

NAMS Regional Symposium on Sleep Medicine

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PHYSIOLOGY OF NORMAL SLEEP: FROM YOUNG TO OLD

SYNOPSIS

Behaviourally, sleep is characterised by reduced motor activity, decreased response to stimulation, stereotyped posture and relatively easy reversibility. Scientifically, sleep is defined on the basis of electrophysiological signals like electroencephalogram (EEG), electromyogram (EMG) and electrooculogram (EOG). Though modern definition and classification of sleep was suggested by Nathaniel Kleitman in 1939, it is described in detail in a manual written by Rechtschaffen and Kales¹. Normal human sleep was divided into non-rapid eye movement (NREM) sleep (four stages) and REM sleep. The American Academy of Sleep Medicine slightly modified the staging rules in 2007².

Sleep starts with a period of NREM sleep. REM sleep takes place after a short period of NREM sleep. This alteration between NREM and REM occurs about 4-5 times during a normal night's sleep. As NREM sleep progresses to deeper stages, the EEG shows increasing voltage and decreasing frequency. Though muscle activity is progressively reduced, the sleeper makes postural adjustments after about every 20 minutes. During NREM sleep the heart rate and BP decline, but the gastrointestinal motility and parasympathetic activity increase. On the other hand, REM sleep is characterised by a profound loss of muscle tone, though the eyeballs show bursts of rapid eye movements. The EEG becomes desynchronised during this phase.

Circadian sleep-wake rhythm with periodicity in physiological, biochemical, and psychological processes is modulated by the suprachiasmatic nucleus of the hypothalamus, and the pineal gland. These brain areas set the body clock periodicity to approximately 25 hours, but with environmental clues (like light exposure) and activity schedule, the sleep-wake rhythm is entrained to a 24-hour cycle.

Newborns show several sleep-wake cycles in a day of 24 hours. This polycyclic rhythm passes through a biphasic pattern before a monocyclic pattern is established in young adults. In newborns, the total duration of sleep in a day can be 14-16 hours. Most of it is REM sleep. In adults, sleep of 7-8.5 hours is considered fully restorative. The amount of sleep needed by each person is usually constant, although there is a wide variation among individuals. During old age,

total sleep is not only reduced, it is often divided into an overnight sleep period of less than 6-7.5 hours and a mid afternoon nap of about one hour. This biphasic sleep pattern is also observed in young adults in some cultures.

Sleep was considered as a passive process till the 1950's. This passive theory of sleep was replaced by the active sleep genesis concept, mainly after the realization that brain activity is only slightly reduced during sleep. There is now growing evidence to suggest that sleep is auto-regulatory and that it is not necessary to attribute sleep genesis to either an active or a passive mechanism^{3,4}.

Sleep is considered essential for life⁵. It may be having a restorative and recovery function, especially for the brain. Energy conservation could be one function of sleep. The role of REM sleep in brain growth has been suggested for long. Sleep may also facilitate neurogenesis. Memory consolidation during sleep has been proposed by many investigators. Discharge of emotions through dreaming is an age-old function ascribed to sleep. Sleep may have a thermoregulatory function.

The importance of sleep is evident from the health problems resulting from sleep disorders. Some sleep disturbances can be described as temporary mild inconveniences, while others are far more serious with disastrous consequences. Persistent and repeated interruption of sleep affects the physical and mental health of the individual. Inadequate sleep causes not only misery to the sufferer, but it also has far reaching socioeconomic consequences.

SUGGESTED READING

1. Rechtschaffen A and Kales AA. A manual of Standardized Terminology: Technique and Scoring Systems for Sleep Stages of Human Subjects. National Institutes of Neurological Diseases and Blindness, Bethesda, MD, 1968: 1–57.
2. Iber C, Ancoli-Israel S, Chesson AL, and Quan SF. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology, and Technical Specifications. Westchester, Ill: American Academy of Sleep Medicine; 2007.
3. Kumar VM (2010). Sleep is neither a passive nor an active phenomenon. *Sleep and Biological Rhythms* **8**: 163–169.
4. Kumar VM (2012). Sleep is an auto-regulatory global phenomenon. *Front Neurol* **3**: 94 (1-2)
5. Siegel JM (2005). Clues to the functions of mammalian sleep. *Nature* **437**: 1264-1271.