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Review on Sleep and Sleep Disorders

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Abstract: Sleep is a complex neurological state, with its primary function of providing rest and restoring the body's energy levels. Normal human sleep is divided into non–rapid eye movement (NREM) and rapid eye movement (REM) sleep, and the alteration between NREM and REM occurs about 4-5 times during a night of normal sleep. Human NREM sleep could be classified into four stages, namely, stage I, II, III and IV, representing successively deeper stages of sleep and rapid eye movement (REM) sleep characterized by rapid eye movements, muscle atonia and desynchronized EEG. Alterations in the quality, quantity and pattern of sleep result in sleep disorders. Though there are more than 100 identified sleep/wake disorders, most sleep complaints can be categorised into five, namely, hypersomnia, insomnia, circadian rhythm disorders, parasomnias and sleep disorders associated with mental, neurological and other medical disorders. Sleepiness during waking hours results from volitional or forced sleep deprivation during previous nights due to social, economic and environmental reasons. Daytime sleepiness, sleep deprivation, and irregular sleep schedules are highly prevalent among college students, as 50% report daytime sleepiness and 70% attain insufficient sleep. Sleep disorders diagnosed based on history and polysomnography findings.
Keywords: Sleep, Sleep disorders, Rapid eye movement, Non rapid eye movement.

DEFINITION OF SLEEP

Sleep is a functional state that comprises combination of physiological and behavioural processes [1, 2]. It is characterized by a relative unconsciousness of the external world, reduction in voluntary body movement and a general lack of memory of the state [3].

SLEEP CYCLE

Based on three physiological measurements electroencephalography (EEG), electrooculogram (EOG) and electromyography (EMG), sleep is divided into two states namely non rapid eye movement (NREM) and rapid eye movement (REM) sleep alternating in a cyclic manner (total of 4 to 6 cycles are noted during sleep in adults), each cycle lasts on an average from 90 to 110 min. NREM sleep accounts for 75 to 80 per cent of sleep time in adult human. NREM sleep is characterized by progressively decreased responsiveness to external stimulation accompanied by slow eye movements. REM sleep accounts for 20 to 25 per cent of total sleep time. REM sleep is characterized by rapid eye movements, further reduction of responsiveness to stimulation, absent muscle tone [4].

NREM sleep is subdivided into four stages.

Stage 1

It is characterized by loss of alpha activity and the appearance of a low voltage mixed frequency EEG pattern with prominent theta activity.

Stage 2

It is characterised by the appearance of sleep spindles and K-complexes in the EEG.

Stage 3 and 4

These are also called as slow wave sleep, delta sleep, or deep sleep, since arousal threshold increases incrementally from stages 1 through 4 [3].

According to American association of sleep medicine (AASM) scoring manual NREM is further divided into N1, N2 and N3 on the basis of EEG waves.

REM sleep has two phases namely Tonic and Phasic components [1].

NREM Vs REM

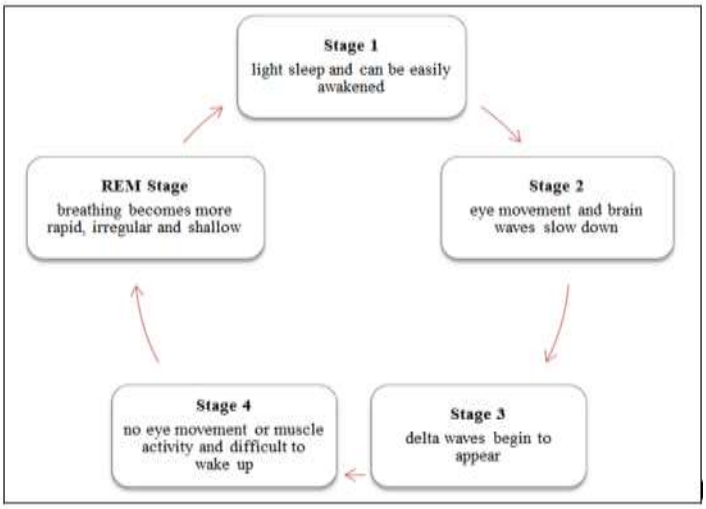
There are a variety of differences between non rapid eye movement and rapid eye movement sleep which were given below [5].

Table–1: Differences between NREM and REM sleep

NREM	REM
Slow eye movement	Rapid eye movement
Restful sleep	Not restful
Decreased metabolism	Increased metabolism
Vital signs low	Vital signs irregular
Muscle tone maintained	Muscle tone depressed
No vivid dreams	Dreams occur

SLEEP CYCLE

The first cycle is usually shorter with deep sleep and the REM stage being shorter. As the night progresses, the deep sleep phase becomes shorter while the REM phase increases. The sleep cycle was given below [6].



Fig–1: Sleep cycle

In humans, the amount of sleep depends upon their age. New born babies sleep for an average of 16 to18 hours per day, further gradual decline to about 13 to 14 hours after one year. Adolescents tend to require more sleep than adults, possibly due to the physiological changes that are happening in the body during this period. As the person reaches adulthood they sleep 7 to 8 hours per day. Older adults tend to sleep roughly 6 to7 hours per day, but take more frequent naps throughout the day [7].

PHYSIOLOGICALCHANGES DURING SLEEP

A variety of physiological and behavioural changes occur during NREM and REM sleep which were given below [2], [8].

Table–2: Physiological changes during sleep

PHYSIOLOGY	NREM SLEEP	REM SLEEP
Heart rate	Bradycardia	Bradytachyarrhythmia
Blood pressure	Decreases	Variable
Cardiac output	Decreases	Decreases further
Respiratory rate	Decreases	Variable
Sympathetic activity	Mild	Decreases or Moderate
Parasympathetic activity	Marked	Very Marked
Gastric motility	Decreases	Decreases
Salivary flow	Decreases	Decreases
Muscle tone	Similar to wakefulness	Absent
Blood flow to brain	Decreases	Increases
Body temperature	Regulated	Not regulated

Many hormones show significant interactions with sleep-wakefulness patterns. Growth hormone (GH) is released during the early part of the night. Sleep also stimulates prolactin secretion, although prolactin peaks after GH, usually during the middle portion of the night. Pulses of growth hormone and prolactin can occur after the onset of sleep. GH enhance slow wave sleep (stage 3 and 4), whereas prolactin increase REM sleep.

Thyroid stimulating hormone (TSH) reaches its peak level in the evening prior to sleep onset. Cortisol level rises at the end of the sleep period. Melatonin, a hormone released by the pineal gland attains its highest secretion levels between 0300 h and 0500 h and then decreases to low levels during the day.

CIRCADIAN RHYTHM AND SLEEP

Regulation of sleep-wakefulness is modulated by two opposing factors, homeostatic drive for sleep and circadian rhythm promoting arousal. The homeostatic factor refers to an increased propensity for sleepiness with longer periods of prior wakefulness while the circadian factor refers to variations in physiological alertness and sleepiness that vary cyclically with time of day. Homeostatic drive gradually increases as the day progresses at the end of the day, homeostatic drive results in the onset of sleep. Early in the morning, homeostatic drive is diminished and circadian arousal influences result in awakening [9].

NEUROTRANSMITTERS INVOLVED IN SLEEP

Most of the neurotransmitters regulate sleep-wakefulness

GABA

GABA is the major inhibitory neurotransmitter in the brain increases wakefulness and inhibits sleep [10].

Acetyl Choline

Acetylcholine is distinguished as being the first identified neurotransmitter in generating the brain-activated states of wakefulness and REM sleep [11].

Adenosine

Adenosine is a breakdown product of adenosine triphosphate (ATP). Increases in endogenous adenosine levels in a specific brain region during a period of prolonged wakefulness indicate that the region has been metabolically active [12].

Serotonin

Serotonin is another neurotransmitter that affects sleep, insufficient levels of serotonin are related to mental health problems like depression and anxiety. In active state levels of serotonin are highest in the brain [13]. Norepinephrine, histamine and dopamine discharge at their fastest rates during wakefulness, slow their firing in NREM sleep, cease discharging prior to and during REM sleep, and resume firing prior to the onset of wakefulness [14].

Glutamate

Glutamate is the main excitatory neurotransmitter in the brain and known about glutamatergic regulation of sleep and wakefulness [15].

Peptides

Hypocretin-1 and -2

Hypocretinergic neurons discharge with the highest frequency during active wakefulness and show almost no discharge activity during sleep [16].

Leptin and Ghrelin

Decreased levels of leptin (a hormone that suppresses appetite) and increased levels of ghrelin (a hormone that stimulates appetite) are associated with short sleep duration in humans [17].

CAUSES FOR SLEEP DISTURBANCES

Sleep disturbances are more common among elders and is associated with functional impairment and poor quality of life [18]. Significant predictors of poor sleep include frequent stress events, regular night time awakenings, and sleep latency period longer than 15 min [19]. Other factors such as education, employment and health factors in poor individuals [20].

In elders

- Circadian rhythm changes
- Primary sleep disturbances (e.g. REM behaviour disorder, Periodic limb movements in sleep)
- Medical illness (e.g. hyperthyroidism, arthritis)
- Psychiatric Illness (e.g. depression, anxiety disorders)
- Multiple medications
- Dementia, poor sleep hygiene habit [21].

In college students

- Television, computer or video games before bed, Cell phones on overnight, Frequent exposure to light before bed
- Caffeine and energy drinks, alcohol use, stimulant use
- College scheduling and activities [22].

During hospital stay

- Excessive lighting
- Uncomfortable bed
- Nursing routine
- Care provided to patients and other patients in the room
- Noise in the ward
- Fear and concern [23].

SLEEP DISORDERS

Sleep disturbances or disorders represent a medical condition that disturbs normal physical, social, mental, and emotional functions of a person [24].

EPIDEMIOLOGY

- One in seven Americans have a chronic sleep/wake disorder, Europe has the highest proportion of elderly people, in whom many sleep problems such as insomnia and sleep apnoea are more common [25].
- Women are at increased risk for developing insomnia, restless leg syndrome (RLS), sleep apnea, REM sleep disordered breathing compared with men

- Women with RLS are at higher risk for comorbid problems compared with men
- Antidepressant use is more strongly associated with RLS in men than in women
- Men are at twice the risk for OSA than women [26].
- Major sleep disorders are more prevalent among the obese [27].
- Sleep problems are common in older adults and these may have a significant impact on quality of life [28].
- Sleep disturbances lasting at least several nights per month have been reported by 30% of population [29].
- According to the National Institutes of Health, the prevalence of sleep disorders in USA is approximately among 14.71% of the population [30].

TYPES OF SLEEP DISORDERS

According to International Classification of Sleep Disorders, second edition (ICSD-2) was published by the American Academy of Sleep Medicine with the goal of standardizing definitions and creating a systematic approach to diagnosis [31].

According to the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV) these are mainly classified as

- **Dyssomnias**
  Dyssomnias are disorders characterized by either excessive sleepiness or difficulty initiating or maintaining sleep [32].

- **Insomnia**
  Insomnia is defined by the presence of an individual's report of difficulty with sleep [33].

- **Hypersomnia**
  It is defined as excessive sleepiness for at least 1 month as evidenced by either prolonged sleep episodes or daytime sleep episodes that occur almost daily.

- **Narcolepsy**
  Narcolepsy is a neurological disorder that is characterised by the tendency to fall asleep during day time, despite having obtained an adequate amount of sleep the preceding night [34].

- **Circadian rhythm sleep disorder**
  Circadian rhythm disorders are the inability to sleep during the desired sleep time [35].

- **Breathing related sleep disorder**
  Sleep disruption, leading to excessive sleepiness or insomnia that is due to a sleep-related breathing condition (e.g., obstructive or central sleep apnea syndrome or central alveolar hyperventilation syndrome) [33].

- **Restless leg syndrome**
  It is characterised by uncomfortable limb sensations at sleep onset and motor restlessness exacerbated by relaxation.

- **Periodic limb movements in sleep**
  It is characterised by repetitive, stereotypic limb movements leads to recurrent arousals from sleep [36].

Parasomnias

Parasomnias can be defined as abnormal movements or behaviours, including those that occur into sleep or during arousals from sleep, intermittent or episodic, or without disturbing the sleep architecture [37].

- **Night mare disorder**
  It is characterised by repeated awakenings from the major sleep period with detailed recall or extended and extremely frightening dreams, usually involving threats to survival, security.

- **Sleep walking disorder**
  It is defined as repeated episodes of rising from bed-during sleep and walking about, usually occurring during the first third of the major sleep episode [33].

- **Sleep terror disorder**
  It is characterized by intense autonomic and motor symptoms including a loud panicky scream.

- **REM behaviour disorder**
  It is defined as intermittent loss of REM sleep related muscle hypotonia or atonia and the appearance of various abnormal motor activities during sleep [38].

DIAGNOSIS

The two most important laboratory tests include polysomnography (PSG) and multiple sleep latency test (MSLT).

Polysomnography

It measures electrographic recordings includes EEG for sleep staging, EOG for eye movements, EMG for movement or atonia during REM sleep [39].

Multiple sleep latency tests

The MSLT is used to confirm the diagnosis of narcolepsy. The maintenance of wakefulness test (MWT) is a variant of MSLT measuring for subject's ability to stay awake [40].

SLEEP HYGIENE GUIDELINES

- Maintain a regular sleep time and wake time
- Do not stay in bed if unable to fall asleep
- Restrict naps to 30 minutes in the late morning or early afternoon
- Exercise regularly
- Eat a light snack (milk, bread) before bed
- Avoid caffeine, tobacco, alcohol after lunch
- Limit liquids in the evening [5, 41].

CONCLUSION

Disturbed sleep is a widespread complaint among elders and is associated with functional impairment and poor quality of life. Lifestyle habits, which are aspects of everyday life, can have significant impacts on sleep regulation. Exercise is a positive behavioural modification tool for all age groups to bring about an improvement in sleep quality. In order to improve the sleep quality of hospitalized patients, change the environmental factors that cause loud noises and excessive lighting during the night.

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