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# Prevalence of Microsleep in Commercial Motor Vehicle Operators during the Maintenance of Wakefulness Test

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## ABSTRACT

The Maintenance of Wakefulness Test (MWT) is a validated objective measure of an individual's ability to stay awake. Pathologic sleepiness is associated with an increased risk of motor vehicle crashes. This fact has significant public safety implications, especially as it relates to commercial vehicle operators. Microsleep is defined as electroencephalography (EEG) evidence of sleep occurring for three seconds or longer but less than 15 seconds of each 30 second epoch observed during polysomnography (PSG). In this study of patients referred for MWT evaluation as part of a medical evaluation for commercial motor vehicle certification, 25% failed the MWT as evidenced by the onset of sleep defined as three consecutive epochs of stage 1 sleep, or one epoch of any other sleep stage. Of the patients who remained awake for the entirety of all four wake periods, 59% had at least one observed episode of microsleep. This is the first study to assess the prevalence of microsleep in the commercial motor vehicle operator cohort.

**Keywords:** Wakefulness Test; Microsleep; Obstructive Sleep Apnea; Multiple Sleep Latency Test; Polysomnography

## INTRODUCTION

The Maintenance of Wakefulness Test (MWT) is a validated objective measure of an individual's ability to stay awake. This test involves a series of four 40-minute observation periods throughout a single day to evaluate how long a person can remain awake under non-stimulating conditions. Pathologic sleepiness is associated with an increased risk of motor vehicle crashes. This fact has significant public safety implications, especially as it relates to commercial vehicle operators who log hundreds of hours behind the wheel each year. Excessive sleepiness may be secondary to sleep apnea which has been reported to be more prevalent in commercial drivers compared to the general population. One clinical application of the MWT is to evaluate individuals with Obstructive Sleep Apnea (OSA) applying for a commercial driving license as part of their comprehensive medical evaluation. Previous studies have demonstrated worsened driving simulator performance in persons with abnormal MWT results. Microsleep is defined as electroencephalography (EEG) evidence of sleep occurring for three seconds or longer but less than 15 seconds of each 30 second epoch observed during polysomnography (PSG). To date, there have been no studies assessing the prevalence of microsleep in the commercial motor vehicle operator cohort.

The MWT was designed to assess the ability to remain awake for individuals where sleepiness constitutes a public or personal safety issue [1]. Individuals with obstructive sleep apnea and other sleep disorders who work in occupations involving public transportation or safety may require regular routine medical examinations to assess their fitness for duty. Importantly, this includes assessment of their sleep health and consequently assessment of their ability to remain awake.

Both the Maintenance of Wakefulness Test (MWT) and Multiple Sleep Latency Test (MSLT) are used in clinic practice. They constitute objective measures of alertness and sleepiness, respectively. The MWT has greater face validity to assess ability to remain awake than the MSLT. However, the MSLT is used much more frequently in the initial evaluation of patients with hypersomnia, such as suspected narcolepsy. The MSLT is also frequently used to assess residual or persistent sleepiness after treatment of OSA. In contrast, the MWT is used much less frequently in clinic practice. Although the MSLT and MWT procedures are in some ways similar in that they are both

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daytime tests, there is a low correlation between the tests (r = 0.41). This suggests that they are measuring different patient attributes [2]. The MSLT measures a patient's sleep propensity through a series of four to five 20-minute daytime nap opportunities. An individual's degree of sleepiness is quantified by the mean sleep latency, i.e., the number of minutes until sleep onset. The shorter the mean sleep latency, the greater the daytime sleepiness. The MWT is essentially a modification of the MSLT. It involves a series of four 40-minute observation periods throughout a single day. Instead of evaluating how long it takes for a patient to fall asleep, this test evaluates how long a person can remain awake under non-stimulating conditions. An impaired ability to stay awake in the context of volitional effort is reflected in a short sleep latency. The MWT is often preferred to assess alertness in individuals in safety-sensitive occupations such as commercial motor vehicle operators and pilots [3,4]. Currently, there is no mandatory or standardized reporting of microsleep during the maintenance of wakefulness test.

## METHODOLOGY

All patients referred to a large academic medical center for MWT evaluation as part of a medical evaluation for commercial motor vehicle certification over a 36-month period were included in this study. Microsleep was defined as a period of at least three but less than fifteen seconds with a 4-7 Hz rhythm replacing an alpha rhythm or appearing on a background of desynchronized EEG, without eye-blinking artifact. The Maintenance of Wakefulness Test was performed and interpreted in accordance with the American Academy of Sleep Medicine Practice Parameter guidelines [1]. Four 40-minute wake tests were performed at two-hour intervals throughout a single day. Recording montage included central and occipital EEG derivations, left and right eye electrooculograms, mental electromyogram, and electrocardiogram.

According to MWT practice guidelines, patients were provided the following instructions: "Please sit still and remain awake for as long as possible. Look directly ahead of you, and do not look directly at the light". Patients were seated in bed with their back and head comfortably supported for each of the wake trials. A dim light (7.5W) was placed in the room to conform with maximal lux exposure at the corneal level. The first test was performed 1.5 to 3 hours following the patient's usual wake up time. Patients were instructed to follow their typical sleep schedule and sleep duration in the two weeks preceding the test. They were also encouraged to use their CPAP or non-CPAP treatment for OSA in the two weeks preceding the test. Stimulating activities to promote wakefulness between MWT trials were not permitted including use of electronic devices 30-minutes before each trial period. Patients were instructed to continue use of all prescription medications and to use their typical amount of caffeine. Consent for drug screening was obtained to assess for presence of any non-prescribed medications or illicit wakefulness promoting substances such as amphetamines or cocaine. Any patients with an abnormal drug screen following testing were excluded from this study.

## RESULTS AND DISCUSSION

Sixteen patients met all inclusion criteria. All subjects were male, ages 35-64 years. Fourteen of the test subjects were long-haul truckers and two were airline pilots. Of this patient cohort, 25% failed the MWT as evidenced by the onset of sleep defined as three consecutive epochs of stage 1 sleep, or one epoch of any other sleep stage. Of the patients who remained awake for the entirety of all four wake periods, 59% had at least one observed episode of microsleep evidenced by at least three but less than fifteen seconds of a 4-7 Hz rhythm replacing an alpha rhythm. Episodes of microsleep were observed in all four observation periods and in more than one test period in some individuals. No patients were found to have a positive drug screen following testing.

Previous studies have shown that approximately 60% of normal subjects remain awake for the entire 40-min trial across each of four trials with a reported mean sleep latency for normal control patients of 30.4 ± 11.20 minutes [5]. In this current study of highly motivated patients whose commercial operator license was at stake, a slightly higher percentage of patients (75%) remained awake for the duration of each observation period. Depending on the clinical circumstances, some researchers have deemed a sleep latency of approximately 30 minutes, i.e., the average adult score, to be acceptable. However, for a certain subset of patients with highly sensitive occupational responsibilities, such as commercial motor vehicle operators, a sleep latency above the mean may be preferable. The MWT has a ceiling effect with a maximally measured wakefulness time of 40 minutes, and thus a maximal achievable score. Thus, a mean sleep latency of 40 minutes is the most reassuring test result demonstrating an individual can maintain a high level of volitional wakefulness in the absence of significant environmental stimulation. Long-haul trucking is monotonous, particularly in non-urban settings.

A few previous studies regarding the utility of MWT and MSLT results to evaluate safety have been published. One study evaluated the results of MSLT and simulated driving performance in patients with narcolepsy and patients with obstructive sleep apnea [6]. Driving performance was negatively correlated with MSLT results in both patient groups, i.e., sleepier patients had poorer driving performance and reaction times. Other studies have shown that treatment of OSA with CPAP was associated with improvement in MSLT scores, improved performance on simulated driving tests and a reduction in the rate of self-reported motor vehicle crashes [7,8]. Similarly, another study showed that CPAP treatment also was associated with improved MWT scores and improved actual driving performance in professional bus drivers [9]. Operating a motor vehicle require a high level of vigilance. At a speed of 65 mph, a vehicle would travel 285 feet during a 3 seconds microsleep, more than twenty times the distance required completely to change lanes on an average highway. Even with a reportedly normal MWT result, a microsleep of 14 seconds would allow a vehicle to travel greater than one quarter of a mile unattended.

Limitations of the current study include that the study population included only those seeking care at large academic center. As such, the results of this study may not be extrapolated to those patients seeking care at smaller community medical centers. Another limitation of this study is the relatively small sample size. It is possible that if a larger patient population including commercial motor vehicle operators who were not specially referred due to concerns regarding daytime wakefulness/sleepiness had been studied, observed periods of microsleep may have been less prevalent.

## CONCLUSION

This is the first study to evaluate the prevalence of microsleep in the commercial motor vehicle operator cohort. Currently, there is no standardized or mandatory reporting of microsleep during the maintenance of wakefulness test. Microsleep may pose a significant public safety danger to both commercial drivers and those with whom they share the road. This type of sleep event should be considered when interpreting the results of the maintenance of wakefulness test. Additional research on MWT results and their relationship to driving and workplace safety are needed. Ultimately, more time-efficient, cost-effective and reliable field tests are needed to accurately assess sleepiness and wakefulness in the workplace.

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