

ISMC

INTERNATIONAL SLEEP MEDICINE COURSE

6TH - 9TH JUNE 2016 | RADISSON BLU - CARDIFF

University Hospital of South Manchester 
NHS Foundation Trust

MSLTs and MWTs

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No Personal Sponsorship

Introduction

- Disorders of Excessive Daytime Sleepiness (EDS) are linked to poor quality of life scores, serious accidents, including loss of life.
- In the modern world, Western lifestyles are becoming increasingly “Sleep-Unfriendly”.
- The following workplace disasters were all due, at least in a significant part, to Sleep Deprivation

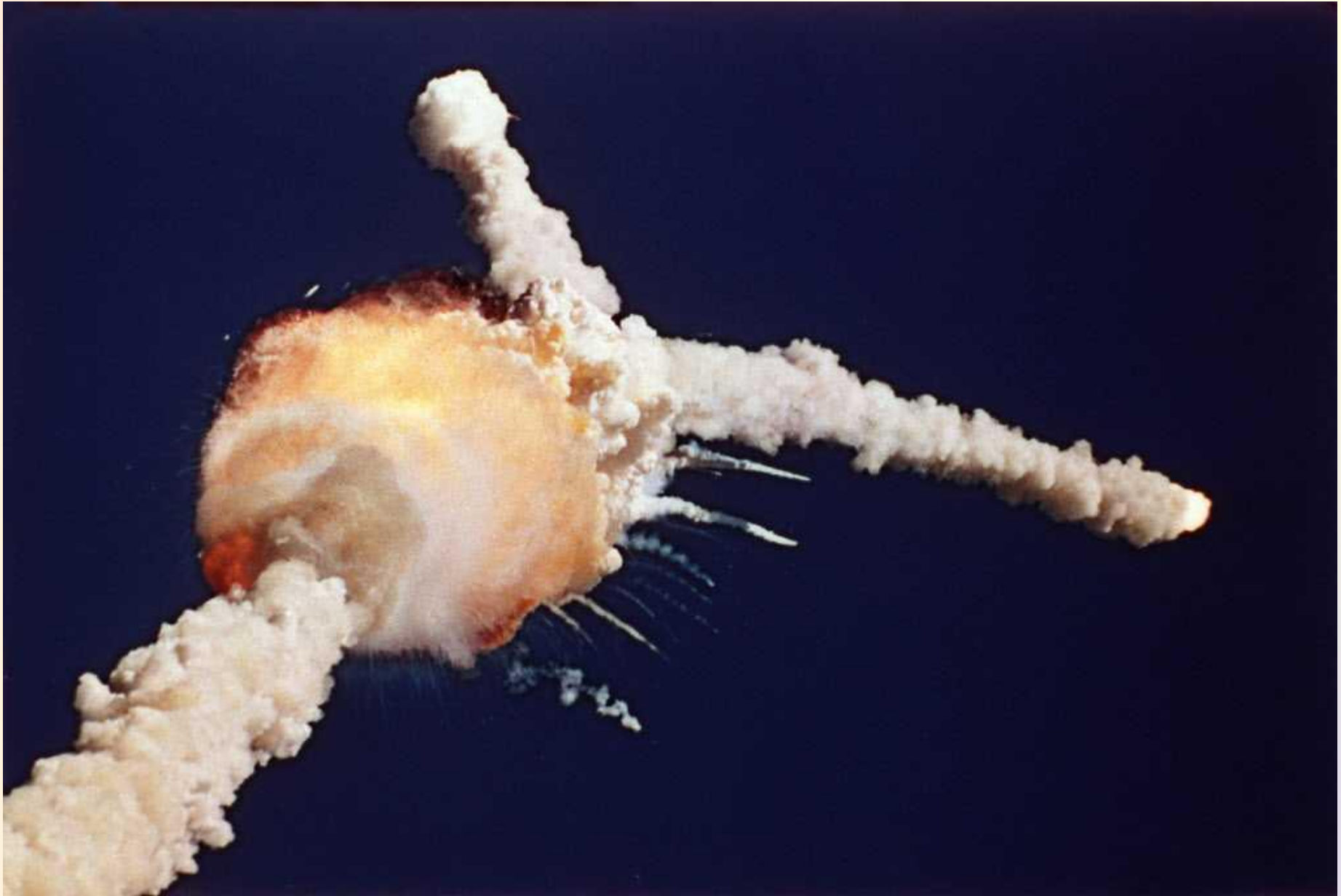
Chernobyl



Three Mile Island



The Challenger Explosion



Exxon Valdez



Now That I've Cheered You Up...

- However it's not just sleep deprivation. Other disorders of EDS include narcolepsy and idiopathic central nervous system hypersomnolence
- As sleep clinicians, it is our role to diagnose and attempt to treat disorders of EDS.
- MSLTs and MWTs are tools that can be used to assess sleepiness, and determine response to therapy.

MSLTs

What are MSLTs?

- ***Multiple Sleep Latency Tests*** (MSLTs)
- “A validated objective measure of the ability or tendency to fall asleep.” [Ref 1]
- Measures the *amount of time* it takes to *fall asleep* under *optimal conditions*.

What are MSLTs?

- MSLTs are a robust, objective measure of sleepiness when used appropriately.
 - They have good test/retest reliability
 - The results are appropriately and reliably affected by physiological, psychological, and test protocol variables
- Test Protocol Variables may include
 - CPAP
 - Night shift workers
 - Medications

What are MSLTs?

- Several nap opportunities throughout the day, spaced **two hours** apart
- Sleepiness is measured by the Mean Sleep Latency (MSL) of the naps
- The presence of Sleep Onset REM periods (SOREMs) is noted



Who Needs MSLTs?

- Patients who complain of Excessive Daytime Sleepiness (EDS) which cannot be accounted for by *behaviour, medical conditions or medication*.
- Certain sleep disorders are characterised by EDS.
 - ICNSH (Idiopathic Central Nervous System Hypersomnia)
 - Narcolepsy
 - Sleep Deprivation

Who needs MSLTs?

- ICNSH (or primary hypersomnolence)
 - Excessive daytime sleepiness persists in the presence of adequate sleep opportunity and absence of sleep pathology (as demonstrated in the PSG)
 - MSL of ≤ 8 minutes
 - Negative for symptoms of narcolepsy
 - MSLT: 1 or less SOREMs

Ref 2

- You're sleepy and we don't know why!

Who needs MSLTs?

- Narcolepsy (with and without cataplexy) *Ref 2*
 - A disorder of sleep regulation, characterised by EDS and SOREM.
 - Patients may also report cataplexy, sleep paralysis, automatic behaviour and hypnogogic hallucinations
 - Diagnosis of narcolepsy must be confirmed by PSG followed by MSLT, the latter showing:
 - sleep latency ≤ 8 minutes and
 - ≥ 2 SOREMs
 - 80% of narcoleptics have a positive MSLT

Who needs MSLTs?

- Sleep Deprivation (SD)
 - SD can be caused by sleep fragmentation due to an untreated sleep disorder; or by poor sleep hygiene.
 - MSLTs may give a false positive
- Consider Sleep Diaries +/- Actigraphy may be of more value than MSLTs in some conditions.
 - circadian rhythm disorders; primary sleep deprivation
- PSG + MSLTs could be considered in patients who remain pathologically sleepy following treatment of another sleep disorder.

The Test Procedure

- Overnight polysomnography (PSG) is performed the night before the MSLTs
 - TST of six hours is required
 - Screens for other sleep disorders
 - Allows staff to control sleep environment
- The first nap should start between 1.5hrs-3hrs after the end of the overnight PSG
 - Patients have limitations on caffeine, alcohol, food and smoking
- Minimum of four naps, spaced 2hrs apart

The Test Procedure

- A fifth nap is added if a SOREM is recorded on one of the preceding naps
- If two or more SOREMS are sampled, the fifth nap is not required.

Prior to MSLTs

- 1-2 week sleep diary preceding PSG + MSLT is helpful if not essential
- Medication review and 'washout' at least two weeks prior to PSG/MSLTs
 - This may not be possible, so effects of medications should be considered
- Urine screen morning of MSLT
 - ?sedatives or stimulants

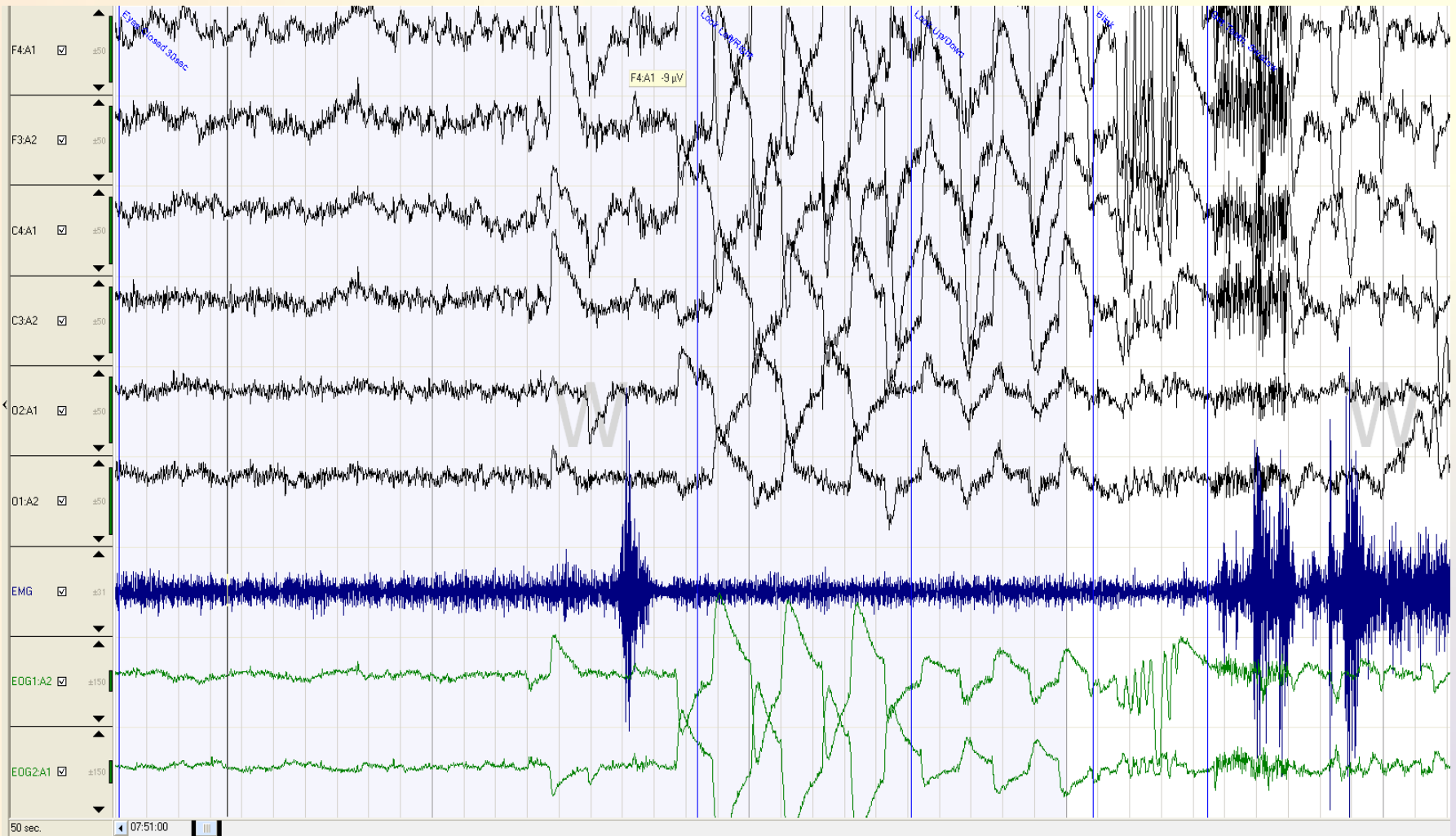
MSLTs and CPAP?

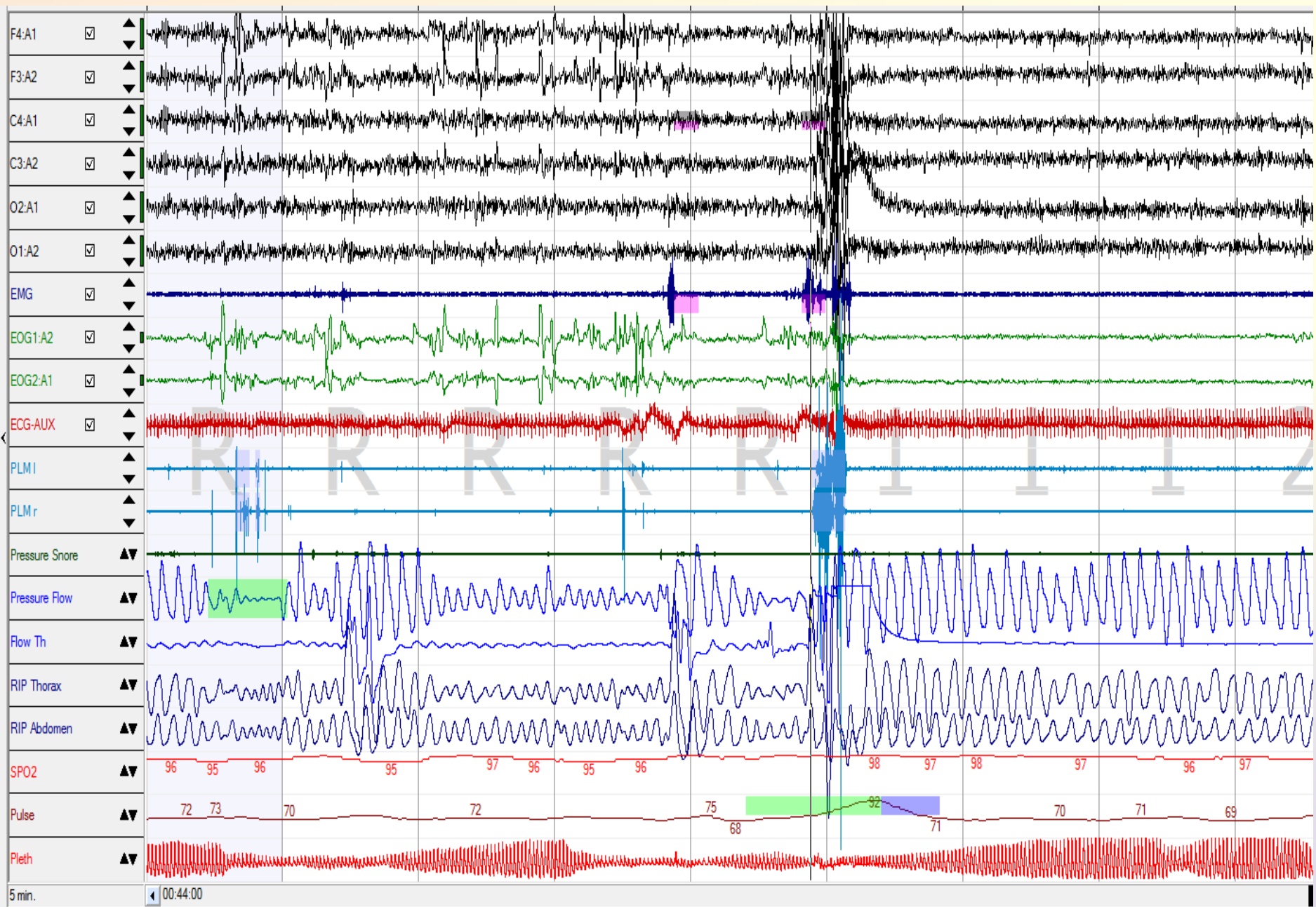
- Naps should be performed on CPAP
 - Snore/UARS/OSAHS events fragment sleep
 - Will likely cause DIMS (Difficulty Initiating and Maintaining Sleep)
 - This may influence the MSL and overall findings
- ?Non-compliant CPAP users with mild sleep disordered breathing (SDB) but high EDS?
 - PSG should confirm severity and MSLT results should be considered *potentially suspect*.
 - MSLTs may be cancelled if SDB significantly disruptive on PSG

Technical Considerations

- EEG, EOG, EMG (submental), ECG (optional).
- Bio calibrations performed before the first nap
 - (Eyes open 30sec, eyes closed 30sec, look left/right/up/down, blink, clench jaw and swallow)
 - Depending on individual equipment, it may be necessary to repeat bio-cals prior to every nap.
 - Signals and impedances should be checked and optimised prior to each nap.
- ? Respiratory bands a helpful indicator for identifying REM – phasic irregularity in respiratory effort is a feature of REM.

Bio-Calibrations





Patient Instructions

- Refrain from caffeine and alcohol during the day
- Avoid smoking 30 minutes prior to each nap
- Avoid vigorous activity during the day
- Avoid falling asleep in between naps
- Avoid lying down in between naps – keep mobile if feeling overwhelmingly sleepy
- Avoid bright lights and direct sunlight
- Light breakfast and lunch are permitted – but should be taken at least one hour prior to the next nap

Study Conditions

- Bedroom should be quiet, dark and cool (not cold)
- Patient should be in comfortable non-restrictive *daytime* clothing
- Patient should be given the same verbal instructions before the start of each nap:

“Please lie quietly, with your eyes closed, and try to fall asleep.”

- ‘Lights Out’ is marked at the point of the light being turned out
 - not at the point the patient settles.

Ending a Nap

The nap should be ended if:

1. No sleep occurs within 20 minutes of 'lights out'.
2. 15 minutes after Sleep Onset
 - That means if SO occurs at 19min 55sec, then the MSLT continues for another 15 mins, giving a total nap time of 34min 55sec.
3. Unavoidable noise/external disruption occurs
 - (in this case restart the nap as soon as possible and record this in the report)
4. As soon as a SOREM is confirmed (>15sec of REM in a 30sec epoch).

'Last nap' effect

- For all individuals the anticipation of going home can lengthen sleep latency or preclude sleep on the last nap.
- This increases overall Multiple Sleep Latency

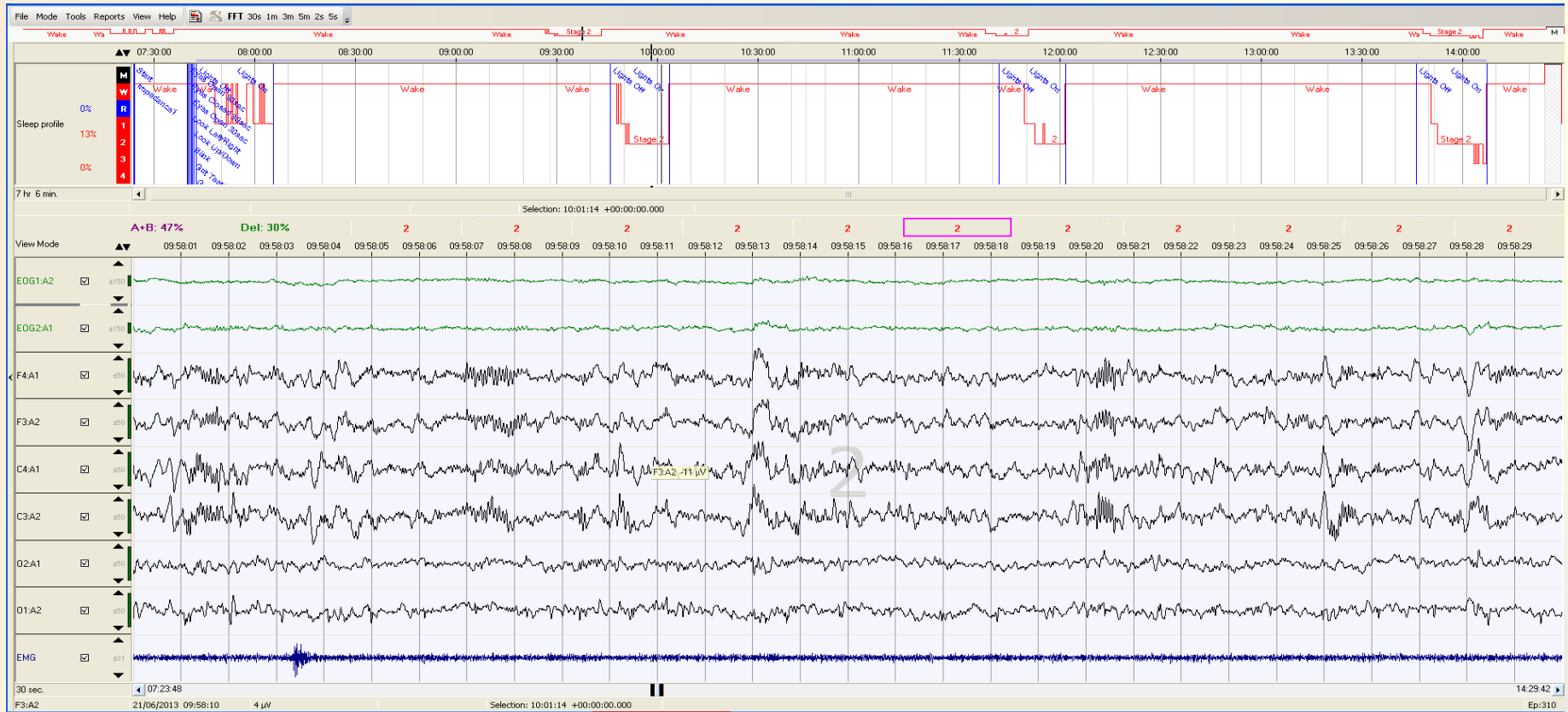
Remember: The 5th nap must be performed if narcolepsy is suspected and there has been only one SOREM in the first 4 naps

Fun Fact!

- Sleep deprivation has been used as a torture technique for thousands of years.
- Therefore, be aware that the MSLT protocol can be very uncomfortable for the extremely sleepy.



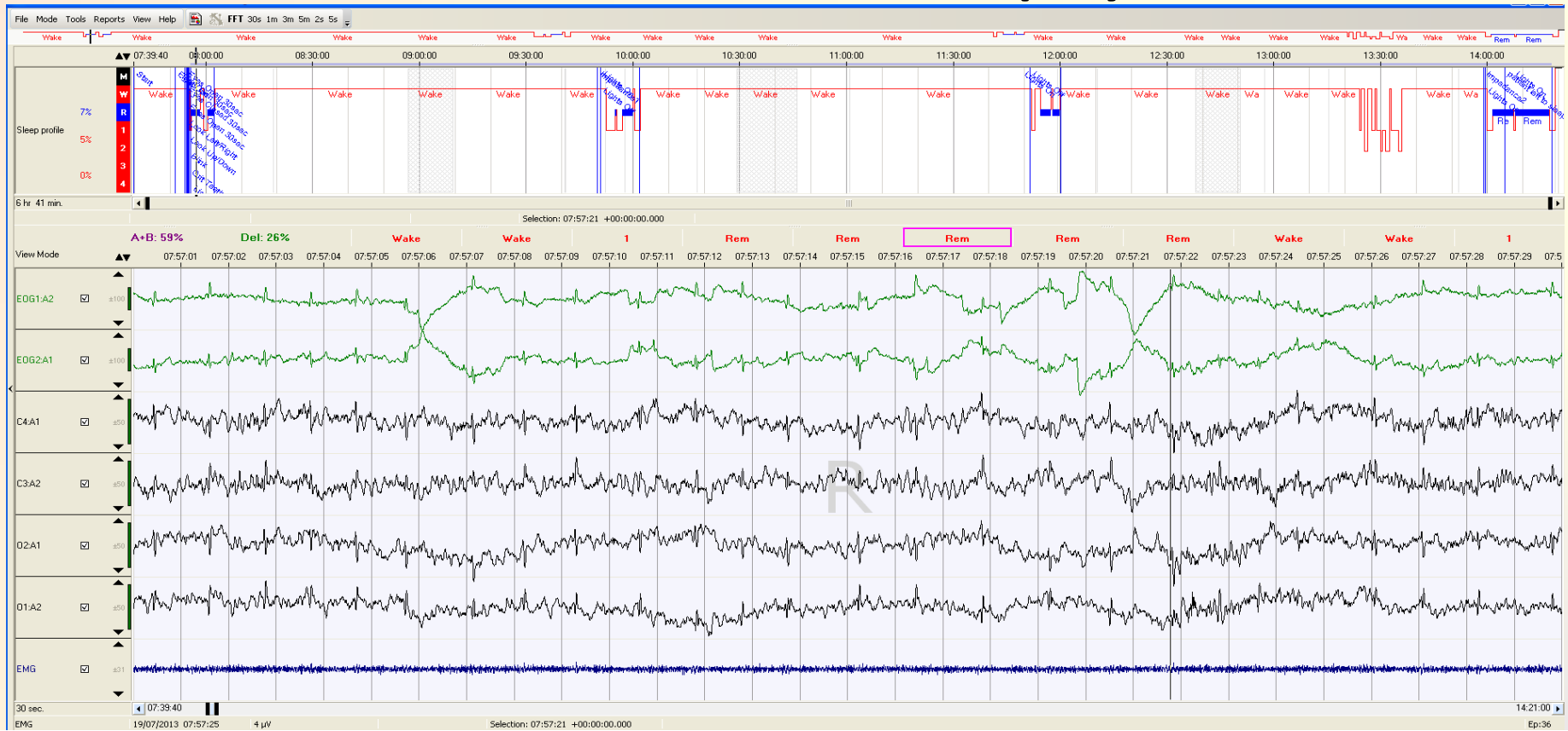
MSLT – EDS ? ICNSH



Record 1 - 07:42:38	00:22:50	-	00:05:21	00:22:50	00:22:50	00:05:21
Record 2 - 09:46:04	00:17:27	-	00:01:55	00:04:25	00:17:27	00:01:55
Record 3 - 11:41:51	00:19:46	-	00:07:38	00:10:38	00:19:46	00:07:38
Record 4 - 13:46:20	00:20:59	-	00:04:09	00:06:09	00:17:09	00:04:09
Average	00:20:16	-	00:04:46	00:11:00	00:19:18	00:04:46

REM Latency not calculated

MSLT - ?narcolepsy



MSLT	TIB	REM latency	Latency S1	Latency S2	Latency S3/S4	SOL
Record 1 - 07:55:39	00:06:40	00:00:30	00:00:20	00:06:40	00:06:40	00:00:20
Record 2 - 09:50:57	00:10:52	00:02:30	00:01:32	00:10:52	00:10:52	00:01:32
Record 3 - 11:51:35	00:08:37	00:02:30	00:00:24	00:08:37	00:08:37	00:00:24
Record 4 - 13:59:26	00:18:39	00:01:30	00:00:33	00:18:39	00:18:39	00:00:33
Average	00:11:12	00:01:45	00:00:42	00:11:12	00:11:12	00:00:42

MWTS

MWTs

- ***Maintenance of Wakefulness Tests*** (MWTs)
- “a validated objective measure of the ability to stay awake for a defined time.” [Ref 1]
- Measures the *voluntary ability to stay awake under conditions that favour falling asleep*.
 - The *intent* to keep yourself awake reflects your physiological *ability* to stay awake

What are MWTs?

- Studies demonstrate significant differences in mean sleep latency values
 - between normal subjects and patients with EDS due to narcolepsy
 - subjects with narcolepsy studied before and after treatment
- Downside of MWTs – not a lot of normative data, so the 40min protocol is used as it is more difficult and provides more data points.
 - Normal mean sleep latency, using latency to first epoch of sleep:

30.4 +/- 11.20 min Ref 3

Who Needs MSLTs?

- Usually performed to see if a person's inability to stay awake represents a risk to themselves or others.
 - Professional drivers (lorry, taxi, school bus etc.), pilots, ambulance workers, fishermen, air traffic controllers etc.
- May be used to determine a response to treatment
 - Provision of CPAP
 - Medications for ICNSH or narcolepsy

The Test Procedure

- Overnight PSG is strongly advised, however not mandatory as in MSLTs
 - Patient is trying to stay awake, not fall asleep, so poor sleep/insufficient TST will be reflected in the trial SLs
- As with MSLTs, drug screening is advised
- First trial starts 1.5hrs-3hrs after the patient's usual wake-up time
- Four trials, spaced 2hrs apart

The Test Procedure

- Bedroom should be quiet and cool (not cold), with a low level of light (like a night light)
- Patient is sat upright in bed, with the back and head supported for comfort
- There are restrictions on caffeine, alcohol, food and smoking, same as for MSLTs
- Technical considerations and biocals same as for MSLTs
 - EEG, EOG, EMG, ECG

Patient Instructions

- Patient is advised to use the toilet etc. to ensure they are most comfortable.
- Patient should be given the same verbal instructions before the start of each trial:

“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 are not allowed to try to stay awake by slapping their face or singing (etc.)

Ending a Trial

- The trial should end if:
 1. No sleep occurs within 40 minutes of 'lights out'
 2. Unequivocal sleep
 - three consecutive epochs of stage 1 sleep, or
 - one epoch of any other stage of sleep.
 3. Unavoidable noise/external disruption occurs
 - (in this case restart the nap as soon as possible and record this in the report)
- Reporting is the same as for MSLTs

Right, so you've spent a day torturing a poor patient who just wants to be left alone to sleep.

What does it all mean?



Reporting

- The Report must include:
 - Start and end times of tests
 - Sleep Latency from Lights Out (SL)
 - Mean Sleep Latency (MSL)
 - Number of SOREMs (**MSLTs**)
 - REM Latencies from Sleep Onset (if applicable)

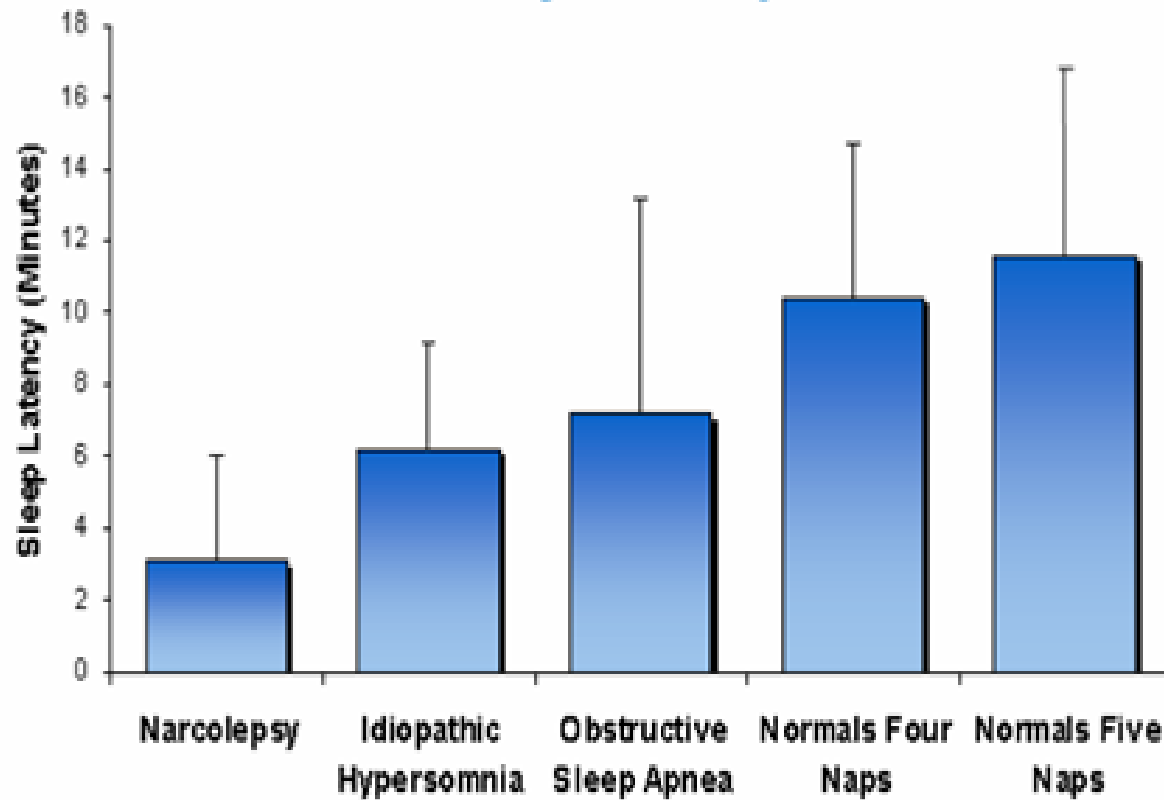
If no sleep is achieved on the MSLT, then SL is recorded as 20mins.

If no sleep is achieved on the MWT, then SL is recorded as 40mins

Calculating Mean Sleep Latency

- Sleep Latency (SL) needs to be calculated for all tests (T1, T2, T3, T4) (?nap 5 for MSLTs)
- When no sleep occurs, SL = 20 mins/40 mins
- Sleep Latency = Sleep Onset Time - Lights Out Time
- Mean Sleep Latency = $\frac{\sum SL (1, 2, 3, 4, ?5)}{\text{number of tests}}$

Mean Sleep Latency on MSLT



From Arand et al 2005

Calculating REM Latency (MSLTs)

- REM Latency can only be calculated for naps where REM is sampled.
- In the absence of REM, it is generally not calculated
- $\text{REM Latency} = \text{REM Onset Time} - \text{Sleep Onset Time}$
- The Mean REM Latency is useful, but it is the ***presence*** of a SOREM which is clinically significant
 - a SOREM is considered to be an abnormal finding.

Further Considerations

- MSLTs and MWTs are useful *tools* in the Sleep Clinician's arsenal (like PSG, actigraphy, sleep diaries, q'naires etc...)
- Disorders of EDS are determined using a ***DIFFERENTIAL diagnosis***. The following are necessary components of the DDx:
 - A robust sleep history
 - 'Normalised' sleep patterns
 - Absence/washout of sleep-influencing medications leading up to the overnight PSG
 - Overnight PSG findings

Further Considerations

- If used, overnight PSG should have not less than 6hrs Total Sleep Time.
 - MSLTs should be considered suspect
 - MWTs may give a false positive
- ? Managing testing with permanent night shift workers.
 - Is your department able to accommodate them?
- In MSLTs, a single SOREM recorded on the first nap may not be significant
 - If the patient has been woken at 0600 when they normally sleep until 0800

Need to Repeat MSLTs or MWTs?

- Initial test is believed to be an invalid representation of patients status
 - (e.g. Patient had a holiday or shift work prior to testing)
- When ambiguous/uninterpretable findings occur
- To confirm a response to treatment
- When more than one sleep disorder is suspected

(Very) Quick Quiz



- What are MSLTs *actually* testing?
 - Sleepiness, or how quickly you fall asleep under optimal conditions
- How many naps in an MSLT?
 - Four, or five if only one SOREM sampled in the previous naps
- How far apart are they spaced?
 - Two hours
- What TWO criteria constitute a positive result for narcolepsy?
 - Short sleep latency (MSL < 8mins), and two or more SOREMS
- What is the other main sleep disorder tested for using MSLTs?
 - ICNSH
- What's the MSL for four naps giving SLs of 6min, 8 min, 10min, (no sleep)?
 - 11mins
- **(Very) Brief Discussion:** How would you test for narcolepsy in a permanent night shift worker, using MSLTs?

- What are MWTs *actually* testing?
 - The ability to stay awake in an environment optimised for sleep
- How many trials in an MWT?
 - Four
- What is the normal MSL in MWTs?
 - 30.4 +/- 11.20 min
- What sort of patients would we perform an MWT on?
 - Those at risk of hurting themselves or others if they fell asleep inappropriately
 - Those who may have had a response to treatment

References

1. Littner MR, Kushida C, Wise M, Davila DG, Morgenthaler T, Lee-Chiong T, Hirshkowitz M, Daniel LL, Bailey D, Berry RB, Kapen S, Kramer M; ***Practice Parameters for Clinical Use of the Multiple Sleep Latency Test and the Maintenance of Wakefulness Test*** Standards of Practice Committee of the American Academy of Sleep Medicine. *Sleep*. 2005 Jan 1;28(1):113-21.
2. American Academy of Sleep Medicine. ***International Classification of Sleep Disorders. 3rd ed.*** Darien, IL: American Academy of Sleep Medicine; 2014.
3. Doghramji, K., M. M. Mitler, J. M. Sangal, R. B. Sangal, C. Shapiro, S. Taylor, J. Walsleben, C. Belisle, M. K. Erman, R. Hayduk, R. Hosn, E. B. O'Malley, S. L. Schutte and J. M. Youakim (1997). "***A normative study of the maintenance of wakefulness test (MWT).***" *Electroencephalography and Clinical Neurophysiology* **103**(5): 554-562.

