SLEEP DISORDERS AND EEG RECORDING

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ABSTRACT- This unit presents the sleep disorder in EEG segments, which is crucial for the localization and classification of sleep disorders. Detailed protocols describe sleep disorders, EEG recording, and recording electrodes. The electroencephalogram (EEG) recording technique is used to monitor and diagnose sleep disorders; sleep deprivative, insomnia and hypersomnia. 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 sleep disorder.

KEYWORDS: Sleep disorders, Insomnia, Parasomnia, Electroencephalogram.

I. Introduction

Physiologically, sleep is a complex process of restoration and renewal for the body. The physiological condition depends on the findings of electroencephalogram (EEG), electro-oculography (EOG) and electromyography (EMG). Scientists still do not have a definitive explanation for why humans have a need for sleep. Sleep is essential for good health, energy, productivity, and emotional balance. And most people do not get nearly enough sleep or proper sleep. Trouble in sleeping is experienced by most of us at one time or another. This is normal and usually temporary, because of factors like stress or other outside factors. But if the occurrence of sleep problems are regular and interfere with daily life, then the person may be suffering from a sleep disorder. Sleep disorders cause more than just sleepiness. The lack of quality sleep can have a negative impact on good health, energy, productivity and emotional balance. Unfortunately, even minimal loss of sleep can affect on health, mood, energy, efficiency, and ability to handle stress. Ignoring sleep problems and disorders can lead to poor health, accidents, impaired job performance, and relationship stress. Sleep is a necessity, not a luxury. It is important to differentiate sleepiness from coma and fatigue. Coma is an unconsciousness, from which the person cannot be aroused and fatigue, can be a secondary consequence of sleepiness.

II. Sleep Stages

Sleep is unconsciousness from which the person can be aroused by sensory or other stimuli. There are two general states of sleep: rapid eye movement (REM) sleep and non-rapid eye movement (NREM) sleep or slow wave sleep. REM sleep was first described in 1953 when researchers of sleep noticed a pattern of brain waves, which was unique. REM sleep accounts for 20% to 25% of total sleep time; in infants it can comprise about 40%. People who are awakened during REM sleep often report that they were dreaming at the time. Traditionally, it has been considered that NREM sleep is divided into 4 stages. However, from the American Academy of Sleep Medicine (AASM) published in 2007, new guidelines recharacterized NREM sleep as occurring in 3 stages, according to the pattern of brain electrical activity:

- Stage N1 sleep, is the transition from wakefulness to deeper sleep. This is the lightest stage of sleep, and people may not always perceive they are asleep when in this stage.
- Stage N2 sleep is a true sleep state, and accounts for 40% to 50% of sleep time.
- Stage N3 sleep has been called deep sleep, delta sleep, or slow wave sleep. This stage accounts for about 20% of sleep in young adults.

About 70 million Americans are believed to suffer from chronic sleep disorders. Doctors have defined more than 70 types of sleep disorders, but the most common sleep disorders are: insomnia, hypersomnia, restless legs syndrome(RLS), narcolepsy, sleep apnea or breathing Related Disorder: Obstructive sleep apnea (OSA) and central
sleep apnea (CSA), Parasomnias: rapid eye behavior disorder (RBD), sleep walking, nightmares, night terror disorder, confusional arousal, Catathrenia (Expiratory groaning), and Bruxism (Tooth grinding).

III. Sleep Disorders

The list of sleep disorders is divided into three groups:
(a) Lack of Sleep (sleep deprivation)
(b) Disturbed Sleep (insomnia)
(c) Excessive Sleep (hypersomnia)

A. Insomnia: Insomnia is a very common sleep disorder and one-third of adults in western countries experience insomnia. Insomnia is hardship in falling asleep and staying asleep, to wake up feeling restorative and rested. Insomnia is often a symptom of another problem, such as stress, anxiety, depression, or an underlying health condition. Insomnia often starts with limited sleep condition or this acute insomnia may persist into a chronic (constant) long term sleep disorder, caused by stressful lifestyle, medication side effects, environmental noise, or misuse of caffeine, generally transient (short term) and intermittent (on and off) insomnia may occur. Transient insomnia is when insomnia lasts for single night to a few weeks, if transient insomnia occurs from time to time, insomnia is intermitted. Approximately 10% of the population may suffer from chronic (long-standing) insomnia. Sleep insomnia in some cases may be due to, anxiety and depression, or by physical illness such as cancer or arthritis, awaken for lengthy periods during the night, increasing the wake-after-sleep-onset (WASO). Depression is the most common cause of chronic insomnia, others may be arthritis, kidney disease, heart failure, asthma, sleep apnea, narcolepsy, restless legs syndrome, Parkinson’s disease, and hyperthyroidism. Insomnia cases are chronic which include psychiatric, medical and neurological disorders or drug and alcohol abuse. With age the nature of sleep changes. Older age is associated with bad quality of sleep with short durations, and more arousals, and these changes may be observed more in men than women, according to a large study of elderly people living at home in the USA. Severe daytime sleepiness typically is an effect of sleep deprivation; effects of insomnia may be fatigue, moodiness, anger, lack of concentration, poor memory, headaches, and sleep anxiety.

B. Hypersomnia: This sleep disorder is reverse of insomnia. A person sleeps longer and for extra hours than what is regular in the course of night or the day. It is challenging for them to wake up. The need to take naps is compulsory, but grants no relief.

C. Restless legs syndrome (RLS): Restless Legs Syndrome Study Group (IRLSSG) criteria established first in 1995 and modified slightly in 2003. RLS is also known as nocturnal leg cramps, which is very common disorder but uncommonly recognized. RLS is a type of sleep disorder characterized by uncomfortable sensations in the legs and an uncontrollable desire to move the legs, when resting or lying down. During the evening these abnormal aching and creeping sensations occur in lower legs. There is no diagnostic test for RLS and hence the diagnosis entirely rests on clinical features and is based on the International Restless Legs Syndrome Study Group (IRLSSG) criteria established first in 1995 and modified slightly in 2003. The prevalence of RLS has been estimated at about 10% for adult populations but the prevalence of most severe cases of RLS is approximately 2.5%. In surveys done, mostly the prevalence is greater in women than in men and the disease is chronic and progressive. Periodic leg movements (PLMs) are related to RLS, but PLMs occur after the onset of sleep and are marked as a sleep disorder when the movements cause increased activity in the brain. During the early stages of sleep, these cycles of leg movement often last up to an hour. The abnormal sensations of RLS include crawling, creeping, pulling, drawing, tingling, or prickly discomfort, burning, aching, cramping, knifelike sensations. These sensations occur mostly between the knees and ankles causing an intense urge to move the limbs to relieve these abnormal feelings. Sometimes similar symptoms occur in arms or other parts of the body.

D. Narcolepsy-cataplexy syndrome: Narcolepsy is a sleep disorder of the central nervous system that uniformly involves uncontrollable, excessive daytime sleepiness (EDS). It is caused by a dysfunction of the brain mechanism that controls sleeping and waking. In most cases the start of narcolepsy-cataplexy is in adolescents and young adults with ages between of 15 and 30. The major clinical prove of narcolepsy include narcoleptic sleep attacks (100%); cataplexy (60-70%); sleep paralysis (25-50%); hypnologic hallucinations (20-40%); disturbed night sleep (70-80%);
and automatic behavior (20-40%). In addition to the major proofs, patients with narcolepsy may also have four important co-morbid conditions: sleep apnoea, periodic limb movements in sleep (PLMS), REM behavior disorder (RBD) and nocturnal eating disorder. During sleep attack uncontrollable desire to fall asleep in inappropriate circumstances and at inappropriate places (e.g., while talking, driving, eating, playing, walking, working, sitting, listening to lectures or music, watching movies, during sexual intercourse, or when involved in boring circumstances) may occur. These episodes last from a few minutes to as long as 20 to 30 min and on waking the patient generally feels refreshed. Variations in frequency of attacks, anywhere from daily, weekly, monthly or every few weeks to months are wide. Attacks generally last throughout the patient’s lifetime although fluctuations may occur. Patient encounters decline in performance at school, work, psychosocial and socio-economic difficulties as a result of sleep attacks and EDS. Momentarily patient may have head-nodding, sagging of the jaw, buckling of the knees, dropping of objects from hands, loss of voice, but sometimes they may slump or fall forward to the ground for a few seconds. Usually during the attack, consciousness is retained in a few seconds to minutes. It is a life-long condition but may even disappear in old age and is less severe.

E. Sleep Apnea: sleep apnea is a breathing related disorder, in which a reduction or pause of breathing (airflow) during sleep, due to the blockage of the upper airways. Central sleep apnea (CSA) occurs when the brain does not send the signal to the muscles to take a breath, and there is no muscular effort to take a breath. Obstructive sleep apnea (OSA) occurs when the brain sends the signal to the muscles and the muscles make an effort to take a breath, but they are unsuccessful because the airway becomes obstructed and prevents an adequate flow of air. Mixed sleep apnea occurs when there is both central sleep apnea and obstructive sleep apnea. The existence of OSA is 4 per cent in men and 2 percent in women between ages 30 and 60. Sleep apnea is common in men older than age 40 and among women incidence of obstructive sleep apne syndrome is greater after menopause. Sleep apnea is a serious, and potentially life-threatening, sleep disorder as the short term consequences may be impairment of quality of life and work related accidents, and long term consequences may result as heart failure, hypertension, myocardial infarction, cardiac arrhythmia as well as depression and insomnia. Symptoms of sleep apnea may include: loud snoring, frequent pauses in breathing during sleep, choking during sleep, feeling exhausted after waking and sleepy during the day, chest pains, headaches, nasal congestion, or a dry throat.

F. Parasomnias: By definition, parasomnias are “events that occur intermittently or episodically during the night”. These occur due to abnormal transition between the three sleep stages; wake, REM sleep and NREM sleep. RBD, rapid eye behavior disorder occurs in normal night sleeps, which lasts for 5-30 minutes and occur every 90 minutes. RBD is associated with active dreaming and active bodily muscle movement, the heart rate and respiratory rate become irregular (dream) and brain gets highly active.

G. Sleep Walking/Somnambulism: Typical accomplishment of actions with being awake like eating, walking around or dressing without sensible knowledge or recognition. Sleep walking is common in children between the ages of 5 and 12. Sometimes it persists into adulthood or rarely begins in adults. This disorder lasts less than 10 minutes.

H. Nightmares: During REM sleep nightmares-intense, frightening dreams followed by awakening and vivid recall- occur. The middle to the late part of the night is the most common time of occurrence. Nightmares are typically normal phenomena. At the beginning of 3-5 years approximately 50 per cent of children have nightmares. The incidence of nightmares continues to decrease As one grows older the incidents of nightmares decreases and the elderly have very few or no nightmares.

I. Night Terror: Quick awakening with moaning, crying out or gasping instead of nightmares. In the morning there is no recall of the incident. It is not peculiar in growing children, but grown up can experience it as well.

G. Confusional Arousal: These occur mostly before age 5 yr. As in sleepwalking and sleep terror, the episodes arise out of slow wave sleep but occasionally may occur out of Stage 2 NREM sleep. With the withdrawal of REM-suppressant drugs nightmares are common and side effects of certain medications, such as antiparkinsonian drugs, anticholinergics, and beta blockers may occur.
**H. Catathrenia (Expiratory groaning):** In this parasomnia occurrence of expiratory groaning (high-pitched, loud humming or roaring sounds) during REM sleep but it may also occur during NREM sleep. The clinical relevance of this condition remains unknown.

**I. Bruxism:** Clamping and granulating the teeth in the sleeping time. This situation is frequent in children but appears in adults as well. To prevent dental and temporomandibular complications local injections of botulinum toxin into masseter muscle may be used.

Another disorder is **children Bedwetting:** Other name is nocturnal enuresis which is bedwetting during sleeping.

**IV. EEG Recording**

Electroencephalography is a medicinal imaging technique that reads scalp electrical activity achieved by brain structures. The electroencephalogram (EEG) is described as electrical activity of varying type listed from the scalp exterior after being preferred by metal electrodes and conductive media. The EEG measured precisely from the cortical surface is called electrocorticogram although when using depth probes it is called electrogram. Thus electroencephalographic reading is absolute non-invasive method that can be practised repeatedly to normal adults, patients and children with basically no danger or limitation, for measuring a person’s brainwave. It is used in detection or diagnosis of sleep disorders. When brain cells (neurons) are triggered local current flows are generated. EEG measures oftenly the currents that flow at the time of synaptic excitations of the dendrites of many pyramidal neurons in the cerebral cortex. Changes of electrical potentials are induced by summed postsynaptic graded potentials from pyramidal cells that build up the electrical dipoles between soma (body of neuron) and apical dendrites (neural branches). Brain electrical current consists mostly of Na+, K+, Ca++, and Cl- ions that are stimulated over channels in neuron membranes in the guidance carried out by membrane potential. Encephalographic measurements employ recording system comprising of:

(i) Electrodes with conductive media  
(ii) A/D converter  
(iii) Amplifiers with filters  
(iv) Recording device.

Electrodes scan the signal from the head surface, amplifiers carry the microvolt signals into the range where they can be initialized accurately, converter changes signals from analog to digital mode, and personal computer (or another relevant device) stores and shows attained data. Scalp recordings of neuronal movement in the brain, classified as the EEG, allow measurement of potential changes over time in essential electric circuit conducting between signal (active) electrode and mentioned electrode. Extra third electrode, known as ground electrode, is required for getting various voltages by eliminating the same voltages showing at active and reference points.

Minimum configuration for single channel EEG measurement consists of one active electrode, one (or two specially linked together) reference and one ground electrode. The multi-channel configurations can compose up to 129 or 257 active electrodes.

The EEG recording electrodes and their appropriate action are critical for achieving appropriately high quality data for analysis. Different types of electrodes exist, often with distinct characteristics. Basically there are following kinds of electrodes:

(a) Needle electrodes  
(b) Reusable disc electrodes (silver, gold, stainless steel or tin)  
(c) Headbands and electrode caps  
(d) Saline-based electrodes  
(e) Disposable (gel-less, and pre-gelled type)

For multichannel montages, electrode caps are adopted, with number of electrodes connected on its surface. Regularly used scalp electrodes consist of Ag-AgCl disks, 2 to 4 mm in diameter, with long adjustable leads that can be plugged into an amplifier. AgCl electrodes can exactly record also very slow differences in potential. With expendable and disc electrodes, caustic paste is used for slight skin abrasion. With cap arrangement, adjoining needle at the end of injection is used for skin cleaning, which can cause tenderness, pain and contagion. That is why the right hygiene and security protocol should be kept. By using the silver-silver chloride electrodes, the area between the electrode and skin should be filled with conductive paste also helping to stick. With the cap
arrangement, there is a small hole to infuse conductive jelly. Conductive paste and conductive jelly deliver as media to assure lowering of contact impedance at electrode-skin interface. In 1958, International Federation in Electroencephalography and Clinical Neurophysiology adopted standardization for electrode placement called 20-30 electrode placement arrangement. This organization regulates environment placement and descriptions of electrodes on the scalp. The head is branched into proportional distances from outstanding skull landmarks to give descent analysis of all regions of the brain. Electrode placements are characterized according to adjacent brain areas: F (frontal), C (central), T (temporal), P (posterior), and O (occipital). The letters are followed by odd numbers at the left side of the head and with even numbers on the right side. Left and right side is treated by assembly from point of view of a subject.

V. Conclusion

The outline of this review is an overview of sleep and sleep disorders. In society, sleep disorders are common and general physicians should have a high index of consideration about it. Sleep disorders once diagnosed can be treated best by a sleep specialist. EEG recording technique is used to measure the brain activity, where there is no introduction of instruments into the body. It can be used in almost any environment and has high time-resolution. Therefore EEG is an interesting technique to study brain activity including sleep disorders related to present research.

References


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