EEG

=Electroenencephalogram

...bioelectric activity of the brain

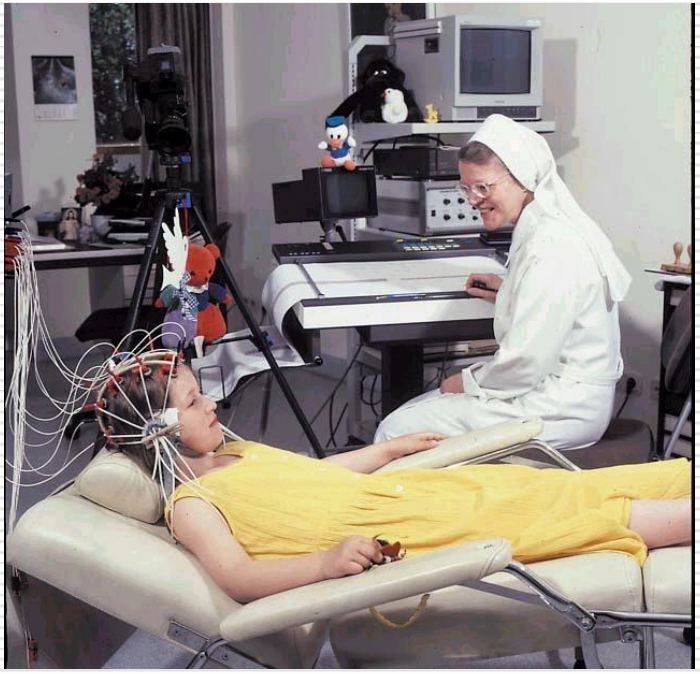
... The recording of the electric currents developed in the brain, by means of electrodes applied to the scalp, to the surface of the brain (intracranial e.) or placed within the substance of the brain (depth e.).

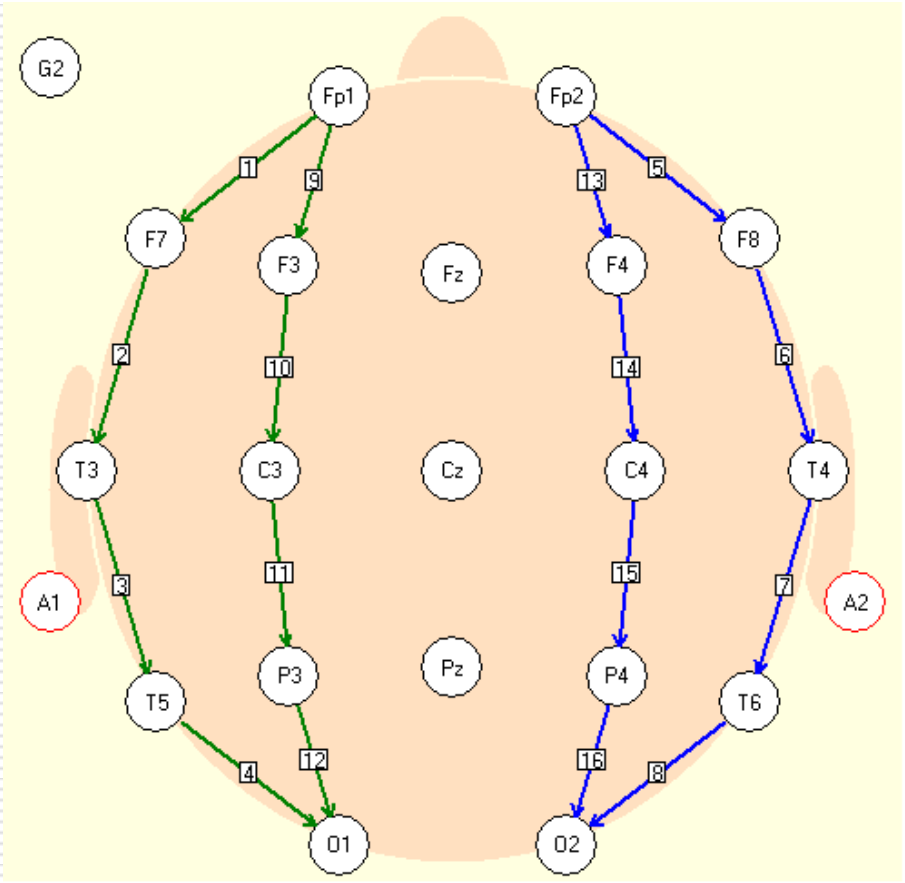
EEG- indications

- Epilepsy: the origin within the brain of the individual's seizures
- Dementia syndromes- dif. Dg. Creutzfeld Jacob disease, infection

- Intoxications-alcohol, drugs
- ?Brain death

Scalp EEG



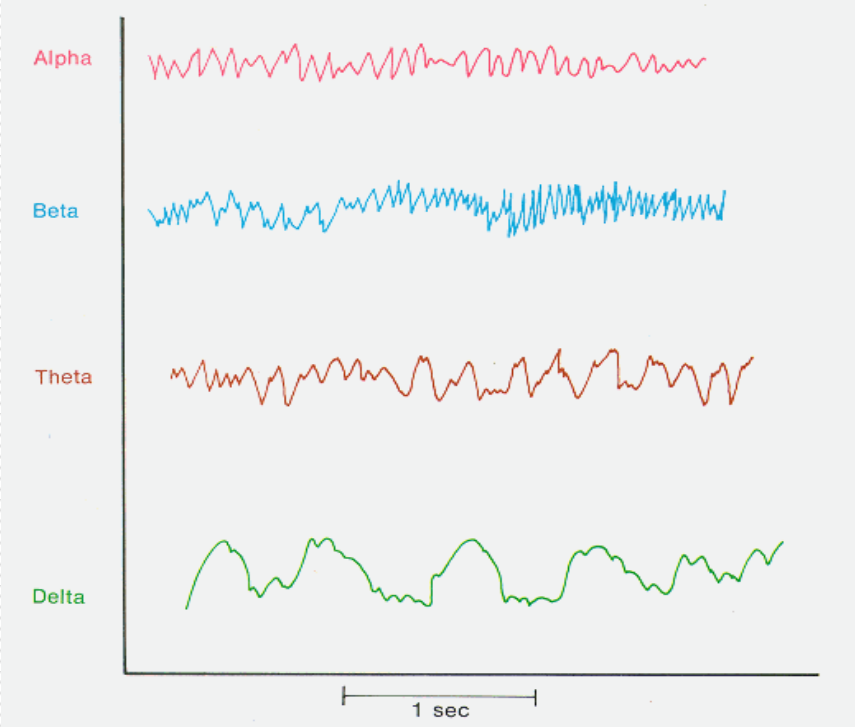


Scalp EEG

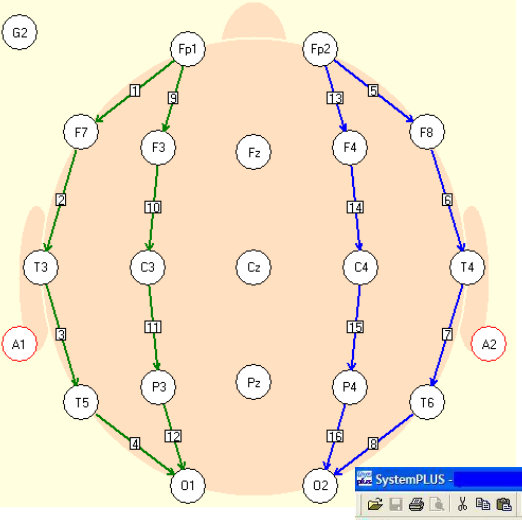
- International system 10-20
  - Bipolar montage -Each channel (i.e., waveform) represents the difference between two adjacent electrodes.
  - Referential montage - Each channel represents the difference between a certain electrode and a designated reference electrode. There is no standard position at which this reference is always placed; it is, however, at a different position than the "recording" electrodes. Midline positions are often used because they do not amplify the signal in one hemisphere vs. the other. Another popular reference is "linked ears," which is a physical or mathematical average of electrodes attached to both earlobes or mastoids.
  - Average reference montage

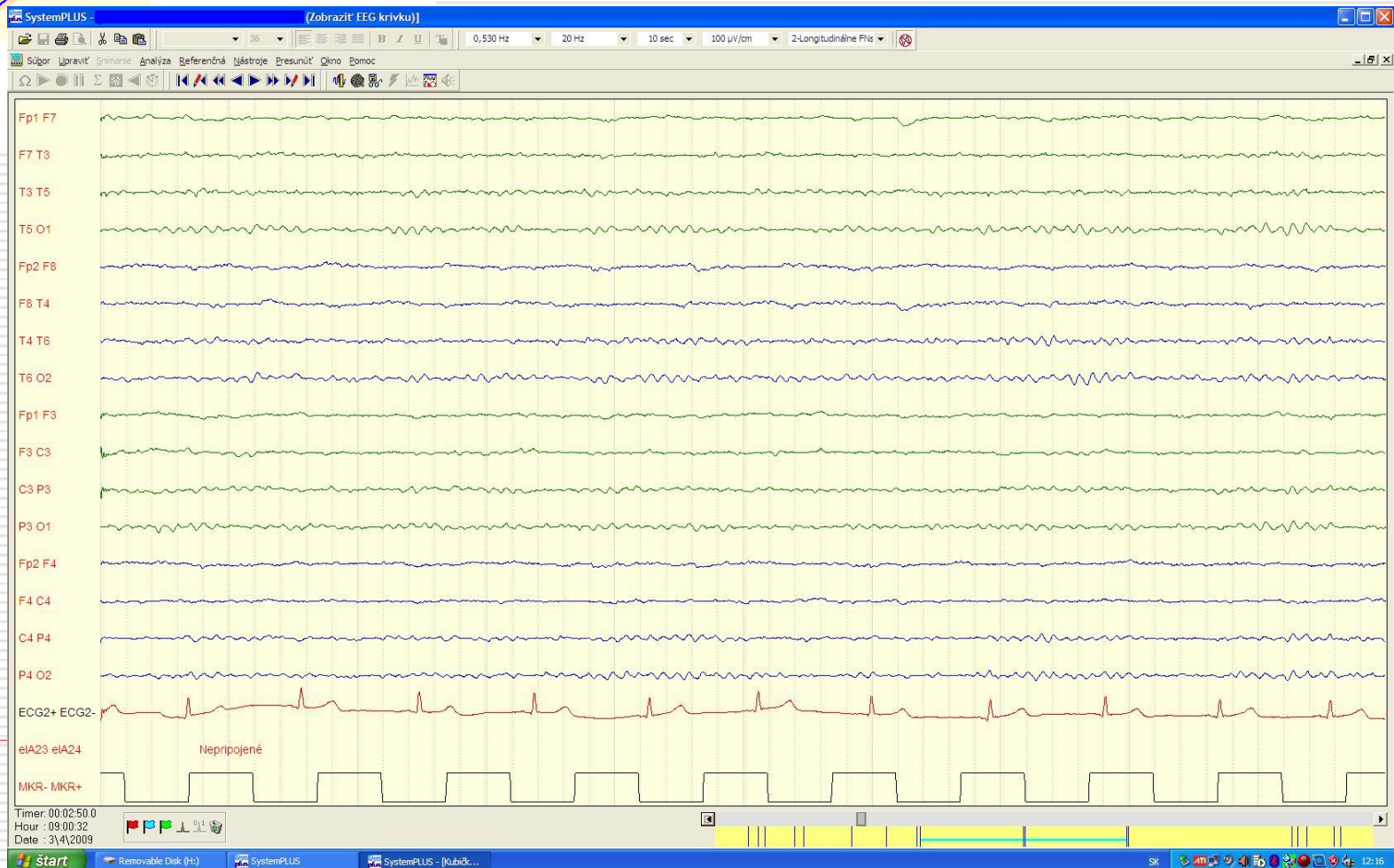
Comparison of EEG bands

Type	Frequency (Hz)	Location
Delta	up to 3	frontally in adults, posteriorly in children; high amplitude waves
Theta	4 - 7 Hz	
Alpha	8 - 12 Hz	posterior regions of head, both sides, higher in amplitude on dominant side. Central sites (c3-c4) at rest .
Beta	12 - 30 Hz	both sides, symmetrical distribution, most evident frontally; low amplitude waves
Gamma	26–100	



Scalp EEG


G2
Fp1
Fp2
F7
F3
Fz
F4
F8
T3
C3
Cz
C4
T4
A1
A2
T5
P3
Pz
P4
T6
O1
O2
1
9
13
5
2
10
14
6
3
11
15
7
4
12
16
8


SystemPLUS - (Zobraziť EEG krivku)]
Súbor Upraviť Snímanie Analýza Referenčná Nástroje Presunúť Okno Pomoc
0,530 Hz
20 Hz
10 sec
100 µV/cm
2-Longitudinálne FNs
Fp1 F7
F7 T3
T3 T5
T5 O1
Fp2 F8
F8 T4
T4 T6
T6 O2
Fp1 F3
F3 C3
C3 P3
P3 O1
Fp2 F4
F4 C4
C4 P4
P4 O2
ECG2+ ECG2-
eIA23 eIA24
Nepripojené
MKR- MKR+
Timer: 00:02:50.0
Hour : 09:00:32
Date : 3\4\2009
štart
Removable Disk (H:)
SystemPLUS
SystemPLUS - [Kubič...
SK
12:16

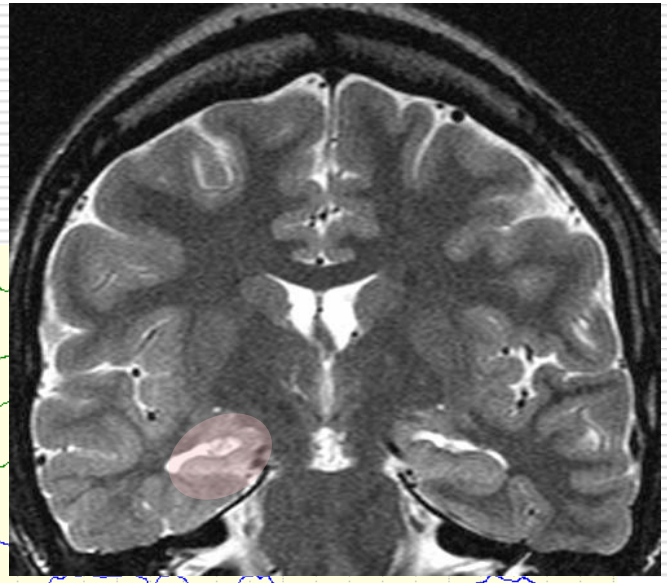

SystemPLUS - (Zobraziť EEG krivku)]
0,530 Hz
20 Hz
10 sec
70 µV/cm
3-Transverzálne FNs
Súbor Upraviť Snímanie Analýza Referenčná Nástroje Presunúť Okno Pomoc
Zatvorené oči
F7 F3
F3 Fz
Fz F4
F4 F8
T3 C3
C3 Cz
Cz C4
C4 T4
T5 P3
P3 Pz
Pz P4
P4 T6
Fp1 Fp2
Fz Cz
Cz Pz
O1 O2
ECG2+ ECG2-
elA23 elA24
Nepripojené
MKR- MKR+
Opened eyes
Timer: 00:06:07.0
Hour : 08:15:50
Date : 1\10\2007
štart
SystemPLUS
SystemPLUS - [Kristia...
SK
9:54

Pathological finding:

FOCAL SPIKE-WAVE DISCHARGE with GENERALIZATION

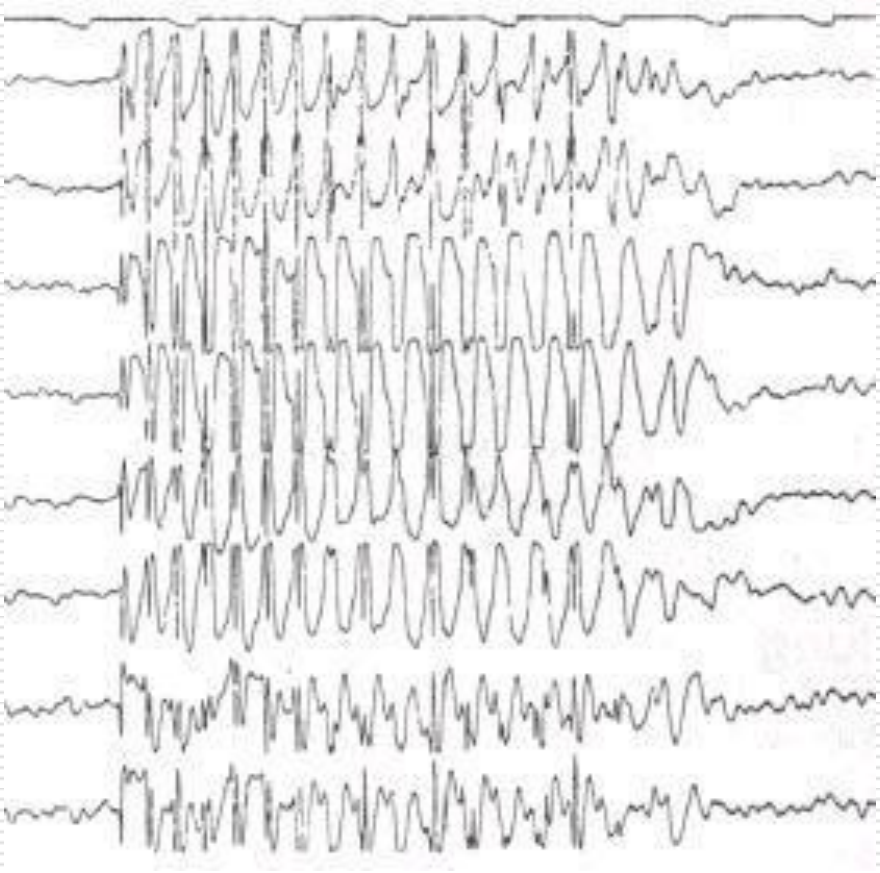
Pathological finding:

FOCAL SPIKE-WAVE DISCHARGE



Pathological finding:

GENERALIZED SPIKE-WAVE COMPLEX DISCHARGE



Absence seizure 3c/s

Pathological findings: periodic discharges

Creutzfeldt-Jacob D.

Pathologic findings: periodic discharges

Creutzfeldt-Jacob D.

Stimulation procedures

- Deep breathing
- Photic stimulation
- Sleep deprivation

- Mediaction withdrawal

Implanted electrodes

- presurgical evaluation

EEG

Indications

- Epilepsy: the origin within the brain of the individual's seizures
- Dementia syndromes- dif. Dg. Creutzfeld Jacob disease, metabolic abnormalities- He, Re failure
- Infections- encephalitis herpetic
- Intoxications-alcohol, drugs
- ?Brain death

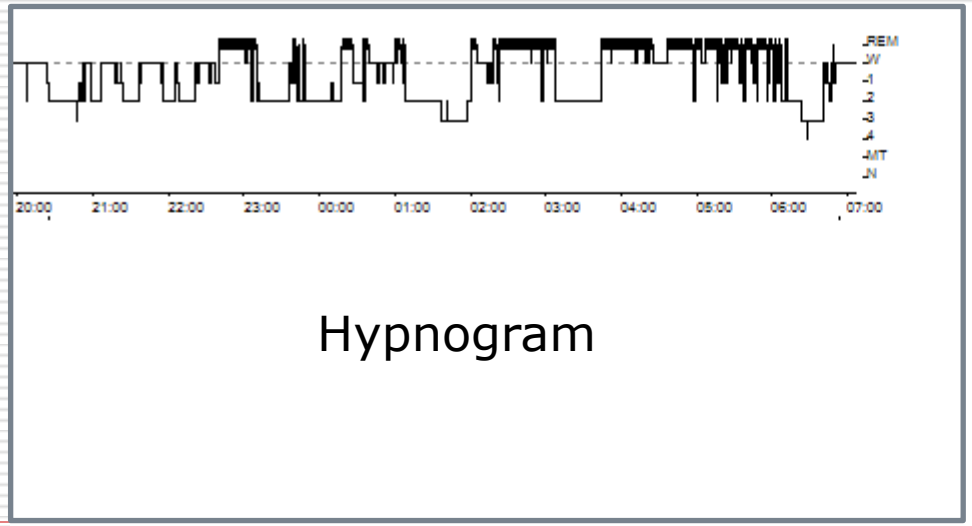
Pathological findings

- Spike and Wave Complexes
  - Focal
  - generalized
- Periodic spike and Wave discharges
  - Generalized
  - Lateralized
- Generalized slowering (normal: alpha over occipital areas)

Polysomnography

- Recording of several vital functions:
  - EEG
  - EMG
  - EOG
  - Breathing
  - ECG
  - O2 saturation
  - Leg movements

Sleep stage (1, 2 NREM, slow wave sleep, REM) or Wakefulness–HYPNOGRAM –sleep architecture



Hypnogram

Polysomnography

- **NIGHT STUDIES:**
  - EEG
  - EMG
  - EOG

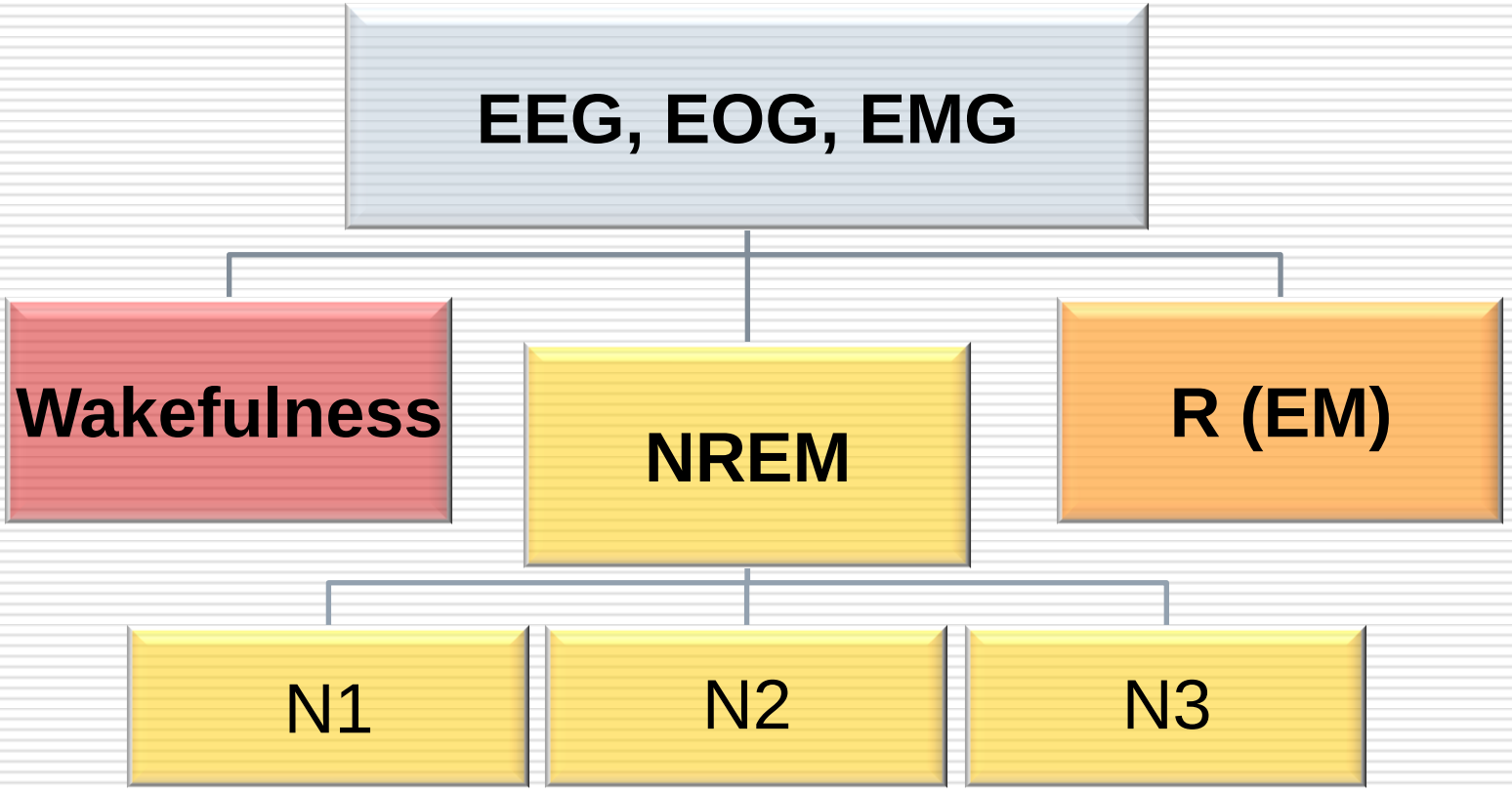
  Sleep stage (1, 2 NREM, slow wave sleep, REM) or Wakefulness–HYPNOGRAM –sleep architecture
  - Breathing
  - ECG
  - O2 saturation
  - Leg movements
- **DAYTIME STUDIES**:MSLT- Multiple Sleep Latency Test

  MWT- Maintenance Wakefulness Test
  - EEG
  - EMG
  - EOG

  Sleep stage (1, 2 NREM, slow wave sleep, REM) or Wakefulness–HYPNOGRAM –sleep architecture

POLYSOMNOGRAPHY

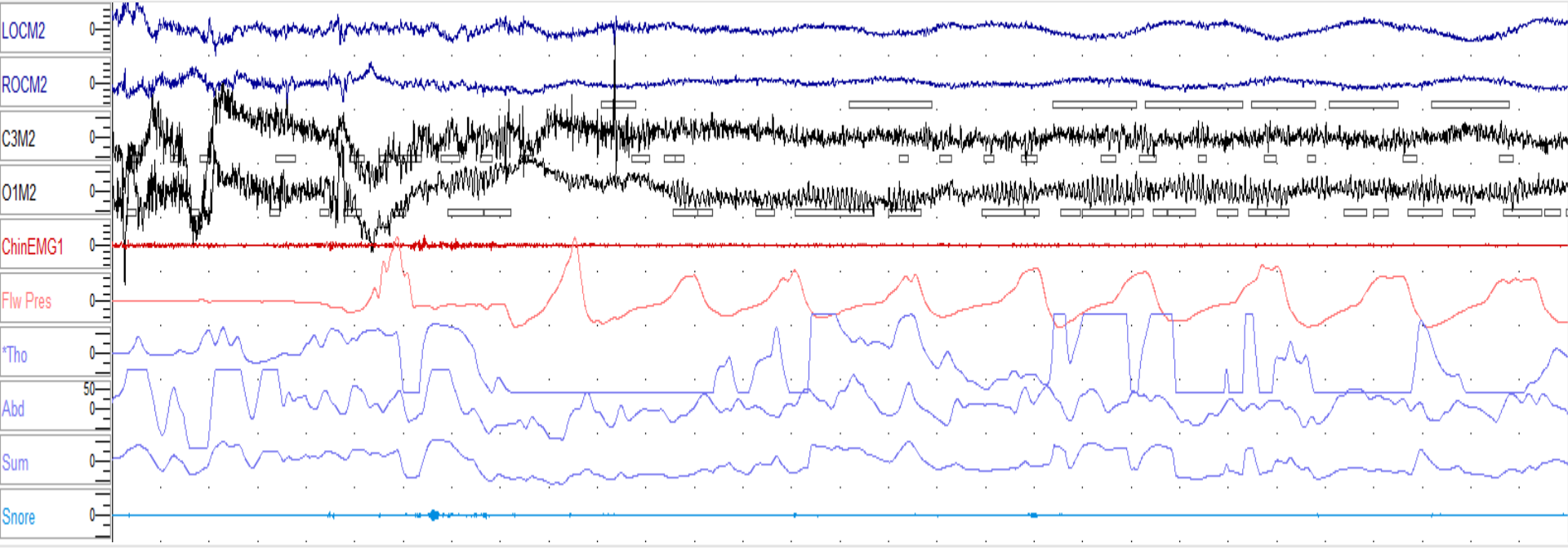
Sleep ? Wakefulness



SLEEP STAGE SCORING

Stage WAKE

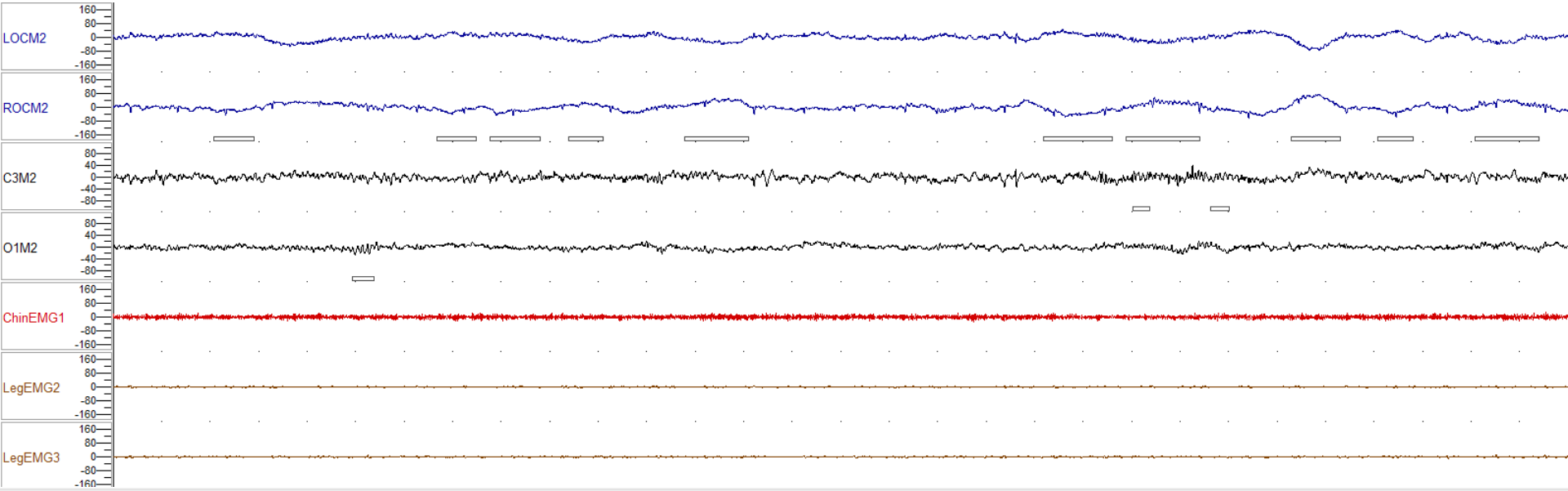
- The EEG consists of a frequency of 8 – 13 cps (8 – 13 Hz)
- It is predominantly seen in the Occipital Region



SLEEP STAGE SCORING

Stage N1

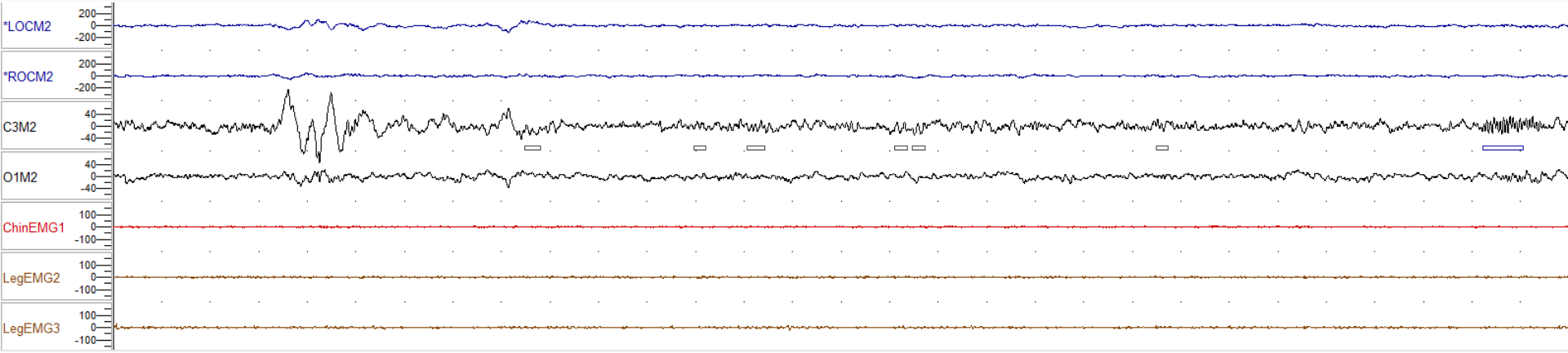
- The EEG consists of theta waves, 4-7 cps (4-7 Hz)
- Low Voltage Mixed Frequency (LVMF)



SLEEP STAGE SCORING

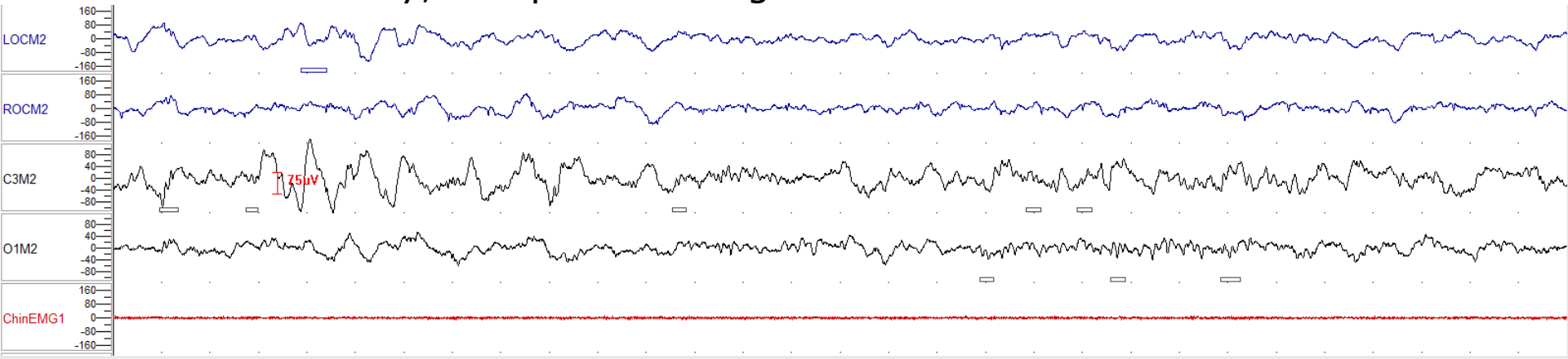
Stage N2

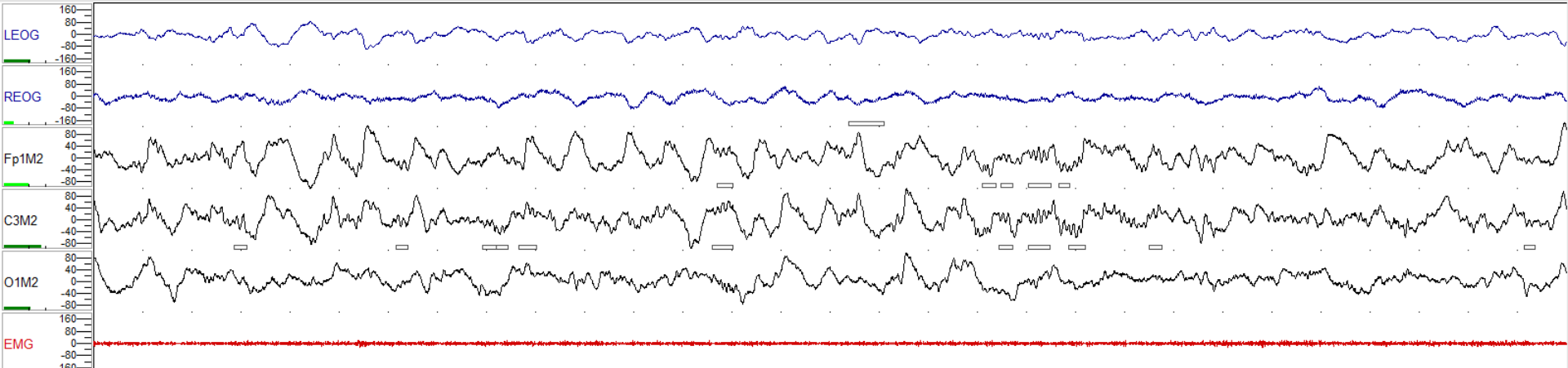
- Makes up 50% of the Total Sleep Time
- The EEG consists of Theta waves interspersed with
- **K-complexes** and/or **Sleep Spindles**
- The EMG has variable amplitude, but usually lower than Wake



SLEEP STAGE SCORING- N3

- **Slow wave activity**: Waves of frequency 0.5Hz-2Hz and peak-to-peak amplitude>75 uV, measured over the frontal regions.
- Score stage N3 when **20% or more of an epoch** consists of slow wave activity, irrespective of age.

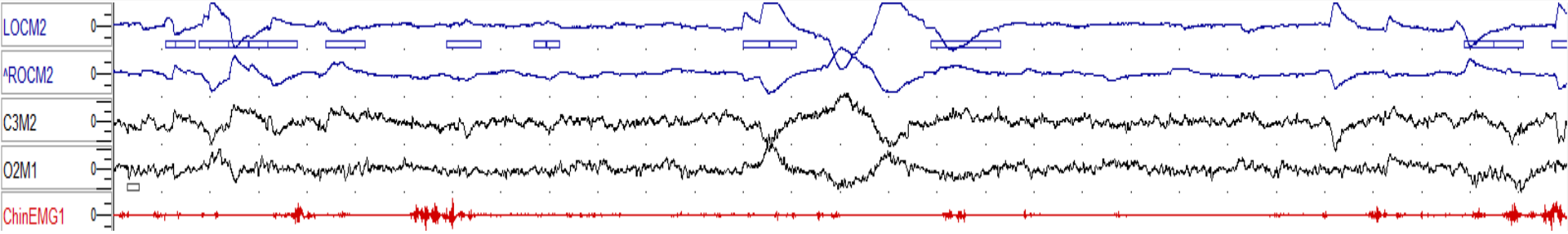




SLEEP STAGE SCORING- R

- **Rapid eye movements** (REM): Conjugate, irregular, sharply peaked eye movements with an initial deflection usually lasting <500 msec.

- **Low chin EMG tone (ATONIA)**: Baseline EMG activity in the chin derivation no higher than in any other sleep stage and usually at the lowest level of the entire recording.



Polysomnography- **NIGHT STUDIES**
Abnormal findings

- **Sleep related breathing disorder**

  /sleep apnea

- **Periodic leg movements**

  /restless leg syndrome

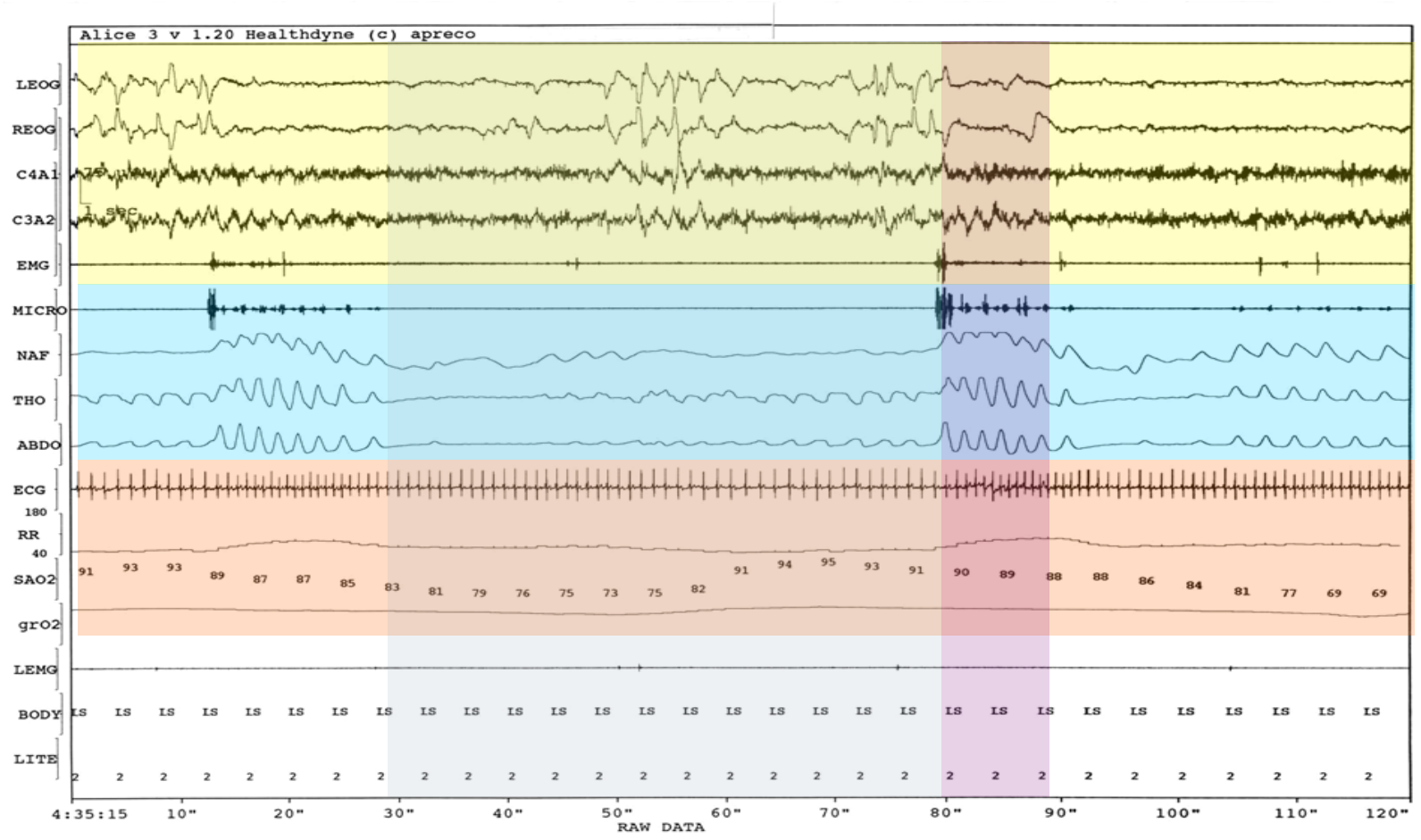
- **Abnormalties of R sleep**
  - **Loss of REM atonia**

    /REM behaviour disorder

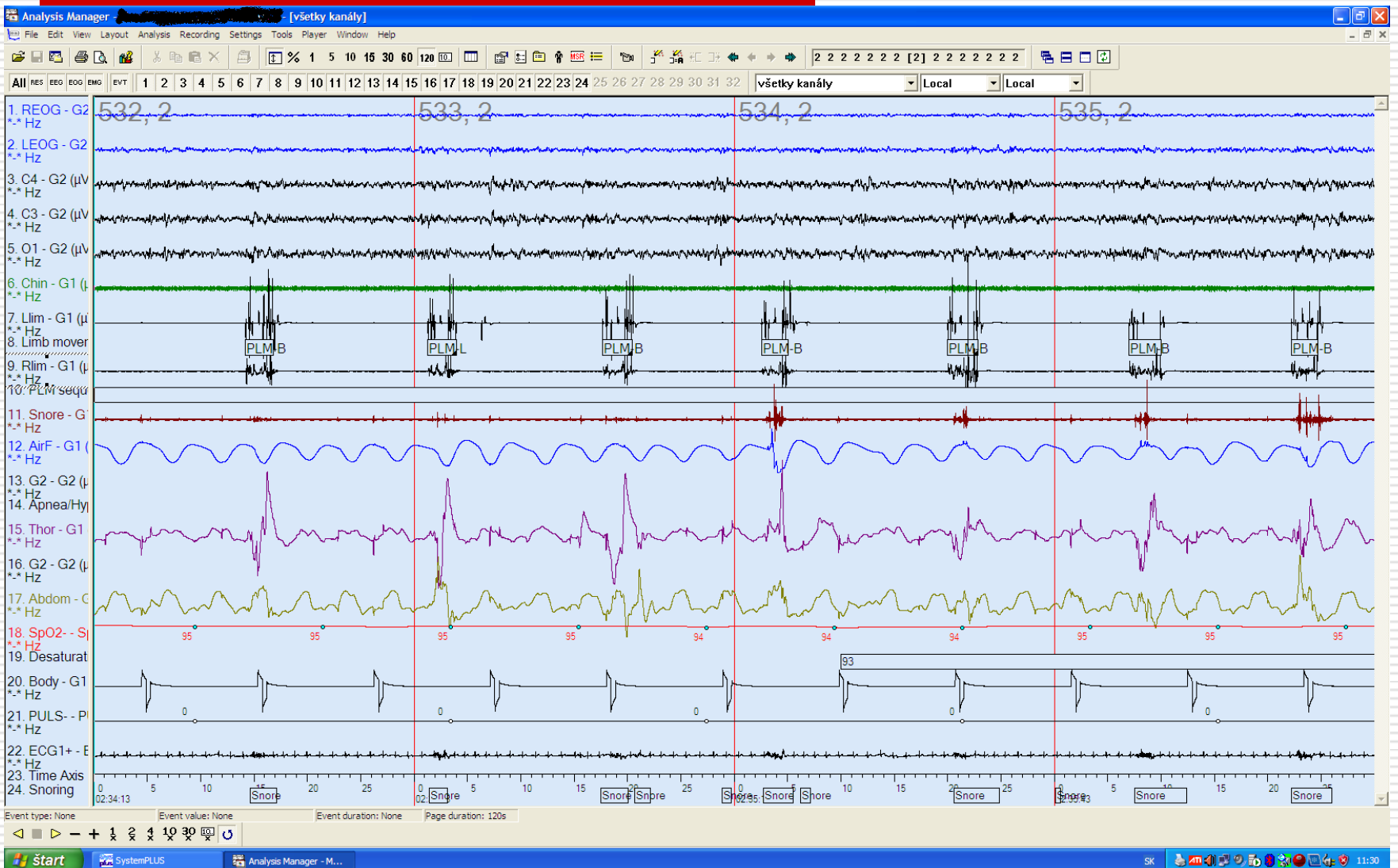
- **Disorders of arousal**

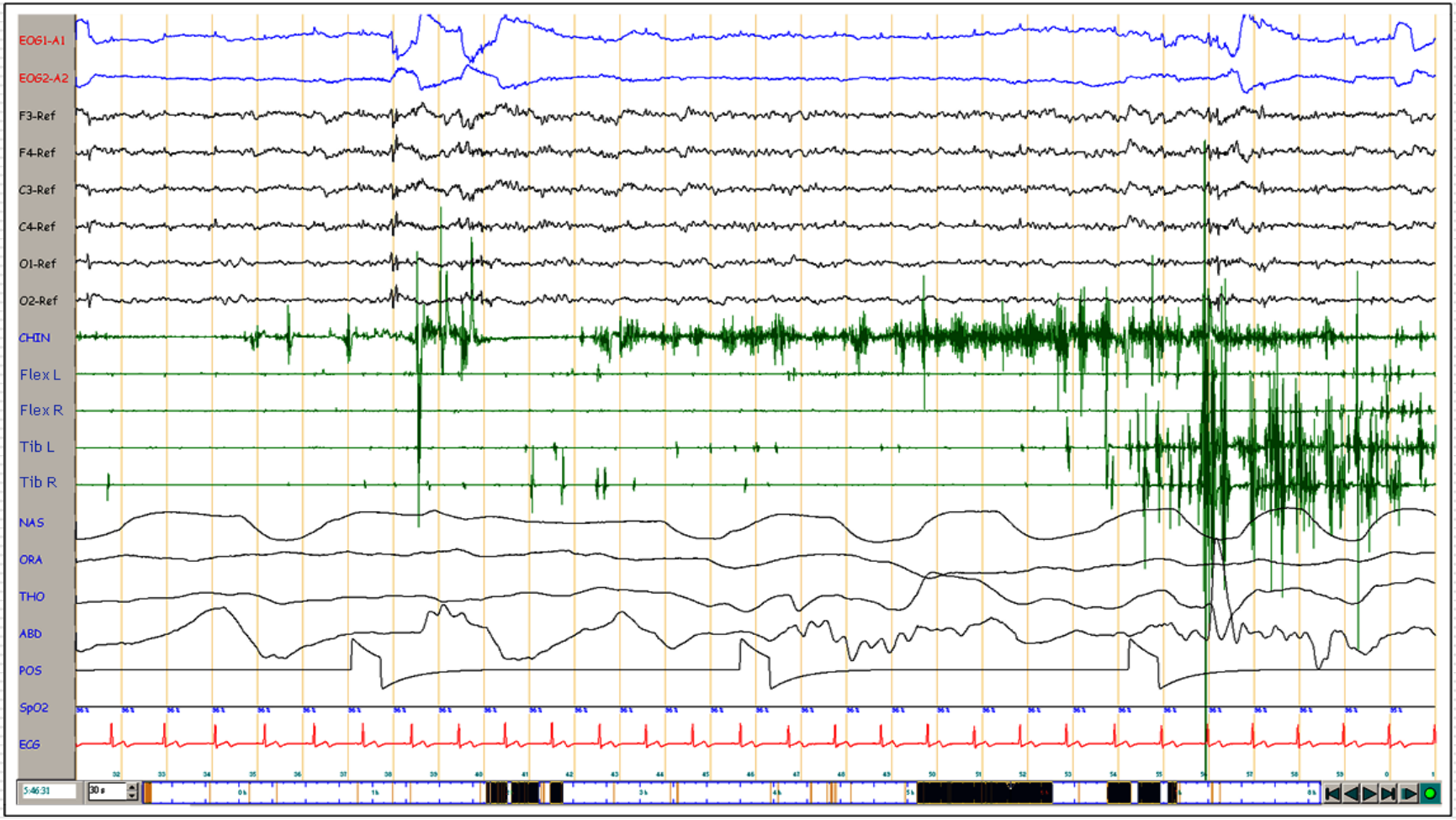
  /NREM parasomnias- somnambulism

Polysomnographic recording - disordered breathing during night



Polysomnographic recording -periodic leg movements

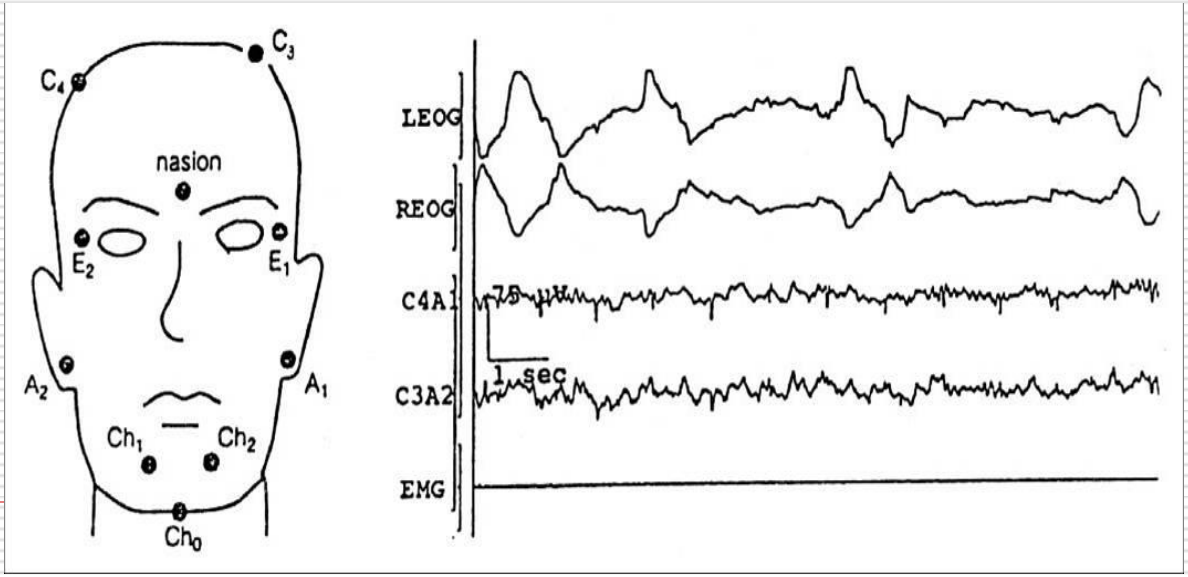




REM sleep without atonia

Multiple sleep latency test (daytime polysomnography)

- Objective diagnostic method used in measuring excessive daytime sleepiness
- Diagnostic tool for narcolepsy diagnose



Multiple sleep latency test

- **NARCOLEPSY**

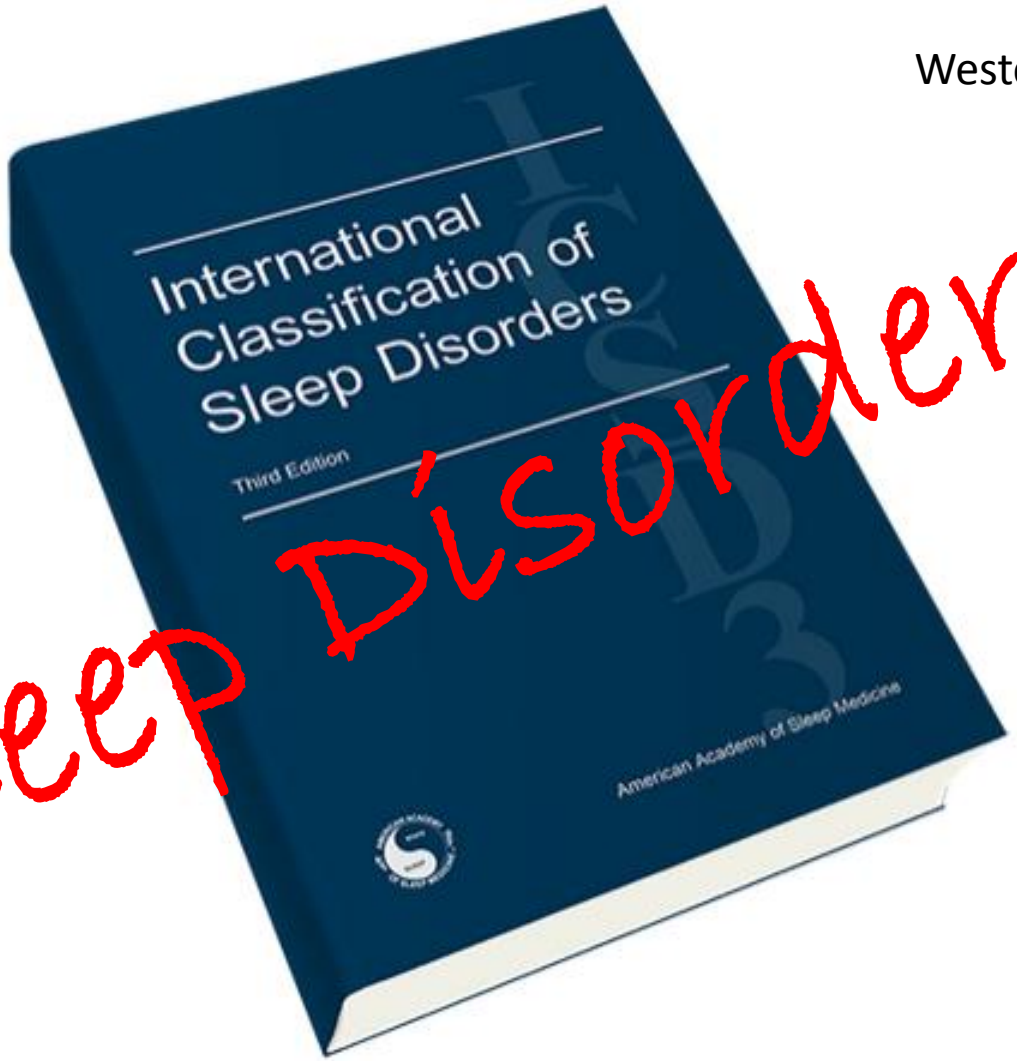
  Sleep latency LESS than 8 min

  2 or more SOREMs (Soon onset of REM sleep)

PSG

Indications	Pathological findings
Excessive daytime sleepiness: NARCOLEPSY	Night sleep: Fragmented, short latency, +/- Sleep Onset REM (SOREM)
	Daytime PSG: MSLT: short sleep latency, SOREMS 2/ or 1 + night sleep SOREM
Interrupted breathing in sleep: Sleep apnea	Apneas/hypopneas in sleep
Abnormal movements in sleep:	
NREM Parasomnias	Awekenings from NREM3
REM parasomnias- RBD	REM sleep without atonia (RSWA)
Rhytmic movement Disorders	Stereotyped movements without sleep stage predisposition
Restless leg syndrome (severe)	Periodic leg movements

Westchester, 2014



Sleep Disorders

International Classification of Sleep Disorders, 2014 (ICSD-3)

1. **INSOMNIA**
2. **SLEEP-RELATED BREATHING DISORDERS**
3. **CENTRAL DISORDERS OF HYPERSOMNOLENCE**
4. **CIRCADIAN RHYTHM SLEEP-WAKE DISORDERS**
5. **PARASOMNIAS**
6. **SLEEP RELATED MOVEMENT DISORDERS**
7. **OTHER SLEEP DISORDER**

- Hypersomnolence= Daytime sleepiness= the inability to stay awake and alert during the major waking episodes of the day, resulting in periods of irrepressible need for sleep or unintended lapses into drowsiness or sleep
  - variable severity
    - Mild: in sedentary, boring, and monotonous situations that require little active participation
    - Moderate: pt. awares of increasing sleepiness before falling asleep
    - Severe: pt. falls asleep with little or no prodromal symptoms (“sleep attacks”)
- Hypersomnia= disorder with hypersomnolence

International Classification of Sleep Disorders, 2014 (ICSD-3)

CENTRAL DISORDERS OF HYPERSOMNOLENCE

1. Narcolepsy Type 1
2. Narcolepsy Type 2
3. Idiopathic Hypersomnia
4. Kleine-Levin Syndrome
5. Hypersomnia Due to a Medical Disorder
6. Hypersomnia Due to a Medication or Substance
7. Hypersomnia Associated with a Psychiatric Disorder
8. Insufficient Sleep Syndrome

Narcolepsy Type 1

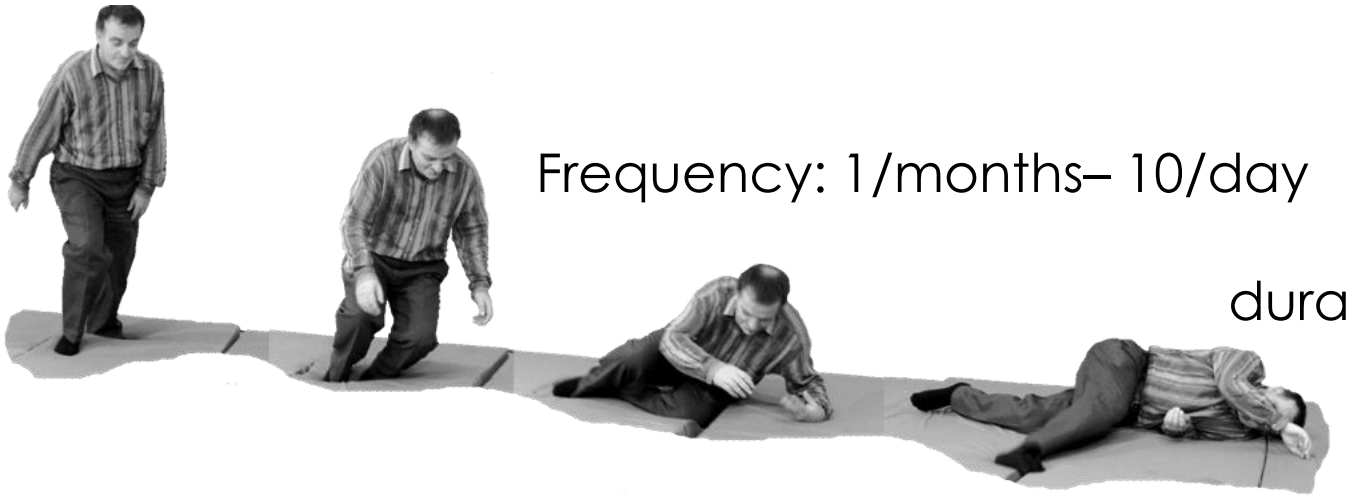
- **Alternate Names:** Hypocretin deficiency syndrome, narcolepsy-cataplexy, narcolepsy with cataplexy
- **Essential features:**
  - **Excessive daytime sleepines with irresistable sleep attacks**
  - **Cataplexy**
- **Associated Features**
  - **Fragmented sleep (Disruption of nocturnal sleep)**, an inability to maintain continuous sleep
  - **Hypnagogic/ Hypnopompic hallucinations**
    - vivid dreamlike experiences occurring at the transition from wake to sleep or at sleep to wake transitions.
    - multimodal or "holistic" character, often combining visual, auditory, and tactile phenomena.
  - **Sleep paralysis**
    - disturbing temporary inability to move voluntary muscles at sleep-wake transitions. Despite being awake and conscious of the sleeping environment, it is impossible for subjects to move their limbs or even open their eyes. The experience may last for several minutes.
  - **Obesity**
  - An increased frequency of several **other sleep abnormalities**
    - sleep talking
    - periodic limb movements of sleep
    - sleep disordered breathing
    - REM sleep behavior disorder

NARCOLEPSY

Cataplexy

A sudden, bilateral loss of muscle tone, with preserved consciousness, triggered by emotions (laughing, anger, excitement)

Rarely: excessive sports, anticipation



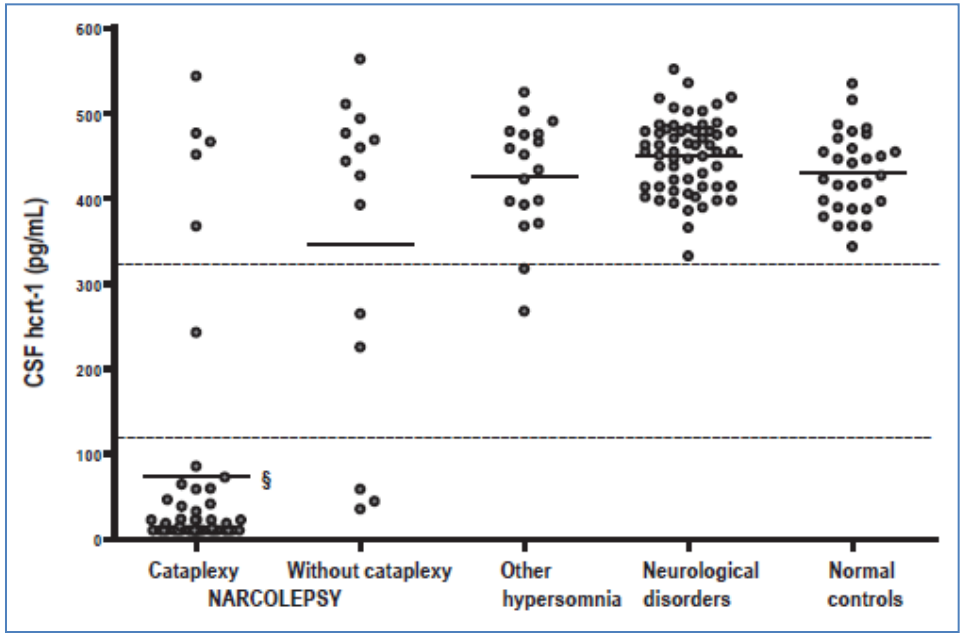
Frequency: 1/months– 10/day

duration: 1-2 min

Narcolepsy Type 1

- HLA class II typing: DQB1*0602

- CSF-hcrt-1 is a valid method when using reference samples from referal centers (<30% of mean value)
- It is recommended in unclear cataplexy or PSGs, and in patients not being able to tolerate PSG



Narcolepsy Type 1

- hypocretin deficiency syndrome- **selective loss** of hypothalamic hypocretin producing neurons

- strong HLA association in narcolepsy
- Association with gen polymorphism for
  - T-cell receptor alfa (TCR)
  - Purinergic receptor P2RY11
- autoantibodies against
  - Tribbles homolog 2 (TRIB2)
  - ASLO

Vaccination against H1N1

autoimmune process

Narcolepsy Type 1

Diagnostics

- ✓ Medical history
- ✓ HLA
- ✓ PSG, MSLT
- ✓ CSF –hcrt-1 in unclear cases of cataplexy, pts. not able to tolerate PSG

- histamine

Narcolepsy Type 1

Treatment

- Causal: 0
- Symptomatic
  - Excessive daytime sleepiness
    - Stimulants: Amfetamín, Metamfetamín, Dexamfetamín, Metylfenidát, **Modafinil**
  - Cataplexy
    - Tricyclic antidepressants
    - SSRI, NSRI
  - Excessive daytime sleepiness + Cataplexy
    - **GAMMA-HYDROXY BUTYRÁT** ® XYREM

5. Parasomnias

- **NREM parasomnias**
  - Confusional Arousals
  - Somnambulism
  - Sleep Terror
- **REM parasomnias**
  - REM Behavior Disorder
  - Nightmare Disorder
- **Other Parasomnias**
  - Sleep Enuresis
  - Exploding Head syndrome

10% children
Familial distribution
Risk of injury
Amnesia in the morning

Adults
Injuries
„idiopathic“ binded with synucleopathies (PD, MSA, LBD)

REM Behavior Disorder

PSG: Loss of REM atonia

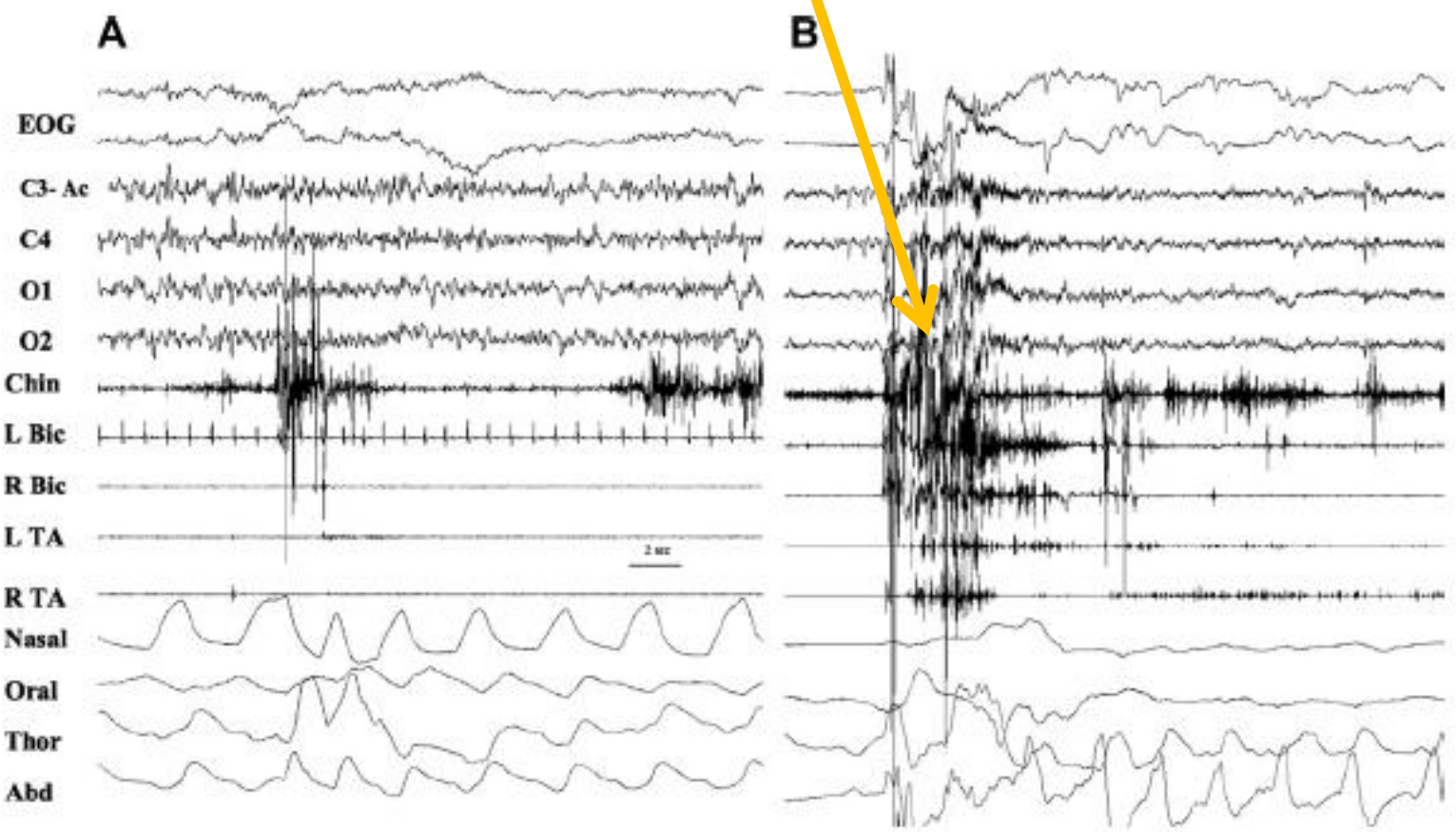


Fig. 2. A) Excessive phasic electromyographic activity and intermittent increased tonic electromyographic activity in the chin with normal atonia in the limbs during REM sleep in a patient with RBD. B) Abnormal phasic electromyographic burst of all the muscles recorded associated with a sudden body jerk during REM sleep in a patient with RBD. (Abbreviations as in Fig. 1).

Treatment: Clonazepam

6. **SLEEP RELATED MOVEMENT DISORDERS**

Diagnostic criteria for

Restless Legs Syndrome (RLS)

Essential features

1) An urge to move the legs
2) that is present at rest
3) relieved by movement, and
4) demonstrates a circadian pattern with peak symptoms occurring at night or in the evening

Allen et al Sleep Med 2003

6. **SLEEP RELATED MOVEMENT DISORDERS**

Diagnostic criteria for

Restless Legs Syndrome (RLS)

Non essential but common features

Etiopathogenesis:

- **CNS dysfunction**
- **Iron system abnormalities**
- **Genetic factors**
- **Dopamine system abnormalities**

The role of iron in RLS

R. Allen and C. Earley

Mov Disord, 2009

There are 3 major secondary causes of RLS:

- *Iron deficiency*
- *End-stage renal disease*
- *Pregnancy*

In each of these conditions there is a higher than expected prevalence of RLS, that commonly resolves when the condition is corrected

They all compromise **iron sufficiency**

Dopamine and RLS

- The rapid and dramatic improvement of RLS with dopaminergic treatment is the strongest argument in favour of dopaminergic system involvement in the pathogenesis of RLS

Merlino G et al, Neuropsychobiology 54: 195-200, 2006

Manconi M et al, Sleep Med 8: 491-7, 2007

RLS- treatment

- Primary RLS
  - Dopaminergic stimulation
    - Levodopa/carbidopa
    - Pramipexol, Ropinirol, Rotigotin
  - Gabapentin, Pregabalin
- Secondary cases
  - Fe supplementation
  - Treatment of underling condition