Use and Interpretation of the MSLT and MWT

Montana Sleep Seminar
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Daytime Testing for Hypersomnia Disorders

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No Conflicts to Disclose
Daytime Evaluation of Hypersomnia

- Questionnaires
  - Epworth Sleepiness Scale (ESS)
- Laboratory Testing
  - Multiple Sleep Latency Test (MSLT)
  - Maintenance of Wakefulness Test (MWT)
Epworth Sleepiness Scale
How likely are you to doze off or fall asleep in the following situations?

• Sitting and reading
  Watching TV
• Sitting inactive in a public place (e.g. a theater or a meeting)
• As a passenger in a car for an hour without a break
• In a car, while stopped for a few minutes in traffic
• Lying down to rest in the afternoon when circumstances permit
• Lying down to rest in the afternoon when circumstances permit
• Sitting quietly after a lunch without alcohol
What do the MSLT & MWT measure?

**MSLT**
- Measures the tendency to fall asleep
- Assesses excessive daytime sleepiness

**MWT**
- Measures the ability to stay awake
- Assesses daytime alertness
MSLT/MWT Correlation of 0.41

- 258 patients; alternated MSLT nap and MWT trial
- Some patients with abnormally low MSLT scores were able to stay awake for the MWT
- Some patients who failed to stay awake for the MWT were unable to fall asleep quickly for the MSLT

R B Sangal; L Thomas; M M Mitler
Variance

1. Inherent difference between what is measured: sleep tendency vs ability to stay awake

2. Brain mechanisms for sleep latency may be different from the mechanisms for maintenance of wakefulness

3. May be related to circadian differences

R B Sangal; L Thomas; M M Mitler
# Uses of the MSLT & MWT

<table>
<thead>
<tr>
<th><strong>MSLT</strong></th>
<th><strong>MWT</strong></th>
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<tbody>
<tr>
<td>• Measure the tendency to fall asleep</td>
<td>• Measure the ability to stay awake</td>
</tr>
<tr>
<td>• Show change following interventions</td>
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<tr>
<td>• Documents REM onset in narcolepsy</td>
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</table>
Validity of MSLT & MWT

• Both show decreased latencies following
  ○ sleep deprivation
  ○ the use of hypnotics and sleep promoting agents

• Both show an increase in latency following use of stimulants
Test Retest Reliability of MSLT

- Test retest reliability = 0.97 in normals over 4-14 mos
- Test retest reliability decreases for 3 naps =0.85 and 2 naps=0.65
- Test retest reliability of 2 SOREMPS = 0.93 in narcolepsy patients

Test-Retest Reliability of the Multiple Sleep Latency Test in Narcolepsy without Cataplexy and Idiopathic Hypersomnia Trotti LM, Staab BA, Rye DB
Scoring Reliability of MSLT

- Interscorer reliability = 0.85 - 0.90
- Intrascorer reliability = 0.87
- Interscorer reliability of SOREMPs = 0.91
- Intrascorer reliability of SOREMPs = 0.78

Sleep. 2000 Nov 1;23(7):911-3.
Scoring reliability of the multiple sleep latency test in a clinical population.
Drake CL, Rice MF, Roehrs TA, Rosenthal L, Guido P, Roth T.
Factors Affecting Sleep Latency

• Sleep latency definition
• Prior sleep quantity
• Number of naps/ trials (4 vs 5)
• Age: Sleep latency increases with age (0.6 min/decade)
Effect of 4 vs 5 naps on MSLT

Figure 3—MSL with SEM on the MSLT in four and five nap protocols. Linear regression lines are plotted.

MSL = Mean sleep latency, SD = standard deviation, SEM = standard error of the mean

SLEEP, Vol. 28, No. 1, 2005  The Clinical Use of the MSLT and MWT  Arand D. et al
Age Effects on MSLT

Figure 2—MSL with SEM on the MSLT by age. Linear regression line is plotted.
Circadian Effects on MSLT

- Last nap effect: anticipation of going home
- SOREMPs more likely in AM trials
- Nocturnal MSLTs (3\textsuperscript{rd} shift) show latencies decrease across the night
Other Sources of Variability

- Latencies are increased by:
  - increased activity prior to nap
  - sitting up
  - allowing patients out of bedroom between naps
The mean sleep latency from the MSLT cannot discreetly distinguish normal from pathologically sleepy populations.
# Overlap of MSLT latency in controls and patient populations

<table>
<thead>
<tr>
<th>Population</th>
<th>Mean (minutes)</th>
<th>Standard Deviation</th>
<th>2 SD Range (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Narcolepsy</td>
<td>3.1</td>
<td>2.9</td>
<td>0-8.9</td>
</tr>
<tr>
<td>Idiopathic Hypersomnia</td>
<td>6.2</td>
<td>3.0</td>
<td>0.2-12.2</td>
</tr>
<tr>
<td>Normal Controls 4 naps</td>
<td>10.4</td>
<td>4.3</td>
<td>1.8-19</td>
</tr>
<tr>
<td></td>
<td>(11.6)</td>
<td>(5.2)</td>
<td>(1.2-20)</td>
</tr>
<tr>
<td>Normal Controls 5 naps</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
MSLT data must be interpreted within the context of the patient sleep history.
ICSD-2 Narcolepsy Criteria

- Sleep latency less than 8 minutes is used to document sleepiness for diagnostic purposes
- Additionally, 2 SOREMPS are listed criteria for the diagnosis of narcolepsy with or without cataplexy
MSLT Criteria in the Diagnosis of Narcolepsy

- Prior PSG is required and is normal (no other sleep disorders account for EDS)
- >6 hours of sleep time in PSG
- MSLT shows $\geq$ 2 SOREMPs
- MSLT: MSL < 5 minutes
SOREMPs on MSLT

- 2 SOREMPs have a sensitivity of 0.79 and specificity of 0.98 for diagnosis of narcolepsy pts.

- SOREMPs occur frequently in patients with untreated sleep apnea (29% reported by Walsh, 1992)
SOREMPS are Not Diagnostic if:

- Patient is sleep deprived
  - Chronic partial sleep deprivation
  - Acute sleep deprivation
- Other untreated sleep disorders exist
- Recent discontinuation of REM suppressing medication (stimulants, SSRIs (typically high %REM in PSG))
MSLT in OSA Patients

- Patients should be using CPAP regularly with documented compliance
- Prior PSG shows CPAP effective
- MSLT should never follow a split night PSG
- MSLT naps should be run on CPAP
MSLT Preparation

• 1 week sleep log prior to MSLT
• Stop stimulants and REM suppressants (eg. SSRIs) 2 weeks before MSLT
• Prior night PSG must be done before MSLT
MSLT Procedure

- 4 or 5 naps are given but a 5th nap must be done if there is one REM onset in the first 4 naps
- Naps are 2 hours apart starting 1.5 - 3 hours after nighttime sleep
- Patients are out of bed between naps
- Room must be quiet, comfortable and dark
- No caffeine allowed during the study
- No music, TV or radio during naps
- Optional drug screen in AM or after test
MSLT Procedure

• 30 min before test: no smoking
• 15 min before test no stimulating activity
• Record LEOG, REOG, chin EMG, C3A2 or C4A1, O2A1 or O1A2, ECG
• Bio calibrations (lay down, eyes open 30 sec, eyes closed 30 sec, move eyes only (left, right, left, right), blink 5X, grit teeth.”
MSLT Instruction to Patient

“Please lie quietly, assume a comfortable position, keep your eyes closed and try to fall asleep.”
MSLT Termination

- If there is no sleep, terminate 20 min after Lights Out
- If sleep occurs, terminate 15 min after the first epoch of any stage of sleep (simple clock time)
MSLT Scoring

• 4 or 5 naps are used to calculate mean sleep latency and number of naps with REM sleep

• Sleep latency is determined from Lights Out to the first epoch of any stage of sleep

• REM latency is determined from Lights Out to the first epoch of REM
The MWT in the Evaluation of Alertness
# MWT 40 min Normative Data

<table>
<thead>
<tr>
<th>Sleep onset definition</th>
<th>Mean (minutes)</th>
<th>Standard Deviation</th>
<th>2 SD Range (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st epoch any stage</td>
<td>30.4</td>
<td>11.2</td>
<td>8 - 40</td>
</tr>
<tr>
<td>3 epochs stage 1 or 1 epoch other stage</td>
<td>35.2</td>
<td>7.8</td>
<td>20.4 - 40</td>
</tr>
</tbody>
</table>
In a study using 64 healthy subjects, 42% (27/64) did not sleep on any of the 4 trials in the 40 min MWT (SO definition was first epoch)
Various Evidence for Clinical Decisions

• On the 40 minute MWT, the mean is 30 minutes

• 2 SD (‘normal’) range is 8-40 minutes

• 42% of normal controls don’t sleep on any MWT trial (MSL=40)

Journal of Clinical Sleep Medicine, Vol. 2, No. 2, 2006
The MSLT/MWT Should be Used for the Assessment of Workplace Safety. Arand D.
MWT data must be interpreted within the context of the patient sleep history.
FAA Recommendations

FAA requests a "current status report“ from the treating physician. If the physician states that the airman is not compliant with treatment, an MWT is required. If the test is positive, the airman is denied medical certification.

If the physician states that the treatment has eliminated the symptoms and the airman is compliant with the treatment, this is accepted. If a surgical procedure was used to correct the sleep apnea, then one MWT test is required.
FMCSA Recommendations
Federal Motor Carrier Safety Association

• Suggests the use of the MSLT for demonstrating the effectiveness of CPAP in the treatment of OSA patients.

• They do not reject the use of other measures; medical examiners don’t have to follow their recommendations.
FAA Regulations for OSA
Return to Duty

• Signed ‘compliance with treatment’ statement
• Results and interpretive report of most recent sleep study
• Current status report indicating OSA treatment is effective
  – CPAP, BiPAP or APA
    • Cumulative annual PAP device report showing 75% use in sleep periods with average 6 hrs per night usage
  – Dental appliance or positional therapy
    • Cumulative report once capability is available

Validity of MWT & Safety

• MWT has more face validity for evaluation of an individual's ability to stay awake than the MSLT
• Strong and predictive relationship between MWT latencies and safety.
• However the validity of the MWT or MSLT for evaluation of safety has not been established for either test.
MWT and Workplace Safety

• Lack of data on:
  ○ the association of MWT scores and safety
  ○ MWT use to predict safety
Standards of Practice Guidelines for the MWT Procedure

• 40 minute MWT trials are recommended
• A preceding PSG is optional
Optional PSG prior to MWT

- MWT addresses one question “Can the patient stay awake?” It does not ask why.
- Drug screen probably more useful
Reasons to Support Using a PSG Prior to MWT

• Patient may be malingering or has motivation not to “pass” the test

• Relatively recent PSG not done and there is a suspicion of underlying sleep disorders
Reasons for Not Performing a PSG Prior to MWT

– No suspicion of underlying sleep disorder or it has been effectively treated

– OSA patients are compliant with effective CPAP

– Patient indicates that sleepiness is not or no longer a problem

– Patient is motivated to “pass” the test
MWT in OSA Patients

• CPAP should not be used in MWT trials
• Patients should be using CPAP regularly with documented compliance
• MWT should never follow a split night PSG
MWT Preparation

• Optional
  – Prior night PSG optional based on clinical circumstances
  – Sleep logs optional

• If evaluating treatment, effective treatment should be used consistently during prior 2 weeks
Recommended MWT Procedure

- 40 minute MWT
- 4 trials sitting up in bed
- Trials are 2 hours apart starting 1.5 – 3 hrs after usual wake up time
- Patients are out of bed between trials
- Light source behind patient at .1 -.3 lux
- Use of caffeine, tobacco or medication is based on clinical decision
- No music, TV or radio during trials
- Optional drug screen in AM or after test
MWT Procedure

• 30 minutes before each trial: no smoking or strenuous activity
• Record LEOG, REOG, chin EMG, C3A2 or C4A1, O2A1 or O1A2, ECG
• Bio calibrations (eyes open 30 sec, eyes closed 30 sec, move eyes only (left, right, left, right), blink 5X, grit teeth
MWT Directions to Patient

“Please sit still and remain awake for as long as possible. Look directly ahead of you and do not look at the light.”
MWT Trial Termination

• If no sleep occurs, terminate 40 minutes after Lights Out
• If sleep occurs, then patient is awakened after 3 consecutive epochs of stage 1 or one epoch of any other stage of sleep
MWT Scoring

• Sleep Onset is defined as the first epoch of any stage of sleep
Case Sample 1

- 70 y.o. Female
- CC: falling caused by excitement: “legs go to jelly” and face is distorted
- DX with OSA 14 years ago, put on CPAP but did not use very long
- Has occasional leg cramps and sleep talks
- Meds: Pravachol, quinine
PSG results

- Total sleep time = 5.8 hours (SE=80%)
- REM latency: 89 min
- REM = 94 min (27%)
- PLMI = 1.9
- PLMA = 0
- AHI 4.8
- Min SaO2 = 88%
MSLT Results

• Mean Sleep Latency = 2.1 min
• REM onsets = 3
Case 2

- 67 year-old Female, 5’4, 286 lbs
- CC: EDS
- HX: diagnosed with narcolepsy in her 20’s; diagnosed with OSA in 1999
- Rarely takes Ritalin or uses her CPAP
- Reports 10 previous sleep studies confirmed her DX
- Classic history of cataplexy
- Smoker, hypertensive, chronic bronchitis, GERD
Test results

- NPSG:
  TST 5.7 hours (SE: 71%)
  AHI = 36.5 (193 hypopneas)
  min $\text{SAO}_2 = 67%$
  PLMI = 18, PLMA=1
  REM latency: 152 min
  2 REM periods (44 min or 14% REM)
MSLT

- Mean sleep latency = 1.0 minute
- 1 SOREMP
- HLA negative
Future Directions

• Correlational studies between objective tests, safety and occupational risk
• Development of new tests based on biological changes (e.g., hypocretin levels)
• Investigation of biological markers of sleep deprivation and development of new tests
• Development of simple and inexpensive tests for alertness to use in the field