

Sleep and You

I. Ubiquity of effects of sleep

Sleep is a personal experience. We detach from the external environment and enter our own personal world of dreams and internal experience. We silently process, sort, and store information and restore depleted resources. And we do this every 24 hours or so. It is not surprising that such a pervasive and foundational process has critically important implications for general health and psychological well-being. Individuals with sleep problems are your clients! The most prominent disorders involve either inability to initiate and maintain sleep or excessive daytime sleepiness. These problems are typically an integral part of major depressive disorders and anxiety. Chronic sleep deprivation has a well documented negative impact on health. Sleep disorders also are common in children and frequently underlie behavioral problems and academic difficulties.

I am trained in research neuropsychology and am currently an Associate Researcher in the Department of Psychology at UCLA. I have been operating a clinical sleep lab, The Valley Sleep Center, in Burbank, over the past 10 years. We have combined our interest in sleep with measurement of brain electrical activity using electroencephalography (EEG), quantitative EEG analysis, and event-related potentials (ERPs), and use of EEG biofeedback, usually called neurofeedback.

In the sleep lab we measure sleep architecture, the progression from light sleep to deeper slow wave sleep and REM. In addition respiratory and cardiac events, arousals, body position, and limb movements are tallied. We can document the amount of time in each stage and progression through sleep stages. Further, we measure both respiratory effort as well as changes in air flow. This brief review covers the major sleep disorders, methods for measuring sleep, and treatments for sleep problems.

II. Sleep Disorders

A. Insomnia

The most common and underserved problem in sleep is chronic insomnia. Although new medications such as Ambien™ and Lunesta™ are effective in initiating and to some extent maintaining sleep, these medications are not intended for long term use and have significant side effects. We have all seen reports in the media about dissociations in consciousness and associated automatic behavior, including unawareness while driving an automobile or shopping in a grocery store.

Clinicians often hear from clients that they “never” sleep, or haven’t slept in several nights. The clinician should realize that although clients firmly believe these assertions, it is more likely that they are not accurately self-reporting. We routinely receive reports of “no sleep” where we can document the presence of considerable amounts of slow wave sleep and rapid eye movement sleep (REM). The opposite is also true: We receive reports of good, restful sleep with a maximum sleep depth of Stage II. This variability

in self report is an interesting psychological issue, and underscores the need for objective measurement and documentation.

Sleep deprivation causes serious health consequences. Recent research has shown a relationship between difficulty with sleep initiation, sleep deprivation, and the presence of inflammatory chemical in the blood called cytokines (Michael Irwin, UCLA). This type of mechanism indicates a process involving psychological factors and neurological changes that directly influence the immune system.

B. Hypersomnia

The problem of excessive daytime sleepiness (EDS) is a large scale medical problem. EDS has a significant impact on productivity and safety in the workplace and particularly in operating an automobile. Excessive sleepiness impairs learning and memory and often causes significant academic difficulty. The main cause of chronic excessive daytime sleepiness is sleep apnea, a well known syndrome that can be caused by a number of factors. The most common presentation is in aging males who are deconditioned and overweight. The musculature in the nasopharynx is reduced in tone, obstructing, or partially obstructing the airway during sleep. The individual must briefly awaken to re-establish muscle tone to allow breathing. This process deprives the individual of deeper restorative sleep and excessive daytime sleepiness occurs. It has been shown that cardiac disease involving atrial fibrillation is related to the presence of obstructive apnea. It is increasingly recognized that treatment of sleep apnea is important in order to provide effective treatment of atrial fibrillation, blood oxygen desaturation (SAO₂), and high blood pressure.

Children often have undiagnosed sleep disorders, typically from blockage of the airway due to inflamed tonsils or adenoids. If chronic sleepiness or snoring is observed in a child, the possibility of obstructive apnea should be evaluated.

Narcolepsy is a rare form of sleep disorder characterized by rapid onset of sleep and progression to REM following a full night sleep. Multiple serial nap studies (or multiple sleep latency testing, "MSLT") are used to document repeated rapid transition to REM. Maintenance of wakefulness tests ("MWT") are used for to evaluate efficacy of CPAP or other treatments.

C. Parasomnia

The last major category of sleep disorders is called "parasomnias", often referred to as night terrors, and is often accompanied by sleep walking and talking. Enuresis is a common form of parasomnia. REM Behavior Disorder is characterized by disruptive behaviors emerging during rapid eye movement sleep. Behaviors such as laughing, talking, shouting, gesturing, flailing arms, punching, grabbing, kicking, and sitting up or leaping from bed disrupt sleep. These rapid and often violent movements often also place the patient at risk for injury. Episodes of this type may occur rarely or up to several times nightly. At Valley Sleep Center we tested an individual with a history of parasomnia

who committed a murder “in his sleep”. The history of violent parasomnias was used in his defense, although he was subsequently convicted of murder. These disorders are very disturbing and medical and psychological treatment often is sought.

Nightmares are also a prevalent type of parasomnias affecting some 4% of the adult population, and are also difficult to treat with medication. Nightmares associated with post traumatic stress disorder has been studied most extensively.

III. Measurement of sleep

A. Polysomnography

The method traditionally used to investigate sleep is polysomnography (PSG) in a clinical sleep lab. This procedure involves overnight recording of EEG to detect depth of sleep, as well as monitoring eye and muscle activity, EKG, blood oxygen saturation, breathing effort and nasal airflow. Musculature also is monitored to detect periodic leg movements and drop out of chin muscle tone with sleep onset. The record is scored for progression of sleep stages, identification of arousals from sleep and their association with significant respiratory or cardiac events. As an indicator of the general medical acceptance of PSG, most insurance companies will pay for the procedure. Many payors require PSG for the first half of the night, and, if apnea is detected, a trial of continuous positive airway pressure (CPAP) is initiated over the remainder of the night. There are also now portable medical devices that can be used in the home to detect sleep apnea.

B. Automated Assessment of Depth of Sleep

At Valley Sleep Center we have collaborated on sleep studies with normal sleepers to evaluate automated methods of scoring depth of sleep. We have studied the BIS™ monitor, a device routinely developed to measure depth of anesthesia in surgery, to measure depth of sleep in normal sleepers. The BIS™ monitor utilizes an algorithm called bispectral analysis which automatically measures the coupling of high frequency and low frequency EEG activity from the forehead (for more information see: www.aspectmedical.com). Our study showed good correlation between human scored sleep staging and the BIS index. Interestingly, REM sleep appeared similar to wakefulness based on EEG analysis, but concurrent monitoring of EMG shows greater muscle activity during wakefulness compared to REM thus allowing for automated separation of these stages.

More recently, we have studied the “Zeo” device, now commercially offered as a non-medical consumer product. This is a wireless system that transmits the frontal EEG to a base station that looks like an alarm clock and processes the EEG to determine wakefulness, light sleep, slow wave sleep, or REM. Normal sleepers (n=29) were recorded on two nights in the sleep lab and results of “gold-standard” polysomnography were compared to automatic sleep staging. The PSG was scored by two expert human sleep technologists and it was found that the Zeo algorithm showed excellent

correspondence with the concordance of the two human scorers. A full manuscript detailing these results has now been submitted for publication.

Given that this is a widely available consumer device, it provides a resource for clinicians, including psychologists, to routinely monitor sleep quality in the client's home. It is possible to use this system to evaluate effects of medication changes or behavioral changes. Changes in sleep quality associated with clinical changes can now be easily evaluated over multiple nights and the Zeo website allows users to track changes over time and review more detailed information about their personal sleep in a way that has not been previously available. More information about Zeo system can be ordered directly from the manufacturer on-line (www.myzeo.com).

C. Measuring Sleep Apnea

- 1) Apnea is a decrease in airflow, usually caused by an obstruction in the nasopharynx. Mild obstructions, "hypopneas", and increased respiratory effort, "areras" involve arousals that fragment sleep stages and frequently produce excessive daytime sleepiness. The combination of respiratory effort, measured by strain gauges placed over the lumbar and thoracic regions, and decreased nasal air flow define obstructive apnea.
- 2) Measurement of peripheral arterial tone ("PAT") by mean of a finger plethysmograph and an SAO₂ monitor, can also be used to diagnose sleep apnea. Profound, transient vasoconstriction and periodic tachycardia are seen during each apneic event. Good correspondence has been found between total apnea-hypopnea scoring and PAT (Schnall et al., 1999).

IV. Treatment

A. Continuous Positive Airway Pressure (CPAP)

The most widely used treatment for sleep apnea is presentation of continuous positive airway pressure using a nasal or oral/nasal mask. Increased pressure in the nasopharynx keeps the airway open and prevents snoring due to vibration of the uvula. The pressure setting used requires titration so that there is enough pressure to hold the airway open but not so much as to wake the patient or produce central apneas where the breathing reflex is inhibited. Since it may require relatively high pressure to maintain the airway, the pressure often is set higher for inspiration than for expiration, call BiLevel or BiPAP therapy.

The main issue in use of CPAP is lack of compliance due to discomfort and claustrophobia after placement of the mask over the nose and mouth. This is a significant issue and one in which the psychologist can play an important role. We have many reports of patients unable to tolerate use of the mask. Cognitive Behavioral Therapy may be useful in desensitizing these clients.

I recently had an overnight a sleep study myself and was able to easily accommodate the CPAP mask. I attribute this to practicing wearing a variety of masks prior to my study, so I knew better what to expect.

An alternative approach is the use of dental appliances to prevent occlusion of the airway. Individuals who cannot tolerate the CPAP mask may be able to accommodate the dental device. Dental devices are not as effective with more severe forms of apnea and are not appropriate for use with children.

B. Medication and behavioral treatment of chronic insomnia

The first line of treatment for chronic insomnia is typically following rules of good sleep hygiene. This involves standardizing the time of going to bed, controlling the sleep environment for temperature light, and sound. The bedroom is used for sleeping, and not eating, working, or otherwise living in bed. It is useful to use relaxation techniques and avoid stressful activities.

As mentioned above, chronic insomnia is now frequently treated with a variety of sleep inducing medications. Psychostimulant medications or wakefulness promoting agents, such as Provigil™ are sometimes used during the day to maximize wakefulness so that daytime drowsiness does not cause napping and interfere with sleep onset at bedtime. Many of these medications have significant side effects and often simply do not produce good clinical outcome. The use of behavioral techniques such as CBT and biofeedback, discussed further below, may be more effective for certain individuals. Further research studies are needed to evaluate neuromodulation techniques such as transcranial magnetic stimulation on sleep initiation and maintenance.

C. Treatment of Parasomnias

No evidence based treatments are currently available for parasomnias although Clonazepam and modifying the sleep environment is often suggested to help reduce sleep related injury.

Antihypertensive agents are sometimes effective in treatment of nightmares. Venlafaxine, likely because of inhibition of uptake of norepinephrine has been shown to produce negative outcome. Psychological therapies such as Cognitive Behavior Therapy (CBT), eye movement desensitization training (EMDR), Progressive deep muscle relaxation (PDMR), Imagery Rehearsal Therapy, and hypnosis are often used with varying success.

D. Neurofeedback

Neurofeedback involves recording EEG, analyzing and extracting specific features of the EEG, and presenting results to the client on a video screen. If pre-set criteria are met for specific frequencies to be increased or decreased, the client is rewarded. A brief tone is presented and the client is rewarded by scoring points in a video game. With some practice, individuals can be trained to win the video game and in the process modulate

their EEG. Conscious attempts to change the EEG are ineffective. Indeed, conscious attention is not required, nor is it desirable. Conscious awareness of brain activity is not required to perform psychological functions and is not necessary to achieve a beneficial therapeutic effect. This also allows the technique to be used in preverbal children.

Biofeedback has traditionally been used as a relaxation technique. Devices now commercially available are all labeled as devices to promote relaxation. It is clear that the traditional use of EEG biofeedback for relaxation is useful in the treatment of insomnias and in compliance with CPAP.

In addition, feedback of brain electrical activity is useful beyond simple relaxation training. Neurofeedback procedures are often used globally to increase arousal or decrease behavioral arousal. In addition, neurofeedback can be targeted to modulate specific brain regions, and has been effective in inhibition of left anterior alpha excess in the treatment of major depression. New neurofeedback techniques are currently being used to influence brain connectivity by modulating EEG coherence between regions. For a discussion of these approaches to neurofeedback see Johnstone, 2009. Anecdotal evidence suggests possible effectiveness of rewarding very low frequency component of the EEG. Clinicians also have reported success with introduction of very small electromagnetic signals to the scalp according to specific protocols, with many reports of improved sleep quality.

Neurofeedback can address compliance issues in use of CPAP. In addition, it may be useful in also addressing related clinical components of the sleep disorder such as anxiety and depression, without the use of medications. Clinicians can use neurofeedback to promote physiological arousal while decreasing dosage of psychostimulant medications thereby avoiding side effects such as sleeplessness and weight loss.

Quantitative EEG analysis is increasingly used in conjunction with neurofeedback to identify brain regions for modulation and in selecting specific frequencies of EEG that are excessive or deficient in an individual compared to normative EEG databases. Quantitative EEG assesses neurophysiologic arousal and regional brain activation directly. Importantly, qEEG may be used to predict effectiveness of clinical interventions and help guide therapy to improved clinical benefit. The predictive ability of qEEG data in guiding clinical intervention with medication, neurofeedback, and transcranial magnetic stimulation has recently been reviewed (Johnstone and Lunt, 2011).

Conclusion:

Quality of sleep is a major factor in general health and good psychological functioning. We review the major sleep disorders, assessment of sleep using polysomnography, and techniques for treatment, emphasizing new developments in neurofeedback and quantitative EEG technology. Better awareness and recognition of sleep problems in clinical settings and knowledge of methods for characterizing and treating sleep disorders will assist the clinical psychologist in routine daily practice.

V. Some References

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