CHEST Postgraduate Education Corner

CONTEMPORARY REVIEWS IN SLEEP MEDICINE

Multiple Sleep Latency Test and Maintenance of Wakefulness Test*

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Excessive daytime sleepiness and fatigue are common complaints in the sleep clinic. The objective evaluation and quantification of these symptoms is important for both the diagnosis of underlying health problems and for gauging treatment response. The multiple sleep latency test measures physiologic sleepiness, whereas the maintenance of wakefulness test (MWT) aims to measure manifest sleepiness. Neither test correlates well with subjective measures of sleep such as the Epworth sleepiness scale and the Stanford sleepiness scale. Although in the past methodological testing differences existed, in 2005 updated practice parameters were published, promoting the standardization of testing procedures. In recent years, there has been an effort to document daytime sleepiness when associated with occupational risk. However, these laboratory-based tests may not reflect or predict real-life experience. Normative data for both tests, particularly the MWT, are limited, and are inadequate for the evaluation of pediatric patients, shift workers, and others. ***(CHEST 2008; 134:854–861)***

Key words: excessive daytime sleepiness; maintenance of wakefulness test; multiple sleep latency test

Abbreviations: ASM = American Academy of Sleep Medicine; EDS = excessive daytime sleepiness; ESS = Epworth sleepiness scale; MSLT = multiple sleep latency test; MWT = maintenance of wakefulness test; OSA = obstructive sleep apnea; REM = rapid eye movement; SOREMP = sleep-onset rapid eye movement sleep period; SSS = Stanford sleepiness scale

Symptoms of fatigue and excessive daytime sleepiness (EDS) are common complaints in sleep clinics, as well as in other physician offices. EDS is defined as the inability to stay awake and alert during the major waking episodes of the day, when an individual would usually be expected to be alert.[1] The prevalence of EDS among adults has been reported to be as high as 12%,[2] while others have reported[3] a prevalence of about 5%. In most cases, EDS is a chronic symptom; classically, it must be present for at least 3 months prior to diagnosis.[4] When present, EDS is associated with a host of undesirable consequences, including impaired job and psychosocial performance, diminished intellectual acuity, and a risk of accidents.[5] Such impairments, while common, have also in some cases been implicated in major disasters such as those at the Chernobyl and Three Mile Island nuclear facilities, and the running aground of the Exxon Valdez.[2]

Given such profound consequences, the objective quantification of EDS is critical. Several methods have been used to measure sleepiness subjectively, including self-assessment tools such as the Stanford sleepiness scale (SSS), published by Hoddes and Zarcone[6] in 1972, and the Epworth sleepiness scale (ESS), established by Johns[7] in 1991. The SSS, which involves introspective judgment of one's own sleepiness, has been well-validated in control subjects, but patients with chronic sleepiness may not accurately assess their own level of sleepiness.[8] The main utility of the SSS is in research applications, where it is used for point-in-time estimation of the level of daytime sleepiness. By contrast, the ESS is frequently used in

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The authors have reported to the ACCP that no significant conflicts of interest exist with any companies/organizations whose products or services may be discussed in this article.

Manuscript received March 25, 2008; revision accepted July 8, 2008.

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DOI: 10.1378/chest.08-0822

clinical practice and focuses on self-reported behavior. For the ESS, patients rate the likelihood of falling asleep in eight scenarios, on a scale of 0 (not at all likely) to 3 (very likely). Patients with scores of $\geq$ 10 typically require additional investigation.[9]

Objective measures of EDS have also been investigated. These have included pupillometry,[10] performance-based tasks,[11,12] and, more recently, the multiple sleep latency test (MSLT).

THE MSLT

Background

The MSLT is an objective test of physiologic sleepiness that was first employed at Stanford University by Carskadon and Dement.[13] It has since achieved widespread usage in clinical practice, both because of its intuitive approach to testing sleepiness and its multiple opportunities to test for sleep-onset rapid eye movement sleep periods (SOREMPs), which is useful in the diagnosis of narcolepsy.[14] The American Academy of Sleep Medicine (AASM) has published a report[1] indicating that the MSLT is considered to be the *de facto* standard for the objective measurement of sleepiness.

Testing Methods/Conditions

The MSLT technique is standardized and has been published by the AASM.[1,15] Testing conditions require well-controlled, consistent procedures. Ideally, patients should discontinue therapy with any medication that might affect sleep latency (*eg*, stimulants, hypnotics, and antihistamines) and rapid eye movement (REM) latency (*eg*, antidepressants) for at least 15 days before the study. Therapy with such medications should be stopped for at least five half-lives of the drug and the longer acting metabolite.[4] Urine drug screening is performed on the morning of the test to assist in confirming that the pretest conditions are met. Smoking should be stopped at least 30 min before each nap opportunity, and caffeine should be avoided on the test day, although acute withdrawal from caffeine may affect the test results. Vigorous physical activity and bright sunlight should also be avoided.[1]

A polysomnogram should be performed the night before the MSLT to assess nighttime sleep quality and quantity. Untreated obstructive sleep apnea (OSA) or other causes of disrupted sleep should be ruled out or treated before proceeding with the MSLT. If the subject has known OSA, adequate nocturnal positive airway pressure therapy must be administered leading up to the MSLT in order to ensure that untreated OSA does not confound MSLT results. If the patient has a high number of periodic limb movements with arousals observed on overnight observation, the decision to proceed with the MSLT study must be based on clinical judgment. In addition, a minimum of 6 h of nocturnal sleep should be achieved before proceeding with the MSLT when evaluating for narcolepsy, since the use of this test to support a diagnosis of narcolepsy is "suspect" without a prior night of sleep of at least 6 h duration. The 6-h minimum total sleep time over the preceding night is advised whenever the test is performed.[1]

Since MSLT results may be influenced by sleep up to 7 nights before the test, the preceding sleep-wake cycle should be standardized for at least 7 days, and patients should be advised to obtain adequate sleep for 1 to 2 weeks prior to test performance. They may be asked to complete sleep diaries for 1 or 2 weeks prior to testing.[16] Actigraphy has also been suggested[4] as an objective means to document adequate sleep leading up to the study.

On the day of the test, a light breakfast is recommended 1 h before the first trial, and a light lunch is recommended immediately after the second noon trial.[1] The MSLT typically consists of five nap opportunities performed at 2-h intervals; four naps may also be used, but this may limit its usefulness in the diagnosis of narcolepsy.[1] Naps are conducted in a sleep-promoting environment, typically a dark, quiet room that is maintained at a comfortable temperature. The initial nap begins 1.5 to 3 h after awakening from nocturnal sleep. Prior to the start of the nap, the subject should be asked whether they need to go to the bathroom or whether other adjustments are needed for comfort.[1] Subjects should be in bed 5 min before the scheduled start of the test to perform calibrations of recorded parameters. In addition, this step is helpful in standardizing activity before the start of the test, which may influence nap latency.[17] For each nap, the subject is instructed to "please lie quietly, assume a comfortable position, keep your eyes closed, and try to fall asleep." The start of the test is signaled by turning off the bedroom lights. The test is ended 20 min later if no sleep has occurred or 15 min of "clock time" (not sleep time) after the first epoch of sleep, irrespective of whether REM sleep has occurred or not.[15] Although positive airway pressure therapy is typically not used during the MSLT study itself in those patients with OSA, this matter has not been addressed in the guidelines and clinical judgment is recommended.

MSLT Scoring

The basic recording montage used for the MSLT is based on standard Rechtshaffen and Kales[18] technique, which was updated by the AASM in 2007.[19]