taking out sparse oscillatory events from EEG signals in the time-frequency domain. Alzheimer disease have three effects on EEG and they are: EEG signal get slow down, reduced complication of the EEG signals, and agitations in EEG synchrony. In recent years, a range of complicated computational approaches has been proposed to identify those delicate perturbations in the EEG of AD patients. It is necessary to remove those things which is observed in EEG analysis that is not naturally present but occur due to: for example head and eye movement or

interference from electronic equipment. Pre-processing of an EEG signal in recent years received much attention. Here is EEG data recorded of patients. EEG frequency bands of interest were □ (3.5–7.5 Hz), □1 (7.5–9.5 Hz), □2 (9.5–12.5 Hz), and □ (12.5–25 Hz) when they are in rest condition with eyes closed. Complex morlet wavelets is used to transform EEG signal into time frequency and is represented by sparse bump model. Specificity of EEG signal can be enhance by sparse bump model. In the Initial stages of AD there is an increase of theta activity or a decrease of alpha activity. In very severe stages of AD there is an increase in both theta and delta activities, along with decrease in both beta and alpha frequency band.

III. CONCLUSIONS

EEG is used to measure the brain activity; it is a technique in which there is no introduction of instruments into the body. It has a high time-resolution and it can be used in almost any environment. For these reasons, the EEG is an interesting technique to study the brain activity related to presence research. The disadvantages associated with an EEG are the signal to noise ratio is poor and it is essential to deal with large subject-specific such as inter- and intra-trial variability so that is why sophisticated data analysis is required to be done. EEG usefulness depends upon on how many brain states can be distinguished be EEG measurement. Epileptical seizure originating from human intracranial can be predicted by scalp EEG and it has been approved, more studies need to be conducted for increasing the accuracy of prediction.

REFERENCES

[1] E. Niedermeyer, F. H. Lopes da Silva. 1993. Electroencephalography: Basic principles, clinical applications and related fields, 3rd edition, Lippincott, Williams & Wilkins, Philadelphia. [2] H. L. Atwood, W. A. MacKay. 1989. Essentials of neurophysiology, B.C. Decker, Hamilton, Canada

[2] J. D. Bronzino. 1995. Principles of Electroencephalography. In: J.D. Bronzino ed. The Biomedical Engineering Handbook, pp. 201-212, CRC Press, Florida.

[3] R.D. Bickford. 1987. Electroencephalography. In: Adelman G. ed. Encyclopaedia of Neuroscience, Birkhauser, Cambridge (USA), 371 -373.

[4] T.W. Picton ET. al. 2000. Guidelines for using event-related potentials to study cognition: Recording Standards and publication criteria. Psychophysiology 37, 127-152.

[5] http://ric.uthscsa.edu/facts/erp.

[6] http://www.ncbi.nlm.nih.gov/pubmed/20455865

[7] The Research Imaging Centre, University of Texas.

[8] http://www.eegspectrum.com/applications/sleep-disorders/

[9] http://jnnp.bmj.com/content/76/suppl_2/ii2.full

[10] Slater, M. and Steed, A. (2000) A Virtual Presence Counter (PDF).