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Special Article

Assessment of Sleepiness

Evaluación de la somnolencia

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For what is life, if not a frenzy?
What is life, if not an illusion,
a shadow, a fiction?
And the greatest things are but small.
All of life is a dream,
And dreams naught but dreams.

Pedro Calderón de la Barca

Introduction

Sleepiness is the desire to sleep felt by all of us, a desire that we can both evaluate and express. We all experience sleepiness, generally every day. Some people decide to go to bed because it is time; others, because they feel sleepy. Something similar happens with hunger, which is also a sensation that can be experienced, evaluated, and expressed ("I'm hungry," "I'm ravenous," "I could eat a horse"). Some people eat because it is time; others, because they are hungry. Simple observation cannot tell us whether someone is hungry or sleepy. An exception is to be found with infants, who make it very clear through their behavior that their sleepiness (or hunger) has not been satisfied immediately. In this age group, there is almost no latency period between the sensation and the behavioral expression of the unmet desire (at least, such is the impression we have gained from close observation of some infants). A latency period appears later. In the case of both hunger and sleep, our desire could remain unsatisfied as a result of circumstances, such as distance from the food cupboard or bed, or a visit from our mother-in-law. The desire will not disappear, rather it will increase with time. Any doctor who has been on call knows that, initially, it seems easy to keep hunger and sleep at bay, but that they gradually invade our intellectual and emotional world until they almost take it over.

At some point, a person's behavior will change as a result of the unsatisfied desire, and a careful observer will be aware of this change: scanning the immediate surroundings for a piece of bread or some old apple peelings, or yawning accompanied by more frequent blinking, or even relaxed muscle tone in the neck and head.

Assessing sleepiness has become particularly important for those physicians who care for patients with sleep apnea: first, because it is one of the main symptoms of the disease, and, second, because it provides us with information on how the disease affects our patient. Another consequence of this disease is the increase in the number of traffic accidents, which is thought to be related to sleepiness. Although not our main focus of interest, this reveals other patients who also complain of excessive, abnormal, and worrying sleepiness. Insomniacs, patients with restless legs syndrome, and those with chronic joint pain can complain of sleepiness and poor sleep patterns. Therefore, we are faced with the need to assess sleepiness and sleep patterns, and to determine whether there is a relationship between sleep and sleepiness.

Evaluating Sleepiness in Terms of Subjective Feelings: Questionnaires

Several types of questionnaires are available to help us assess sleepiness. Before looking at them in detail, it is worth discussing questionnaires in general. A series of standardized questions and answers aims to bring together answers from several people about a specific symptom. These answers come from an identical series of questions. The basic aim is to ascertain whether some people present the symptom with greater intensity than others, in other words, whether they are more affected by the symptom than others. No interpretation of the answers is necessary, given that both questions and answers are decided beforehand. Questionnaires generally give a numeric result—a higher number of symptoms is represented by a

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higher number (or lower number, depending on the questionnaire). This could lead us to understand—erroneously—that questionnaires "measure" a symptom. In fact, questionnaires do not measure, they assess. To measure, we need a unit of measure. The difference between 100 and 101 meters (or between 100 and 101 kg) is the same as the difference between 1 and 2 meters (or between 1 and 2 kg). In this case, there is a unit of measure. On the other hand, if someone scores 2 points on a questionnaire about hunger and another person scores 3 points, we do not know what the unit of measure is, that is, no one knows what a "unit" of hunger is worth.

Nevertheless, several well-validated sleepiness questionnaires do exist. One is the Stanford Sleepiness Scale,[1] which comprises 7 descriptions of progressive sleep stages, from which the patient must choose the description that best fits his or her current level of sleepiness. The maximum degree of alertness is represented by the answer "Feeling active, vital, alert, or wide awake." This degree is followed by answers such as "Awake, but relaxed; responsive but not fully alert," and "Sleepy, woozy, fighting sleep; prefer to lie down," and, finally, "No longer fighting sleep, sleep onset soon; having dream-like thoughts." The results are expressed on a scale of 1 to 7.

The Karolinska Sleepiness Scale[2] is a questionnaire with 9 options ranging from "Very alert" to "Very sleepy, fighting sleep, difficulty staying awake" and including "Neither sleepy or alert" and "Sleepy but no effort to remain awake." It is scored from 1 to 9.

The visual analog scale for sleepiness requires the patient to mark a cross on a 10-cm line joining 2 sentences such as "Wide awake" on the left and "Fall asleep" on the right. The result is expressed in millimeters, from 1 to 100 starting from the left.

These scales enable sleepiness to be assessed at a given moment. They are valid in that, in normal populations, the scores increase after midday, fall after 5 PM, and increase again at night. Similarly, they increase the longer an individual is prevented from sleeping.

The Epworth Sleepiness Scale[3] attempts to assess sleepiness over recent weeks by examining 8 situations from daily life. For each situation, the patient is asked to estimate the probability of falling asleep. Four possibilities are given ("No chance of dozing," "Slight chance of dozing," "Moderate chance of dozing," "High chance of dozing"). The results are expressed on a scale of 0 to 24. A score greater than 10 is considered to indicate excessive sleepiness. In the original study, patients not affected by sleepiness had an average score of 5.9, patients with sleep apnea scored 11.7, and patients with narcolepsy scored 17.5.

Objective Measurements of Sleepiness or Related Variables

The 2 classic evaluations of sleepiness are the multiple sleep latency test (MSLT),[4] which measures the ease with which a patient falls asleep, and the maintenance of wakefulness test (MWT),[5] which measures a person's ability to resist sleep and remain awake. Both tests are repeated every 2 hours, 4 to 5 times during the day, beginning at 10 AM. The patient is studied under conditions that are conducive to sleep, that is, lying supine or semisupine on a comfortable bed in a dark, silent room. A continuous electroencephalogram (EEG) is recorded during the test. In the MSLT, the patient is asked to sleep, and the latency period between switching out the light and the first (or first 2) phases of sleep are measured at each session. If the patient has not fallen asleep after 20 minutes, the session is considered finished. In the MWT, the patient is asked to remain awake and the latency period between switching out the light and the moment the patient falls asleep is measured. Each session lasts 40 minutes and is considered finished if the patients falls asleep.

A healthy person has a mean sleep latency greater than 10 minutes, whereas an average latency of less than 5 minutes indicates excessive sleepiness. Narcoleptics generally have a latency period of around 3 minutes, and rapid eye movement sleep is observed in at least 2 of the 5 sessions. In the MWT, a healthy individual has a mean latency period of 20 minutes.

The MSLT and the MWT do not measure the same thing in different ways. The correlation between the 2 techniques is not good; therefore, 2 people with the same "amount" of need for sleep may differ in their ability to fall asleep, in one case, and to resist sleep, in the other.[6]

Furthermore, both tests are technically and logistically complex. They require the patient to wear EEG electrodes for a whole day. A special room for only 1 patient is necessary, as is the presence of a technician specialized in reading EEGs who monitors the patient during the session. Therefore, these tests cannot be as widely used as necessary to examine a symptom as common and relevant as sleepiness.

To overcome this difficulty, Bennett et al[7] developed a modified version of the MWT, the Oxford Sleep Resistance Test. This test measures behavior over a 40-minute period during which the patient is asked to press a switch in response to a stimulus (light-emitting diode) that is lit 1 second in every 3, at the same rhythm one would count sheep. The test starts at 10 AM and 4 or 5 sessions per day are performed. The patient is placed in conditions that are conducive to sleep, and told not to sleep and to respond to each stimulus by pressing a button with the thumb of the dominant hand. This test measures the latency between lights out and a missed response to 7 consecutive stimuli, in which case the patient is considered to have slept for 21 seconds, that is, 1 sleep period. The advantage of this test is that neither an EEG or specialist staff are necessary. It has also been shown that the lack of response to more than 4 consecutive stimuli almost always indicates microsleeps and that 2 sessions provide as much information as 4, thus making it easier to perform.[8]

Other Methods of Objective Assessment

Several methods can be used to obtain information on the onset of sleep, or loss of vigilant attention, without requiring the patient to collaborate. For example, pupillography[9] involves recording images of variations in pupil diameter. These depend on the balance of components of the autonomic nervous system and change in line with oscillations during wakefulness. To date, pupillography has not proven practical or reliable. The automobile industry continues to investigate this method.

A similar technique uses a camera to film the eyes and detect blinking.[10] Blink frequency and duration could both prove useful in the detection of sleepiness at the wheel in professional drivers. The results of this technique are also of interest to the automobile industry, although research in this area remains at an early stage. Other devices complement these data with the length of time the eyes are closed. Some systems monitor the position of the driver's head and the direction of the driver's gaze. It seems unlikely that these systems can be applied outside driving motor vehicles.

The automobile industry is also developing prototypes of systems to monitor the direction of a vehicle, deviations from the lines on the road, frequency of small (corrective) movements of the steering wheel, and stability of the feet on the pedals. These are all aimed at providing timely warnings so that drivers do not fall asleep, thus preventing accidents. The availability of smaller and cheaper electronic components means that such devices could be marketed during the next 10 years. However, their use will be limited to well-defined activities, such as driving motor vehicles.

Short Tests

Developed several years ago, the Psychomotor Vigilance Test,[11] is a short, 10-minute test in which the patient is asked to press a button as quickly as possible when a light flashes on the screen of the device.

At this point, a chronometer stops and the patient's reaction time appears on the screen as a guide to his/her performance. The light comes on at random. The items measured are the average reaction time, variations in reaction time during the test (attention fatigue is assessed), excess errors (pressing the button without a stimulus), and default errors (stimulus without response). Despite being a simple, fast, and reproducible test that has a median correlation with sleepiness, it is not yet widely used for assessment.

Conclusion

This brief review has presented the main methods used to assess sleepiness. It is not exhaustive, although it does show in which direction this new field of research on the physiology of sleep and wakefulness is going. Assessing sleepiness involves not only a subjective sensation, but also the objective consequences of this sensation. The difficulty lies in the fact that the correlation between the subjective sensation and the objective consequences is not completely linear, and depends on the history and personal factors of the patient to be assessed. We believe that questionnaires are popular, but provide little information and discriminate poorly, and that classic objective tests are more informative but impractical. The field is wide open for fertile imaginations to develop simple, discriminative, and useful methods.

References

1. Hoddes E, Zarcone V, Smythe H, Pillips R, Dement WC. Quantification of sleepiness: a new approach. Psychophysiology. 1973;10:431-6.
2. Akerstedt T, Gillberg M. Subjective and objective sleepiness in the active individual. Internat Neurosc. 1990;52:29-37.
3. Johns MW. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. Sleep. 1991;14:540-5.
4. Richardson GS, Carskadon MA, Flagg W, Vandenhoed J, Dement WC, Mitler MM. Excessive daytime sleepiness in man: multiple sleep latency measurement in narcoleptics and in control subjects. Electroencephalogr Clin Neurophysiol. 1978;45:621-7.
5. Mitler MM, Gujavarty S, Browman CP. Maintenance of wakefulness test: a polysomnographic technique for evaluating treatment efficacy in patients with excessive somnolence. Electroencephalogr Clin Neurophysiol. 1982;53:658-61.
6. Sangal RB, Thomas L, Mitler MM. Maintenance of wakefulness test and multiple sleep latency test. Measurement of different abilities in patients with sleep disorders. Chest. 1992;101:898-902.
7. Bennett LS, Stradling JR, Davies RJ. A behavioural test to assess daytime sleepiness in obstructive sleep apnoea. J Sleep Res. 1997;6:142-5.
8. Priest B, Brichard C, Aubert G, Liistro G, Rodenstein DO. Microsleep during a simplified maintenance of wakefulness test. A validation study of the OSLER test. Am J Respir Crit Care Med. 2001;163:1619-25.
9. Wilheim B, Wilheim H, Ludtke H, Streicher P, Adler M. Pupillographic assessment of sleepiness in sleep-deprived healthy subjects. Sleep. 1998;21:258-65.
10. Hakkanen H, Summala H, Partinen M, Tihonen M, Silvo J. Blink duration as an indicator of driver sleepiness in professional bus drivers. Sleep. 1999;22:798-802.
11. Dinges DF, Powell JW. Microcomputer analyses of performance on a portable, simple visual RT task during sustained operations. Behav Res Methods Intrum Comput. 1985;22:69-78.