Work and sleep physiology

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Abstract

Sleep is a circadian process coordinated by a pacemaker rhythm generated in the hypothalamus. It is influenced by both exogenous and endogenous factors such as body temperature, light-dark cycle and other factors connected to individual variability (morning/serotine chronotype, long/short sleeper). Sleep is structured in distinct phases defined REM and NON-REM which differ according to the synchronization of the EEG and for the variability of some body functions. Numerous studies have proved that insomnia is the most common sleep disorder worldwide. Sleep disorders have destructive consequences on individual health and can affect the quality of work in terms of injuries, accidents, absenteeism and performance. On the other hand, some working conditions (shift work, work-related stress) may themselves cause sleep impairment leading to the same negative consequences. Among the sleep disorders that are of interest in Occupational Medicine, a leading role is given to syndromes characterized by Excessive Daytime Sleepiness including restless legs syndrome, periodic limb movements and obstructive sleep apnea (OSAS). OSAS is characterized by repeated episodes of upper airway obstruction with sleep apnea followed by a restarting ventilation that cause reduction of sleep or awakening. Occupational Medicine wants to face the problem in terms of prevention and intervention.

KEY WORDS: insomnia, shift work, sleep physiology, sleep disorders.

Sleep is a phase of rest for body and mind promoted by an endogenous circadian rhythm regulated by the suprachiasmatic nucleus of the hypothalamus. This area is involved in the regulation of the biological rhythms of many functions, for example by secreting hormones that control the variations of body temperature. The body temperature is the circadian rhythm that influences the sleep-wake rhythm the most. Body temperature varies during the day, increasing in the very early morning (promoting awaking) and reducing in the evening hours (promoting falling asleep). Body temperature is strictly associated with hypophysal and thyroidal activity. In particular thyroidal hormones balance cells’ biochemical energy and heat production, that in return determine body temperature and its variations (1, 2).

Hexogen factors such as light-dark cycle could participate in the regulation of sleep-wake alternation, especially in the first months of life. Therefore the tendency is to sleep during the night and stay awake during the day. Nevertheless there are variations in sleep cycles among people: morning chronotypes are subjects who have a slightly anticipated endogenous temperature rhythm while evening chronotypes have a delayed one. For these reasons, the first tend to wake up early while the latter tend to fall asleep later. This can be a serious health concern for shift workers, who might need to adapt to timetables in strong contrast to their chronotype (3).

Homeostatic mechanisms are involved in determining the sleep onset, for example the longer is the period of keeping awake the more evident will be the sleepiness. Circadian and homeostatic mechanisms integrate each other and lead to determine the normal sleep/wake rhythm. The average duration of sleep for a healthy adult is about 7-8 hours, but the individual variability is considerable and we can find “short sleepers” (who need less hours of sleep) and “long sleepers” (who may need more than 10 hours of sleep). The analysis of these aspects is essential for the assessment and evaluation of vigilance-disorders, in order to avoid wrong diagnosis and unnecessary therapies, moreover it can be useful to express suitability for night shifts.

From a neurophysiological point of view, there are two different sleep phases: rapid eye movement (REM) phase and non-REM phase, which differ in electroencephalographic characteristics and several vegetative, cardiovascular and respiratory parameters (4). The non-REM phase consists of stages of increasing sleep depth (stage 1, 2, 3 and 4) that correspond to increased synchronization of delta waves in an electroencephalographic scan. A strong wave synchronization is a signature for deep sleep (stage 3 and 4).

Cardiac frequency and respiratory rhythm decrease in the non-REM sleep, since the muscular rest reduces organism oxygen demand. On the other hand, REM
Sleep is associated with a non-synchronized EEG, similar to a wakefulness EEG rhythm. In this phase, we can observe muscular atony, rapid eye movements and irregular vegetative, cardiovascular and respiratory functions. REM and non-REM sleep alternation is not random. In physiological conditions, healthy adults enter sleep with a non-REM phase, increasing sleep depth along the phase. Non-REM and REM cycles alternate about every 90 minutes, giving shape to the macrostructural sleep organization (1).

A chronic lack of sleep leads to cognitive performance reduction, with significant consequences in terms of work safety and quality, and endocrine-metabolic balance alterations, with health consequences.

Insomnia is the most widespread sleep disorder. According to DSM-V about 10% of general population experiences insomnia symptoms, that can be distinguished in nightly (difficulties in falling asleep and maintaining asleep, early awakening and low quality sleep) and daily symptoms (fatigue, sickness, headache, irritability, attention deficit). About 40% of insomnia chronic patients have a higher risk to develop a psychiatric disease, especially depressive disorders (5).

Sleep disorder negative effects concern work ability, because sleepiness is an increasing risk factor for injuries and accidents (6), and learning, memory, concentration, listening, and decision deficiencies (7). Moreover, insomnia has repercussions for the society such as decreased productivity, absenteeism, increased drug use and medical assistance. Finally, insomnia could be a risk factor for long-term work disability in itself, independently from its links with anxiety, depression, physical and psychic diseases (5).

Sleep disorders can affect life quality, on the other hand working conditions such as shift work and work-related stress can alter sleep cycles. Sleep disorders are the most frequent ailments reported by workers affected by psychiatric disorders associated with work environment (8).

Shift work is a kind of organization adopted to ensure service continuity or the production during the 24 hours. Shift work is an occupational practice that assures provision of services or production 24-hours a day. An employee whose work shift coincides with his/her usual sleep chronotype might experience insomnia or excessive daily sleepiness. The most problematic shifts are the ones that collide with the employee’s usual sleep time, in particular night, early morning, evening, and rotational shifts. During the night one’s level of attention are reduced because of biological desynchronization and sleep deficit. This reduces work efficiency and increases the chance of errors and injuries. Moreover, it is important to underline the itinere accidents occurrence, especially in the travel back home at the end of night shift that, as reported in some studies, can involve about 20% of shift workers (3).

Severe interferences on circadian rhythm derive from inadequate shifts organization. Despite it is well known that weekly shifts composed of 5 morning shifts, 5 afternoon shifts, and 5 nights shifts cause strong alteration of physiological circadian rhythm of body temperature and hormone secretion, they are still used in several firms. The intervention of Occupational Health Physicians is necessary to face these problems and to plan adequate prevention measures, keeping in consideration several suggestions: restrict the number of night shifts in a row, interpose at least 11 hours of rest between two shifts, do not start the shift too early in the morning and include breaks during the shift.

In the International Sleep Disorders Classification, more than 80 different types of well-defined pathological conditions exist (DSM-V). Among these, Occupational Medicine focuses on syndromes characterized by excessive daily sleepiness. Sleepiness is the physiological tendency to fall asleep: if it is in excess or appears in wrong situations, it may interfere with cognitive capability and performances of the subject, respectively, with consequences on his/her work and social life.

There are many causes of severe sleepiness for instance: drug use or abuse, acute or chronic lack of sleep, and night sleep disturbed by environmental factors.

Well-known syndromes characterized by daily sleepiness include Restless Legs Syndrome, Periodic Limb Movements Syndrome and Obstruction Sleep Apnea Syndrome (OSAS).

Restless Legs Syndrome is a neurological disorder characterized by “uncomfortable sensations” in the legs, such as burning and “pins and needles”. These symptoms appear during the sleep and determine delay in falling asleep and/or nightly sleep disruptions, that can cause sleep deprivation and significant daily sleepiness. This syndrome may be primary/inherit or may depend on other factors, e.g. alcoholism, uremia, diabetes mellitus, neuropathy, sideropenic anemia.

Periodic Limb Movements Syndrome is characterized by periodical muscular spasms of legs during the rest, causing sleep disruption and reduced restoring power. Obstruction Sleep Apnea Syndrome (OSAS) is characterized by repeated episodes of upper airway obstruction with sleep apnea followed by a restarting ventilation that cause reduction of sleep or awakening. Sleep fragmentation determines bad sleep quality and daily sleepiness, that is generally severe and associated to cognitive disorders.

Common risk factors for OSAS are cranium-facial deformities and obesity (9). OSAS symptoms include snoring, frequent awakening with oppression sensation, respiratory pauses reported by the partner, excessive daily sleepiness and morning headache. Because of different physiopathological mechanisms (hypoxemia, blood hypercoagulation, insulin resistance and sympathetic nervous system activation) this syndrome represents a risk factor for cerebro-vascular events; thus it should always be investigated in patients suffering of sleepiness, especially if obese. Occupational Medicine takes interest in OSAS since incidence of this disorder is higher in the working population (10) and has high prevalence, 2-4%, of general
population. Subjects affected by OSAS are involved in a greater number of accidents and injuries in comparison to control groups and they show alterations of concentration and learning capabilities. It seems that OSAS affects more frequently professional drivers than the general population. This fact is particularly important for the road haulage sector, where sleepiness causes 22% of the accidents (11).

Occupational Physicians and/or General Practitioners can suspect OSAS through guided questionnaires (used to underline anamnesis, sleep-wake habits, presence of sleep disorders) and few other biometric parameters (BMI, neck circumference, measurement of neck-chin angle, cranium-facial dimorphisms).

Perspectives

Recent findings on sleep physiopathology, its connection to metabolic disorders and occupational distress, require attention from Occupational Physicians. Several neurological syndromes, insomnia, shift work and occupational distress may interfere on sleep function, impairing life quality, increasing risk of accidents or injuries and determining psychiatric/psychological disorders.

An Occupational Physician can play an important role in prevention. He has the opportunity to control many workers, find possible risk factors and detect the first symptoms of sleep disorder, in order to avoid the development of pathological conditions.

References