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Short Communication

Sleep: The Surprising Science of Mind at Rest

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Abstract

World Health Organization (WHO) had defined health way back in 1948 constitution as "a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity." In this age of speed and stress we all are fighting to remain healthy and seem to be taking this definition seriously while making all efforts to remain fit. Literature indicates that sleep holds the key to our overall health. Sound sleep has gained global understanding and we all are striving to reach out to this state of our mind and body where the repair of our worn out tissues is done naturally. Today several meditation centers and sleep clinics have mushroomed adding to the quantum of the 'art' of sleep. Every second day we find a column or an article on sleep disorders amongst the people from all walks of life especially the adolescents, the shift workers and of course the old with neurodegenerative disease. This review is a concise account of the various aspects of sleep which we all must know and which would impress upon us to introspect our lifestyle and get sleep the most natural way.

Introduction

Psalm 127:2 In vain you rise early and stay up late, toiling for food to eat---for He grants sleep to those he loves.

The purpose of sleep is one of the great unsolved mysteries of biology that has fascinated people for ages. We all know that sleep is the time when our brains and body, both are at rest which is extremely important for our well being. Even God took rest from all His work the seventh day, sanctified it and called it the Sabbath day. Initially the entire concept of sleep remained unsolved and there were various views about this daily activity such as in 1719 when sermon Cotton Mather, a socially and politically influential New England Puritan minister, prolific author, and pamphleteer called an excess of sleep 'sinful' and regretted that we often sleep when we should be working or when Benjamin Franklin mocked 'there'll be sleeping enough in the grave' [1]. Great progress has been made in understanding the brain mechanisms that control sleep and wakefulness. Such awareness has become of paramount importance to our society, especially in present times when every second person seems to be stressed out and is suffering from sleep disorder. Popping in of sleeping tablets has become more of a habit than a medicine. Researches reveal that these tablets are habit forming and the dependence for a higher dose is a matter of concern [2]. The disturbances in sleep pattern and its poor quality are associated with a wide range of medical and psychiatric conditions. Of several functions played by sleep is combating infection and maintenance of optimal health. Adequate sleep is also essential for optimal cognitive function; and lack of sleep has been implicated in major industrial disasters as well as car and workplace accidents. It is many times proclaimed that poor sleep quality increases chances of early death and so goes the saying 'when your sleep isn't right nothing is right'. Although sleep is more commonly accepted to be a passive and restful time; it actually involves a highly active and well scripted interplay of brain circuits, resulting in sleep's various steps controlled by circadian rhythms and other factors such as age.

In this comprehensive review current knowledge regarding the brain mechanisms controlling wakefulness, Non-Rapid Eye-Movement (NREM) sleep, and Rapid-Eye-Movement (REM) sleep are discussed. The article also deals with a holistic approach towards ways to get 'good' sleep.

Sleep: Is it crucial?

For a long time sleep's apparent uselessness amused even the scientists who studied it. Why should anyone be spending one third of life lying almost inert? But now research has solved the mystery of this diurnal activity which if gets disturbed leads

to several intricate problems. According to sleep scientists sleep might help us abate neurodegenerative disease or other forms of cognitive impairment and might serve to relieve vascular stress (related to circulatory system). It is considered as a natural moisturizer and perspiration during sleep is a natural skin treatment. According to Stick gold, a preeminent sleep researcher at Harward University, sleep is important selective mechanism for strengthening memory [3]. In sleep the neural response is such that things recently experienced are spontaneously relayed and certain other are reactivated while you are asleep. It is this relay and certain reactivation of activities that strengthens our memory. Our brains are in effect practicing while we sleep. It efficiently sifts out the information and helps us remember only a few things out of many that we experience the entire day and replay some during the dreaming phase. Sleeping and dreaming Stick gold argues help us sift through material to isolate and store the important whether it is only a 'gist' or a specific detail. The importance of sleep to our brain function may be even more central. In addition to its memory and problem solving, sleep may help our brains stay sharp, young and healthy. According to Maiken Nedergaard sleep researcher, sleep is the brain's maintenance and vital to our overall health and quality of life [4]. It is a dynamic condition of body and mind which typically recurs for several hours every night in which a host of connections become active. It is in contrast to the inactive nervous system which is in sync with the closed eyes, relaxed postural muscles and consciousness practically suspended. Moreover sleep affects our daily functioning and our physical and mental health in many ways. Proper sleep is necessary for our neurons and can be viewed as growth and repair time. Sleep is a state of unconsciousness in which the brain is relatively more responsive to internal than external stimuli.

SLEEP: The Science Behind

We spend as much as a third of our lives asleep. Understanding what happens during sleep and how it serves a restorative function can help us treat emotional and cognitive problems to sleep and whose explanation lies in 'good' sleep.

A number of theories explaining as to what makes sleep a biological imperative activity have been put forth. It is convincing that by sleeping one gains lot in terms of benefits to memory, the immune system and the sheer preservation of human energy, despite the fact that a sleeping person's metabolism slows down by about 15 percent when compared to waking hours. According to the theory of glymphatic system when we are awake, our activities lead to a building up of debris in the brain [5]. We form toxins, such as beta-amyloid a protein associated with Alzheimer's and other proteins that are usually harmless get misfolded. When we fall asleep, specific channels in our brains expand to allow cerebrospinal fluid to flow in and clear this debris. This pathway which is connected to the lymph nodes of the neck and is concerned with the clearance of interstitial waste products from neuronal metabolism has been termed the 'glymphatic system'. Conversely if brains don't get enough to rest, toxins build up and neurodegenerative disease sets in.

Humans need an uninterrupted six to eight hours of sleep to cleanse their brains overnight of neurotoxins, specially the harmful remnants like beta amyloid which are often found in clumps in brains of Alzheimer's disease. Without sleeping through the entire 6-8 hours process, the brain's cleansing system can't filter bad proteins through the spinal cord. The more beta amyloid you have the less deep sleep you get.

Sleep: Spring Cleaning For Brain

During our working hours we are constantly hearing, seeing, smelling, feeling and tasting and have thoughts and feelings related to these sensory experiences which are translated by our brain into a huge array of sensory information. While we are busy carrying out our daily activities and experiencing things, the connection between neurons in the brain are busy gathering information and the brain tries to process selective information, forgetting that it doesn't want to remember. If we don't filter some of this information our brains become overloaded. We must have a way to sort information we receive during the day storing and consolidating what is important and letting the rest go. This happens during sleep. During deep stage of slow wave sleep, synapses get down scaled again allowing us to recall the salient aspects of our day, without being engulfed by unimportant things.

Did You Know?

- During sleep we pass through five sleep stage: Stages 1-4 are non REM (NREM) and stage 5 is REM (Rapid Eye Movement) sleep. These stages put together form one complete sleep cycle.
- Each cycle lasts around 1and ½ hrs in adult and for a good sleep we need to go through all 4 stages (in children it is shorter). A good night's sleep consists of 5-6 cycles.
- We spend almost 50% of our total sleep time in stage 2, about 20% in REM sleep and remaining 30% in other stages.
- As night progresses, REM sleep periods increase in length while deep sleep (stage 3 & 4) decreases.

Quiet sleep (stage 1-3) restores (to get back) the body, SWS, stage 4 is beauty sleep while REM recuperates (to heal over a period of time) mind and is important for learning and memory [6].

- Dropping to sleep: even the idea of falling into sleep changes in brain-wave patterns at the onset of non REM sleep. Once your eyes are closed and your brain no longer receives visual inputs, brain wave settles into a steady rhythm pattern of about 10 cycles per second -----is the alpha wave.

Box: Learn the Real Secret to Sleep: Sleep Hygine

- Where More Is Better: An adequate night's sleep includes tim-

ing, duration and quality. An adult should sleep generally for about seven to eight hours. However some people can do with a slightly lesser sleep.

- Turn off Technology: Before bedtime and during sleep, avoid light exposure, even from electronic devices. Avoid having a TV, computer, laptop or tablet in your bedroom. These are all stimulating and glowing, and a cause of poor sleep. These devices send out blue wavelengths of light, which can interfere with the natural release of sleep-promoting hormone melatonin.
- DO's AND DON'Ts: Avoid caffeine, and alcohol. Exercise, eat right, take warm water bath and do some mindfulness therapy and have a positive attitude towards life.
- GET REGULAR: Maintain a disciplined sleep regime going to bed and getting up at more or less same time, every day and even on weekend and off days.
- SLEEP WHEN SLEEPY: The best way to judge if you are sleep deprived is to notice how much time you toss in bed, if it takes you less than 5 minutes to fall asleep, then you could be sleep deprived for it should take closer to 10 minutes. In case you haven't been able to sleep after about 20 min in bed, get up and do something not very interesting and, which does not involve you much. Stay away from technology.
- BED IS FOR SLEEPING: Your body should have a connection with it, therefore do not use your bed for other purposes like studying or watching TV.
- SLEEP RITUALS: If you brush your teeth or say a prayer or wash your face just before you sleep every day do it with consistency even when hard pressed for time so that body knows it's time to sleep.
- YOUR PENNED SIGNATURE: The position you take in bed each night can echo the way you deal with your daytime working hours, say sleep scientists. This position is your private scrawl and there is no reason to alter it.

Sleep: Night Life Facts

When we fall asleep, the brain does not merely go offline; instead a series of highly orchestrated events put the brain to sleep in stages.

Stages: Quiet sleep 1-3

Stage 1 or N1: This first stage of sleep called the "introduction into sleep" is marked by a slowing down of brain activity and a beginning of muscle relaxation. It is drowsiness or light sleep during which we can drift in and out of sleep. Slow eye movement is there and therefore the person can be awakened easily. We spend about 5 minutes in this stage. On the EEG the predominant brain waves are slow with about 4-7 cycles per second forming theta wave pattern. The most significant characters are dropping in body temperature, relaxing of muscles and slow movement of eyes from side to side while we start to lose awareness.

Stage 2 or N2: This is true sleep during which eye movement stops, eyes becoming still and the brain waves become slower with occasional burst of rapid waves called sleep spindles. It lasts for 25-30 min, during which the heart rate and breathing are slower than when awake. Brain's electric activity is irregular. The EEG pattern here is called K complex which scientists think represents a sort of built in vigilance system that keeps you poised to awaken if necessary. K complexes can also be provoked by certain sounds or other external stimuli.

Stage 3 or N3: Known as slow wave sleep and marked by extremely slow waves called delta waves. These waves begin to appear interspersed with smaller faster waves. Breathing becomes regular, muscles relax, blood pressure falls and the pulse slows down to about 20% to 37% below the waking rate. Brain is less responsive to external stimulus making it difficult to wake up the sleeper. This helps the body to recuperate after a long day.

Stage 4 or N4: Is the deep sleep with slow delta waves and it is difficult to wake up from it. Deep sleep seems to be a time for our body to renew and repair itself. Blood flow is directed towards our brain which cools measurably. At the beginning of this stage, the pituitary gland releases a pulse of growth hormone that stimulates tissue growth and muscle repair. Researchers have also detected increased blood levels of substances that activate our immune system, raising the possibility that deep sleep helps the body defend itself against infection.

When we sleep after a period of sleep deprivation we pass quickly through the lighter sleep stages into the deeper stages and spend a greater proportion of sleep time there. This suggests that deep sleep plays a large part in restoring alertness and fills an essential role in a person's optimal functioning.

Slow Wave Sleep (SWS) also known as or Deep sleep. Since there is not much distinction between stage 3 (has 20-50% delta activity) and 4 (has 50% delta activity) with respect to delta wave activity both the stages are collectively referred to as Slow Wave Sleep. The waves are produced with a frequency of less than 1Hz and a relatively high amplitude Slow wave sleep is characterized by synchronized activity of neurons in the neo-cortex firing at a slow rate between 0.5 & 3 times per second. The first section of the wave signifies a down state, or the inhibition period in which the neurons in the neocortex are silent and able to rest. The second section of the wave signifies an up state, referred to as excitation period in which the neurons fire briefly at a high rate. The former state is a hyperpolarizing phase and the latter is a depolarizing phase. The principal characteristics during slow-wave sleep that contrast with REM sleep are moderate muscle tone, slow or absent eye movement, and lack of genital activity. You are groggy and find it difficult to engage in conversation in case the phone rings. Slow-wave sleep is considered important to consolidate

new memories. This is sometimes referred to as "sleep-dependent memory processing". Building up physical and mental energy occurs during this phase. This is where the body gets rest and is the deepest phase of NREM. Dreaming and sleep walking can occur during SWS.

Stage 5 or N5: Dreaming (REM) sleep

Dreaming occurs during REM which has been described as "active brain in paralyzed body". During this stage, our brain races, thinking and dreaming as our eyes dart back and forth rapidly behind closed eyelids. Our body temp rises, our blood pressure rises and our heart rate and breathing speed up to daytime levels.

About 3-4 times a night or about every 90 minutes you enter REM sleep. The first such episode lasts for only a few minute but REM time increases progressively over the course of night. If we are deprived of REM sleep and then allowed to sleep subsequent night of undisturbed sleep, we enter this stage earlier and spend a higher proportion of sleep time in it - a phenomenon known as REM rebound. In contrast during REM sleep when most of our dreaming happens, neuronal firing is rapid and synchronized at much higher frequencies between 30 to 80 times per second. Such patterns of brain activity during REM sleep are reminiscent of those observed during wakefulness and for this reason REM is often referred to as paradoxical sleep.

In REM sleep behavior disorder, the usual paralysis that keeps our bodies in check as we enter REM sleep disappears and people physically act out their dreams. This order is fairly reliable predictor of neurodegenerative disease. In sleep apnea, disorder is associated with diabetes and cardiovascular disease leading to cognitive impairment.

Sleep Stage	N1	N2	N3	N4	Rem
Also Known As	Introduction To Sleep	True Sleep	Slow Wave Sleep	Slow Wave Deep Sleep	Dreaming Sleep
Time Spent	About 5min	About 25-30 MIN	60MIN		Occurs EVERY 90MIN
Wave Character	Theta Waves	Theta Waves With OCCASIONAL SLEEPSPINDLES	20-50% Delta WAVES	More Than 50% Delta Waves	Active Brain And PARALYZED BODY
State Of Mind	Light Sleep	Brain Responsive TO EXTERNAL STIMULUS	Brain Less Responsive TO STIMULUS	Mind Is At Rest,Difficult TO WAKE UP	Brain Races And EYES DART BEHIND EYELIDS

Figure 1: Sleep: Stages at a glance.

Sleep: Architecture and the switch

When we are awake, billion of brain cells receive and analyze sensory information and coordinate behavior by sending electrical impulses to one another. During this stage EEG records a messy irregular scribble of activity. Once our eyes are closed and our brain no longer receives visual inputs, brain waves settle into a rhythmic pattern of about 10 cycles per second is the alpha wave pattern characteristic of calm and relaxed wakefulness.

Hypnogram, moves between different sleep stages in a fairly predictable pattern, alternating between non REM and REM, also known as sleep architecture which in adults consists of 4 or 5 alternating non REM and REM periods [7]. Alertness and associated for brain and cortical arousal activities are mediated by several pathways projecting from upper brain stem. However, every 24hrs the arousal system is inhibited during sleep by sleep active γ-Aminobutyric Acid (GABA)-ergic and galaninergic neurons of Ventrolateral Preoptic Nucleus (VLPO). The sleep-active neurons in the ventrolateral preoptic nucleus serve as a brainstem-switch regulating the stability of sleep-wake cycle (www.ncbi.nlm.nih.gov › NCBI › Literature › Pub Med Central (PMC).

The sleep switch is located in the Para acid Zone (PZ) in the brain stem, the primordial part of the brain that regulates basic function s necessary for survival. The activity of this sleep node appears to be both necessary and sufficient to produce deep sleep. The neurons here release a messenger chemical GABA that sets in a series of reactions that lead to sleep. The PZ makes the neurotransmitter GABA. The switch button in brain for sleep has been termed homeostatic which can tell when someone has been awake for too long; the mechanism fires when the body is tired. The sleep homeostatic keeps track of waking hours and acts as a switch to make the body nod off [8].

In another explanation, the human body has a master circadian clock in a control centre of the brain known as Supra Schismatic Nucleus (SCN). The internal clock regulates the timing of such body rhythms as temp and hormone levels. It controls the activity of sodium and potassium channels. Higher sodium channel activity results in more sodium currents (more sodium getting into the neurons), this excites the neurons and in turn wakes up the animal.

At night sodium channel activity will be low (low sodium current, lower sodium getting into the cell), but potassium channel activity (more potassium currents) would be high. In this case, more potassium comes out of the cell which silences (decreases the activity of circadian neurons) and puts organism to sleep.

The circadian clock is set primarily by visual cues of light and darkness that are communicated along a pathway from the eyes to SCN. This keeps the clock synchronized to the 24 hr day. CR may be free running as in case of patients with dementia and mental retardation. It results when brain receives no lighting cues from the surrounding environment. Disorder is also seen in nursing home residents. It is therefore important to get cues from the environment light activity and social schedules.

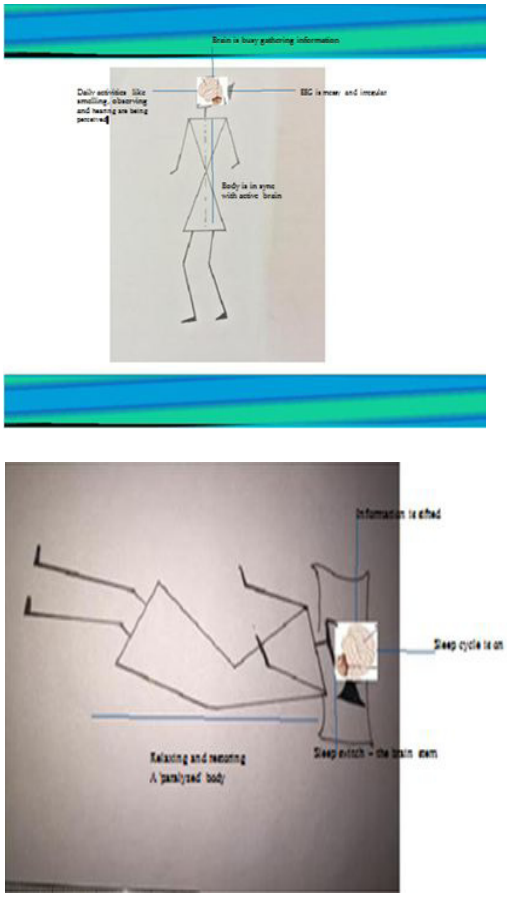

Figure 2a &b: active and sleep states of mind.

Sleep: Disorders and Case Studies

As our society continues to grow, industries seek to maximize production time, increasing the need for night shift workers. Health services are also engaged in providing medical aid to people 24x7. Therefore the hospitals requiring round the clock care have always faced the issue of employing night shift workers, while simultaneously ensuring that the health of workers is not in jeopardy. Most call centre workers and hospital staff work at times when they would normally be sleeping. This could challenge the individual's circardian rhythm because the sleep/wake internal clock setting is at odds with sleep/wake cycle of the shift schedule ultimately resulting in CR sleep disorders.

Symptoms much like jet lag are common in people who work nights. As their work schedule is at odds with powerful sleep regulating cues like sunlight they often become uncontrollably drowsy during the work and build up sleep debt. They may suffer insomnia or other problems when they try to sleep leading to various psychological and psychiatric problems besides behavioral and mood swings. They also have increased risk of heart problems, digestive disturbances and emotional and mental problems [9].

A majority of the shift workers with altered biological rhythm develop cumulative sleep debt leading to significant sleep deprivation. Sleep deprivation if unchecked leads to burn out stress syndrome the symptoms of which are fatigue and mood changes like digestive disturbances, depression, decreased cognitive functioning, poor execution functioning, impaired vigilance and a predisposition to infections.

In a survey, 51.4% BPO employees in Delhi were found to be sleepier as compared with non BPO workers. These are the occupational hazards of night shift workers. To give rest to the body and mind it is important for these shift workers to sleep during day. But this is against nature and biological clock [10]. Surveys reveal that it is better to have continuous night shifts rather than rotate between a day and night shift pattern. Though both lead to occupational hazards but the former will be less taxing on quality sleep than the latter. People with total blindness experience lifelong sleeping problems because their retinas are unable to detect light. Non 24 hr sleep/wake disorder therefore affects mostly people who are totally blind.

Circadian Rhythm Sleep Disorders

- Delayed Sleep Phase Disorder (DSP): DSP occurs when a person regularly goes to sleep and wakes up more than two hours later than is considered normal. People with DSP tend to be "evening types" who typically stay awake until 1 a.m. or later and wake-up in the late morning or afternoon. If able to go to bed at the preferred late time on a regular basis, a person with DSP will have a very stable sleep pattern. DPS is more common among adolescents and young adults with a reported prevalence of 7-16%. It is estimated that DPS is seen in approximately 10% of patients with chronic insomnia in sleep clinics. A positive family history may be present in approximately 40% of individuals with DPS.
- Advanced Sleep Phase Disorder (ASP): ASP occurs when a person regularly goes to sleep and wakes up several hours earlier than most people. People with ASP tend to be "morning types" who typically wake up between 2 a.m. and 5 a.m. and go to sleep between 6 p.m. and 9 p.m. If able to go to bed at the

preferred early time on a regular basis, a person with ASP will have a very stable sleep pattern. ASP affects approximately 1% in middle-aged and older adults and increases with age.

- Jet lag disorder: Jet lag occurs when long travel by airplane quickly puts a person in another time zone. In this new location the person must sleep and wake at times that are misaligned with his or her body clock.
- Irregular sleep-wake rhythm may occur in nursing home residents and other people who have little exposure to time cues such as light, activity and social schedules.
- Free-running (non entrained) type occurs in more than half of all people who are totally blind.
- Shift work disorder is most common in people who work night shifts and early morning shifts Effects These are some of the effects that can occur because of a circadian rhythm sleep disorder:
- Sleep loss • Excessive sleepiness Insomnia • Depression Impaired work performance • Disrupted social schedules • Stressed relationships Treatments • Lifestyle changes: People may cope better with certain circadian rhythm sleep disorders by doing such things as adjusting their exposure to daylight, making changes in the timing of their daily routines, and strategically scheduling naps.

Other Sleep disorders

Insomnia – can be caused by stress, jet lag, diet or other factors like age. Sleep apnea – is a disorder of interrupted breathing during sleep. It usually occurs in association with fat build up or loss of muscle tone with aging also snoring. Restless leg syndrome –is a familial disorder causing unpleasant crawling, prickling or tingling sensations in legs and feet. Nacrolepsy – have sleep attacks at various times of the day.

Sleep: Looking Forward To Good Sleep? Try These

- Aromatherapy: One way to ensure a better quality of sleep is to fill ones home with beautiful flowers and plants. They not only look good but have fantastic relaxing and purifying benefits which in turn can promote a healthy sleeping pattern. A variety of flowers can purify air while you are asleep. Some common ones are Jasmine which reduces anxiety leading to greater quality of life; lavender aromatherapy in which light sleep increases in women; herbs like Hops have a chemical methyl butanol (it was infact putting hop pickers to sleep).
- Mindfulness based therapy (MBT); for insomnia integrates the science of sleep medicines, behavior therapy and meditation practices stemming from the Buddhist tradition.

Any kind of insomnia or sleep disturbance we experience is associated with compromised health. Those who meditate get or spend more time in slow wave sleep and get more REM sleep. There is perhaps increase in melatonin. Anxiety and worries go away so when you meditate you actually improve sleep quality by activating neurotransmitters to release serotonin and melatonin. It brings calmness in mind controlling disturbing thoughts; it controls negative emotions and brings about a positive thinking. It acts as a natural tranquilizer bringing about deep and natural sleep. It also leads to introspection of self and perception of reality of life.

- Cognitive Behavioral Therapy (CBT) requires meeting sleep therapist regularly.
- Take a warm bath which raises body temperature and then when u are out there will be a drop in temperature mimicking temperature drop of sleep.
- Break a sweat do light exercises, Yoga, Progressive muscle relaxation;
- Foods rich in Ca, Mg like banana, walnuts and cherries which help increase melatonin should be included in diet. You can also go in for herbal tea, a rich source of L theanine an amino acid which promotes sleep.

Meditation helps secretion of melatonin and serotonin via neurotransmitters

Maintain a healthy work regime

Shakti mudra in Hindu yoga practice is known to cure insomnia

Concluding Remarks

Sleep is an activity we all carry out every day. In case we find it difficult putting ourselves to sleep some day, nobody can help us do it; it is so very personal. What we must try is to introspect our activities and our extent of stress and then try to choose a couple of ways mentioned above. Just practice them religiously and the body restoration and recuperation will get switched on. However in case of illness medical help has to be taken. Try visiting various sites on the internet and become 'Sleep friendly'.

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