POLYSOMNOGRAPHY:
RECORDING TECHNIQUE AND SLEEP SCORING
AIM – To record and monitor normal and abnormal physiological activity during sleep
OBJECTIVES – The various objectives of sleep study are

- To record electroencephalogram
- To record electromyogram
- To record electro-oculogram
- To record peak airflow
- To record respiratory efforts
- To record snoring
- To record oxygen saturation with pulse oximetry
- To record limb movements
- To record ECG
- To do video recording of the whole study
- To record pCO2 levels
APPARATUS REQUIRED –

ROOM – A room having sense of comfort and spaciousness, designed with concern for the safety and comfort of obese patients, with attached bathroom

POLYSOMNOGRAPHIC RECORDING SYSTEM

- Computer.
- Video camera
- Amplifier.
- Electrodes and application material.
- Pulse oximeter.
- Abdominal and thoracic belts.
- Nasal and oral thermistors / Nasal pressure transducer.
- Continuous positive airway pressure (CPAP) machine.
- Emergency bell by patients bed side
- Trained technician
- Urine pot by patients bed side
- Access to emergency medical care
METHOD –

The patient is given the following instructions to follow before coming for sleep study-

- To take bath in the evening
- To make his shave properly
- Not to apply any kind of oil anywhere on the body
- To take his / her dinner at least 1 hr before coming for sleep study
- To take his medication if he is taking any in the normal way
- Not to consume alcohol on the day of sleep study
- Not to take coffee or tea at least 3 hrs before the sleep study
- To wear the same clothes in which he / she routinely goes to sleep
- To be accompanied by one attendant
- To remove all ornaments
- To bring all previous medical reports
- The patient is called for sleep study on the stipulated day at around 8:45 pm
After making him comfortable, the surfaces for electrode application are cleaned thoroughly first with spirit swabs and then with special cleansing gel.

**Method for recording EEG**

EEG is the core measurement of polysomnography.

Four stages of NREM are distinguished from one another principally along this dimension.

For recording EEG, accurate measurement of skull according to 10-20 international system of electrode placement is done.
Measurements are made from inion to nasion, from left to right, and around the circumference of the head. Thus measurements are specific to each individual.

After measurements are made, the scalp is cleaned, hair removed with scissors at required points and scalp leads for overnight polysomnography are fixed using gauze soaked in collodion and dried with dryer.

The ground electrode is placed on the patient’s forehead. A minimum of 4 channels is needed to study sleep architecture (1 EEG, 2 EOG and 1 EMG), but usually more channels (12-16) are used in the routine PSG. High quality amplifiers and filters are used to enhance signals of interest and minimize artifacts.
Method for recording EOG

EOG is recorded to record the cardinal sign of REM sleep – phasic bursts of rapid eye movements. Sleep onset is also heralded by slow rolling eye movements. These recordings are based on the small electropotential difference from the front to the back of the eye. Standard EOG placements include right outer canthus and left outer canthus.

EOG electrodes should be offset from horizontal, one slightly above and one slightly below the horizontal plane. EOG electrodes are applied with tape and collodion technique is discouraged because of the risk of splashing collodion into the eyes. The standard manual recommends continuous referential recording of two EOG leads, one outer canthus placement referred to the auricular reference on opposite side and the other to the same auricular reference eg- ROC/A1, LOC/A1.
Method for recording EMG

In standard polysomnography recording, EMG from muscles beneath the chin is used as a criterion for staging REM sleep.

EMG from other muscle groups are recorded to assess certain sleep disorders. For instance anterior tibialis EMG is important to evaluate patients with periodic limb movement disorder.

To record EMG, electrodes are pasted over the muscle concerned. In order to monitor bruxism, one EMG electrode is offset to location over the masseter muscle.
Respiratory effort is measured using thoracic and abdominal belts for chest and abdominal wall movements.

Airflow is measured usually with nasal thermistors or nasal pressure transducers.

Pulse oximetry, capnography and ECG give additional useful information in evaluating apneas.

The presence of oxygen desaturation, hypercarbia or arrhythmias helps to assess severity of disease.
The sleep study can be done in the following ways –

- **Diagnostic** – study to determine identifiable problems with sleep
- **CPAP titration** – if sleep apnea is diagnosed, a follow up study to adjust CPAP levels
- **Split night** – combines a diagnostic study and a CPAP titration. Patient is diagnosed in the first half of the night; CPAP is applied in the 2nd half if required by protocol
- **MSLT** – multiple sleep latency test
- **MWT** - maintenance of wakefulness test

A minimum of 6-8 hrs of normal and abnormal physiological activity during sleep is recorded. After waking up the patient in the morning, all leads are removed and surfaces cleaned with spirit swabs and the patient is sent home.
The various abnormal events occurring in sleep are labeled following the standard sleep scoring definitions-

- **Arousal**

  An abrupt EEG frequency shift (a or q frequency or > 16 Hz, not including spindle frequency) > 3s long preceded by > 10s of sleep

  Arousals in REM sleep are scored only when the chin EMG amplitude also increases concurrently

  Arousals may or may not be associated with body movements or respiratory events

- **Apnoea**

  Absence of or > 90% decrease in airflow compared to baseline lasting > 10s, classified as central, obstructive or mixed
Hypopnoea

Any of the following respiratory events lasting >10s are scored:
- 50% reduction of airflow
- > 30% reduction of airflow (but <50%) associated with > 4% oxygen desaturation

Movement time

Scored only during sleep when > 50% of an epoch is obscured by movement artifact

Limb movements

Periodic limb movements (jerks) are scored in sleep only when there are > 4 limb movements in sequence occurring > 5s but < 90s apart
A limb movement is an increase in the EMG activity lasting 0.5 to 5s with an amplitude > 25% of the burst of EMG activity recorded during biocallibration.

**SIGNIFICANCE OF POLYSOMNOGRAPHY**

It helps to identify various sleep related disorders and provides appropriate therapeutic intervention to improve the patients quality of life.
<table>
<thead>
<tr>
<th>STAGE</th>
<th>EEG</th>
<th>EOG</th>
<th>EMG</th>
</tr>
</thead>
<tbody>
<tr>
<td>RELAXED WAKEFULNESS</td>
<td>Eyes closed: rhythmic alpha; prominent in occipital region;</td>
<td>Voluntary control; REM or none; blinks; SEM</td>
<td>Tonic activity relatively high, Voluntary</td>
</tr>
<tr>
<td></td>
<td>attenuates with attention. Eyes open: relatively low voltage, mixed</td>
<td>when drowsy</td>
<td>movement</td>
</tr>
<tr>
<td></td>
<td>frequency.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NREM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 1</td>
<td>Relatively low voltage, mixed frequency. may be theta activity with</td>
<td>SEM</td>
<td>Tonic activity, may be slightly decreased from</td>
</tr>
<tr>
<td></td>
<td>greater amplitude, vertex sharp waves, synchronous high voltage</td>
<td></td>
<td>waking state.</td>
</tr>
<tr>
<td></td>
<td>theta bursts in children.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 2</td>
<td>Background: relatively low voltage, mixed frequency. Sleep</td>
<td>Occasionally SEM near sleep onset.</td>
<td>Tonic activity, low level.</td>
</tr>
<tr>
<td></td>
<td>spindles: waxing, waning, 12-14 cps. K complex: negative sharp wave</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>followed immediately by slower positive component; spindles may</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>ride on ks; ks maximal in vertex.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 3</td>
<td>&gt;20%&lt;50% epoch occupied by delta waves, high amplitude, slow</td>
<td>None, picks up EEG</td>
<td>Tonic activity, low level</td>
</tr>
<tr>
<td></td>
<td>frequency; maximal in frontal area.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Stage 4</td>
<td>&gt;50% epoch occupied by delta waves, high amplitude, slow frequency</td>
<td>None, picks up EEG</td>
<td>tonic activity low level</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>REM</td>
<td>Relatively low voltage, mixed frequency Sawtooth waves Theta activity; slow alpha</td>
<td>Phasic REMs</td>
<td>Tonicity suppression; phasic twitches</td>
</tr>
<tr>
<td>----------------------</td>
<td>----------------------------------------------------------------------------------</td>
<td>-------------</td>
<td>--------------------------------------</td>
</tr>
<tr>
<td>Movement time</td>
<td>obscured</td>
<td>obscured</td>
<td>Very high activity</td>
</tr>
<tr>
<td>Anomalous sleep</td>
<td>Similar to REM</td>
<td>Phasic REMs</td>
<td>Tonic activity; phasic twitches</td>
</tr>
</tbody>
</table>
1. Current Epoch
2. Time Axis
3. Apnea/Hypopnea
4. PFlow (mV)
5. Chest (μV)
6. ABDM (μV)
7. Arousals
8. EKG (μV)
9. Heart Rate (bpm)
10. Snoring
11. Snore (μV)
12. Desaturation
13. SpO2 (%)
All the best..