EVALUATION OF SLEEP THROUGH SCALES AND LABORATORY TOOLS

Marco Zucconi

Sleep Disorders Centre,
Dept of Clinical Neurosciences,
San Raffaele Hospital, Milan, Italy

INDAGINI STRUMENTALI DEL CICLO SONNO-VEGLIA NEL MORBO DI PARKINSON

CARDIO-RESPIRATORY MONITORING

ACTIGRAPHY

POLYSOMNOGRAPHY

MSLT
<table>
<thead>
<tr>
<th>Scale</th>
<th>% of normal</th>
<th>“Well-being”</th>
<th>Information from</th>
<th>Presence of</th>
<th>Timing of</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>DSS</td>
<td>55%</td>
<td>“Well-being”</td>
<td>Quality of sleep</td>
<td>Not evaluated</td>
<td>Over previous week &amp; month</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>PSQI</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep efficiency</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>MODA-5</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>SSS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>ESS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
</tbody>
</table>

Hogl, 2010

<table>
<thead>
<tr>
<th>Scale</th>
<th>% of normal</th>
<th>“Well-being”</th>
<th>Information from</th>
<th>Presence of</th>
<th>Timing of</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Quality of sleep</td>
<td>Not evaluated</td>
<td>Over previous week &amp; month</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>PSQI</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep efficiency</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>MODA-5</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>SSS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>ESS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
</tbody>
</table>

Chaudury, 2002

<table>
<thead>
<tr>
<th>Scale</th>
<th>% of normal</th>
<th>“Well-being”</th>
<th>Information from</th>
<th>Presence of</th>
<th>Timing of</th>
<th>Used for</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Quality of sleep</td>
<td>Not evaluated</td>
<td>Over previous week &amp; month</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>PSQI</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep efficiency</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>MODA-5</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>SSS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
<tr>
<td>ESS</td>
<td>50%</td>
<td>“Well-being”</td>
<td>Sleep quality &amp;</td>
<td>Over previous week</td>
<td>Over previous week</td>
<td>Recomended for mild sleep impairment as a screening tool and as a measure of severity.</td>
</tr>
</tbody>
</table>

Trenkwalder, 2011
PDSS-2 factors

1. PD specific nocturnal motor symptoms: akinesia, early morning dystonia, tremor, at night, PLMs, RLS and probably RBD
2. PD-specific nocturnal non-motor symptoms: hallucinations, confusional states, pain, muscle cramps, difficulties in breathing with snoring, and immobility
3. Sleep specific disturbances: insomnia, sleep maintenance, unrestored sleep in the morning, getting up at the night to pass urine, and overall quality of sleep
Advantages of PDSS-2

- It reflects a greater spectrum of nocturnal disabilities in PD patients
- It addresses the frequency of nocturnal symptoms observed during the previous week
- It could be used in screening for nocturnal disturbances and monitoring of pharmacological treatment
- It is easy to handle for PD patients

Suzuki, 2014

SCOPA-SLEEP SCALE
Spectrum of disorders

- Motor behaviors
- Excessive daytime sleepiness
- "sleep attacks"
- Parasomnias
- Hallucinations
- Sleep disordered breathing
MOTOR PHENOMENA DURING SLEEP IN PD

- Blinking at sleep onset
- Restless legs syndrome (at sleep onset)
- Unpatterned increased motor phasic activity
- Fragmentary myoclonus
- Periodic leg movements during sleep
- ALMA
- Increased phasic muscle activity (twitches) and/or loss of the muscle atonia (RFA) in REM sleep
- REM behavior disorder
- Tremor modulation
- Increased bradicinesia

Instrumental evaluation of sleep disorders in PD

- Actigraphy
- Video-Polysomnography in lab
- Dynamic (unattended) polysomnography
- Dynamic Video-Polysomnography
- Cardiorespiratory monitoring (Polygraphy)
- Vigilance Test (MSLT, MWT)

<table>
<thead>
<tr>
<th></th>
<th>PSG</th>
<th>VIDEO PSG</th>
<th>CARDIO-RESPIRATORY MONITORING</th>
<th>ACTIGRAPHY</th>
<th>MSLT/MWT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sleepiness</td>
<td>*</td>
<td>*</td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Hallucinations</td>
<td></td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Clinical suspect of sleep-related breathing disorders</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>Complete paroxysmal motor or behavioral episodes during sleep</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>NREM Paroxysm</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REM Paroxysm</td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>Seizure</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Instrumental evaluation of sleep disorders in PD

POLYSOMNOGRAPHY

POLYSOMNOGRAPHY FOR THE EVALUATION OF NOCTURNAL SLEEP

- Video-Polysomnography in lab
- Dynamic Video-Polysomnography

POLYSOMNOGRAPHY FOR THE EVALUATION OF NOCTURNAL SLEEP. Different montage choices
Video usefulness for a correct interpretation of motor phenomena

REM Sleep Behaviour Sleep Disorder

DYNAMIC POLYSOMNOGRAPHY

- "unattended" long-lasting electrophysiologic monitoring
- EEG/Polygraphic recording on magnetic support
- Temporal extension 24 h (and more)
- Naturalistic recording with freedom of movements and actions

Video-EEG-polygraphy with telemetry

Telemetry: it allows the patient to move into the room and in the nearer space without cables of recording
VIDEO-POLYSOMNOGRAPHY FOR THE EVALUATION OF NOCTURNAL SLEEP

SLEEP LAB

ROOM IN HOSPITAL

Domestic Setting?

A. Recording station
B. Video-acquisition system (IR camera connected with a control system)
C. EEG-PSG telemetric recording
IT PROVIDES THE ON-GOING OF THE VIGILANCE DURING THE DAY BEHIND THE NIGHT SLEEP

IT PROVIDES FREQUENCY, TIMING AND LENGTH OF EVENTUAL NAPS

IT ALLOWS USEFUL TOOLS FOR DIFFERENTIAL DIAGNOSIS OF EPISODES

DYNAMIC POLYSOMNOGRAPHY

NEEDS FOR A CORRECT IMPLEMENTATION

- patient instructions to best avoid biological artifacts
- day-night diary
- external observation (siblings; caregivers)

LETTER TO THE EDITOR

Scoring Sleep in Neurological Patients: The Need for Specific Considerations

- PSG recording must be always performed with synchronized audiovisual recording of the patient.
- 2. Once the periods of wakefulness and sleep are established by a combination of all the available data, identification of the different sleep stages should be performed if possible.
- 3. The report of a sleep study in these patients should include the following variables:
  - Total time awake
  - Total sleep time
  - Subdivide sleep in REM and NREM
c. Dissociations.

When the PSG and behavior are discordant for the different sleep stages, each behavioral pattern should be described.

- Hallucinatory-like behaviors with different mixtures of EEG/EMG/EOG patterns
- RBD-like movements (jerky, sudden contractions of the limbs and or body, vocalizations) without EMG atonia associated with an undefined EEG/EOG pattern or with a NREM sleep pattern.
- Other behavioral and PSG patterns

DIFFICULTIES IN SLEEP SCORING IN PD

- In advanced disease sleep may appear all destructured (up to dissociated state).
- Difficulties in distinguishing NREM stages (N2; N3)
  - decreased density of physiologic sleep EEG elements as spindles and, to a lesser extent, K complexes
  - Slow wave activity (delta band) at the EEG (in wakefulness)

DIFFICULTIES IN SLEEP SCORING IN PD

- Difficulties in distinguishing REM and NREM from Wake
  - REM fragmentation;
  - REMs (rapid eye movements) during sleep stages different from REM sleep;
  - persistence of muscle activity during REM sleep; independently by the presence of REMs, and with alpha activity intrusion;
  - inadequate and poor difference between wake and NREM N1
  - Possible simultaneous slow wave activity (delta) at EEG
  - Increase of phasic motor activity
Good level of agreement in distinguishing REM sleep from NREM sleep and wakefulness

Low level of agreement in distinguishing the different NREM stages
EVALUATION OF SLEEPINESS

AIM
Establish the eventual pathologic level
When and which sleepiness may be defined “excessive”
- Perception ?
- Objective data ?
- Outcome measures ?

It’s needed to build up and to refer to normative data

Sleep attack

TO ESTABLISH CUT-OFF FOR CONSIDERING PATHOLOGIC SLEEPINESS MAY BE COMPLEX AND IT PRESENTS SOME DIFFICULTIES

A degree of daytime sleepiness is physiologic in normal conditions

This physiologic degree of sleepiness is different regarding
1. Age
2. Circadian type (evening/night)
3. Sleep Need (long/short sleeper)
The Epworth Sleepiness Scale may not reflect objective measures of sleepiness or sleep apnea

Ronald D. Chervin, MD, MS and Michael S. Aldrich, MD

The ESS score did not reflect mean sleep latency on the MSLT or severity of sleep apnea in 237 patients.

MSLT and MWT

- MSLT is a measure of sleep propensity in "soporific" conditions.

  Measure of Sleep Drive

- MWT is a measure of capacity in resisting sleep conditions "only partially soporific".

  Measure of Arousal/Sleep Drive balance

MSLT Recording parameters

- EEG
  - F4-M1
  - C4-A1
  - O2-A1

- POLYGRAPHY
  - EOG
  - EMG
  - submental m.
Night PSG

No smoking

Relaxed activities

Preparation to go to sleep

Montag

Verify

Lights off

-30 s

Start acquisition

-15 s

Comfortable position

-5 s

Instruction to the patient

T0

Lights off

Wake + 20 min

NREM + 15 min

REM

TEST END

Mean of the sleep latency for each single test.

Number of SOREMPs (Sleep Onset Rem Periods)

SOREMP

Mean of the sleep latency for each single test.

Number of SOREMPs (Sleep Onset Rem Periods)
Visual hallucinations in relationship with SOREMPs in PD patients

Arnulf 2000

Adviced clinical setting: 40 min for each test
Sleep Onset: one epoch (30s) of any sleep stage
Mean sleep latency of 40 min indicates very good level of vigilance
Mean sleep latency in between 8 and 40 min may be considered in the normal range
Mean sleep latency < 8 min is to be considered as pathological

MAINTENANCE WAKEFULNESS TEST

EXCESSIVE DAYTIME SLEEPINESS MUST NOT TO BE REDUCED TO A SINGLE SLEEP INDEX OR MEASURE

Each single tool
- HAS NOT AN ABSOLUTE VALUE
- THE DIFFERENT TESTS/MEASURES HAVE TO INTEGRATED EACH OTHER
- THE MEASURE RESULTS HAVE TO CONSIDERED TOGETHER WITH THE CLINICAL DATA
OBJECTIVE/INSTRUMENTAL EVALUATION OF SLEEPINESS IN PD

Multiple Sleep Latency Test
- For the definition of excessive daytime sleepiness

Maintenance Wakefulness Test
- For the definition of the daytime sleepiness during treatment

SLEEP APNEA DIAGNOSTIC EVALUATION (INSTRUMENTAL)

- Nocturnal Video-Polysomnography in laboratory
- Dynamic Nocturnal Polysomnography
- Nocturnal cardio-respiratory monitoring (III Level)
- Oximetry

JCSM Journal of Clinical Sleep Medicine, Vol. 3, No. 1, 2005

Clinical Guidelines for the Use of Untethered Portable Monitors in the Diagnosis of Obstructive Sleep Apnea in Adult Patients
Portable Monitoring Task Force of the American Academy of Sleep Medicine

Journal of Clinical Sleep Medicine, Vol.5, No. 3, 2009

Clinical Guideline for the Evaluation, Management and Long-term Care of Obstructive Sleep Apneas in Adults
Portable Monitoring Task Force of the American Academy of Sleep Medicine
PSG is routinely indicated for the diagnosis of sleep related breathing disorders (Standard).

- Following the history and physical examination, patients can be stratified according to their OSA disease risk.
- PMs may be used in the unattended setting to diagnose OSA when utilized as part of a comprehensive sleep evaluation in patients with a high pretest likelihood of moderate to severe OSA (Consensus).

PM testing may also be indicated for the diagnosis of OSA in patients for whom in-laboratory PSG is not possible by virtue of immobility, safety or critical illness and to monitor response to non-CPAP therapies (Consensus).

**CAVEAT**

1.2.2. PM is not appropriate for the diagnostic evaluation of OSA in patients suspected of having other sleep disorders, including central sleep apnea, periodic limb movement disorder (PLMD), insomnia, parasomnias, circadian rhythm disorders, or narcolepsy.

1.2.3. PM is not appropriate for general screening of asymptomatic populations.

Ambulatory cardio-respiratory monitoring
NICTEMERAL ACTIGRAPHIC PATTERN

SLEEP HYGIENE

BAD HYGIENE

GOOD HYGIENE
NORMAL SUBJECT

INSOMNIA
EVALUATION OF SLEEP DISORDERS IN PD

CLINICAL DATA
QUESTIONNAIRES/SCALES

Motor episodes and complex behaviours
Resistant to-treatment insomnia
Non-iatrogenic daytime sleepiness

Instrumental/objective tools