Sleep comprises two states that alternate cyclically across sleep episodes: non-rapid eye movement sleep (stage N sleep) and rapid eye movement sleep (stage R sleep). Sleep is an active process; there is less incoming sensory information, but the brain is also involved in the process of metabolism and memory consolidation. The study of fluctuating levels of a series of neurotransmitters, including the biogenic amines and acetylcholine, helps further the understanding of sleep and its role in various physiological functions of the body.

**THE BRAIN & NEUROTRANSMITTERS**

The brain is divided into three major regions: the forebrain, the midbrain and the hind brain. It is also subdivided into four lobes in each of the right and left hemispheres: frontal, temporal, parietal and occipital. Each lobe is involved in numerous vital functions that include, but are not limited to, the following: The occipital lobe is the center for vision; the temporal lobe is primarily involved in hearing, memory and language comprehension; the frontal lobe is involved in thought, imagination, planning (including planning and execution of movements), language, impulse control and learning; and the parietal lobe is involved in further motor and sensory processing. The brainstem is mainly responsible for several vital functions including respiration and cardiac functions; it also plays an important role in sleep-wake regulation.

Neurotransmitters are chemical messengers secreted by neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other. They transmit nerve signals across synapses (i.e., space between neurons), where they facilitate the transfer of impulses between neurons to communicate with each other.

The autonomic nervous system (ANS) is the major involuntary part of the nervous system and is responsible for automatic bodily functions, such as control of heart rate and blood pressure. The ANS is divided into the parasympathetic nervous system (PNS) and the sympathetic nervous system (SNS). The PNS and SNS often utilize nicotinic and muscarinic receptors.

One can identify subclasses of receptors and corresponding neurotransmitters. Examples would include alpha and beta-adrenergic, serotoninergic, gamma-aminobutyric acid, and glutamatergic receptors. Understanding these concepts makes it possible to correlate structure with function, and to provide a rational basis for molecular classification of drug actions. Briefly, some of the main neurotransmitters include the following:

- **Acetylcholine** (ACh) is present at both nicotinic and muscarinic receptors; all direct transmission from central nervous system uses ACh.
- **Norepinephrine** is the neurotransmitter at most adrenergic receptors in organs, as well as in cardiac and smooth muscles.
- **Dopamine** causes vasodilation in renal and mesenteric vascular beds and plays an important role in motor and limbic systems.
- **Epinephrine** activates most adrenergic receptors and is transported in the blood.
- **Serotonin** is involved in mood regulation and sleep-wake processes.

**SLEEP & NEUROTRANSMITTERS**

Jouvet first described the role of monoamines and acetylcholine in the regulation of the sleep-wake cycle.

Cerebral monoamines like dopamine, norepinephrine and acetylcholine play an important role in waking and are also involved in stage R sleep. A high level of these biogenic amines in specific regions of the brain promotes wakefulness; lower, more moderate levels induce stage R sleep.

The histamines play a significant role in the regulation of vigilance during wakefulness. Mutual interactions of histamine with other transmitter systems form a network that links basic homeostatic and higher brain functions, including sleep-wake regulation, circadian and feeding rhythms, immunity, learning, and memory in health and disease.

Acetylcholine (ACh) activates cortical neurons and is released at the maximal rate during both waking and stage R sleep. This compound activates muscles in the peripheral nervous system. In the central nervous system ACh is associated with arousal and reward, short-term memory and learning. Damage to the cholinergic system is thought to play a role in memory deficits observed in Alzheimer’s disease.

Orexins, also known as hypocretins, are neuropeptides that promote wakefulness. Orexins also have been linked with the cholinergic system; cholinergic neurons stimulate cortical activation with muscle tone if orexins are present, and cortical activation with muscle atonia if orexins are inactive. Loss of orexin neurons is thought to cause narcolepsy. Loss of these neurons also reduces CO2-induced, increased breathing by 50 percent.

Glutamate is an excitatory neurotransmitter in the brain and is released in greatest quantities from the cerebral cortex in response to spontaneous wakefulness. A particular activation of glutamate receptors also might be associated with slow wave sleep.

Serotonin is an inhibitory neuropeptide and normally facilitates sleep onset; its role in sleep maintenance is unclear. Serotonin is involved in the regulation, synthesis and storage of factors that induce sleep, and it plays a role in the gating of stage R sleep. Deficits in serotonin receptor functioning have been as-

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Adenosine is a neurotransmitter and is present in extracellular space. A relationship between adenosine surges and sleep was first discovered when scientists found that caffeine blocks its receptors from binding to cells, thus preventing sleep onset. Adenosine promotes sleep as it accumulates in increased amounts during wakefulness.

Gamma-aminobutyric acid (GABA) is an inhibitory neurotransmitter that acts with two types of receptors: GABA-A and GABA-B. Drugs like benzodiazepines and barbiturates suppress respiration in toxic doses and act on GABA receptors by increasing either the frequency or the duration of opening of chloride channels. GABA-A could enhance spindling and slow wave sleep.

CONCLUSION

Having a better knowledge of neurotransmitters and drugs that act on these receptors plays an important role in the diagnosis and management of many sleep disorders. Sleep technologists should become familiar with medications that act specifically on different receptors and neurotransmitters either by inhibiting or exciting neurons. It is important to be aware of how numerous medications affect polysomnographic findings.

REFERENCES


ADDITIONAL READING