Polysomnograph for cardiorespiratory sleep disorders analysis

Psychophysiological telemetric system "Rehacor-T" with "Encephalan-PSG" software for somnological studies

Complies with Type III devices according to AASM classification:
a device for autonomous study with registration at least 4 parameters

AASM — American Academy of Sleep Medicine.

- Airflow
- Respiratory effort
- ECG (or heart rate)
- Oxygen saturation (SpO₂), etc.
Polysomnograph based on the psychophysiological telemetric system "Rehacor-T" provides multichannel registration of various physiological parameters and signals (from 8 to 19 in required combinations) with wireless modules, units and sensors.

**Basic set of polysomnograph** (Basic variant) includes autonomous patient transceiver-recorder ABP-4 (the main amplifier of polysomnograph) and wireless pulse oximeter module.

**Complies with Type III devices according to AASM and CSM classification** – a device for autonomous (unattended) study with registration at least 4 parameters – the airflow, respiratory effort, heart rate or ECG, oxygen saturation in blood.

**Patient transceiver-recorder ABP-4**
Records parameters via 4 channels and provides data reception and synchronization with other wireless modules.

**Modes:**
- autonomous (unattended) – data record onto the memory card
- telemetric (attended) – data transmission into computer via wireless Bluetooth channel.

**Recorded parameters via 4 channels**
- pressure airflow
- integrated sensor
- oxygen saturation in blood (SpO2),
- data on movements and body position (integrated accelerometer movement activity sensor).

**Optional wireless modules** increase number of recorded parameters

**Wireless respiration module**
Records respiratory parameters via 4 channels

**Universal wireless module Poly-4**
Records polygraphic parameters via 4 channels for advanced cardiorespiratory monitoring and analysis of limbs movement.

Three main variants of polysomnograph:
- **Basic** – cardiorespiratory monitoring.
- **Optimal** – advanced cardiorespiratory monitoring (3 ECG channels) connected to respiratory disorders.
- **Professional** – advanced cardiorespiratory monitoring, registration of limb movements in sleep (restless legs syndrome).

**Compliance of sensors, wireless modules and recorded data**

<table>
<thead>
<tr>
<th>Sensors and electrodes</th>
<th>ABP-4</th>
<th>WPM</th>
<th>POLY-4</th>
<th>WRM</th>
<th>Signals and parameters</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulse oximeter sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oxygen saturation</td>
</tr>
<tr>
<td><em>is connected to wireless pulse oximeter module</em></td>
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<td></td>
<td></td>
<td>Photoplethysmogram</td>
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<tr>
<td>Pressure airflow sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pulse rate</td>
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<tr>
<td><em>(integrated into wireless pulse oximeter module)</em></td>
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<td></td>
<td></td>
<td>Perfusion index</td>
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<tr>
<td>Accelerometer movement activity sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Pressure airflow</td>
</tr>
<tr>
<td><em>(integrated into wireless pulse oximeter module)</em></td>
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<td></td>
<td></td>
<td>Snore <em>(via cannula of P-flow sensor)</em></td>
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<tr>
<td>Respiratory effort sensor</td>
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<td></td>
<td></td>
<td>Airflow</td>
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<tr>
<td><em>(thoracic and abdominal)</em></td>
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<td></td>
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<td></td>
<td>CPAP Pressure</td>
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<tr>
<td>Thermistor airflow sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Movements</td>
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<tr>
<td>Snore sensor</td>
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<td></td>
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<td></td>
<td>Body position</td>
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<tr>
<td>Electrocardiographic sensor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Respiratory effort thoracic</td>
</tr>
<tr>
<td>Wired limbs movement sensors <em>(2 pcs.)</em></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Respiratory effort abdominal</td>
</tr>
<tr>
<td>Electromyographic sensors <em>(2 pcs.)</em></td>
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<td></td>
<td></td>
<td></td>
<td>Temperature airflow</td>
</tr>
<tr>
<td>PG-ECG connector</td>
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<td></td>
<td></td>
<td></td>
<td>Snore</td>
</tr>
<tr>
<td>DC-inputs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electrocardiogram <em>(1 derivation)</em></td>
</tr>
<tr>
<td><strong>Sensors and electrodes</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Motility <em>(2 channels)</em></td>
</tr>
</tbody>
</table>

**Signals and parameters**
- Oxygen saturation
- Photoplethysmogram
- Pulse rate
- Perfusion index
- Pressure airflow
- Snore *(via cannula of P-flow sensor)*
- Temperature airflow
- Snore
- Electrocardiogram *(1 derivation)*
- Motility *(2 channels)*
- Electromyogram *(2 channels)*
- Electrocardiogram *(3 derivations)*
- Impedance pneumogramm
- Data and synchronization signals from other devices
"Encephalan-PSG" software, "basic" suite provides monitoring, recording and analysis of data obtained during PSG study

Main Signal window with signal graphs and automatically searched sleep events marked with colored rectangles.

Trends window containing Movement Data graph, Sleep Events panel and Parameters Trends panel.

Sleep Events panel displays searched events in a compressed form in unified time scale with trends, which allows quickly compare the dynamics of parameters on trends with sleep events to clarify the diagnosis.

Body movements
Desaturation
Critical SpO2
Apnea
Hypoapnea
Central apnea
Obstructive apnea
Mixed apnea
Cheyne-Stokes respiration
Airway obstruction
Limb movements
Periodic limb movements
Tachycardia
Bradycardia
Extrasystole
Autonomous arousal

Trend is a compressed representation of initial data and various calculated parameters – SpO2, pulse rate, conventional respiration amplitude, snoring amplitude, etc. Compression ratio (scale of the time axis) can be changed.

Trends provide quick visual evaluation and comparison of dynamics of parameter changes during continuous record.

Access to required fragment of initial signals for detailed analysis is provided by clicking at any trend point.

Telemetric mode of polysomnograph (in a hospital ward or at home with data transmission to a doctor's PC via wireless Bluetooth channel) provides continuous over-night PSG video-monitoring with synchronous record of physiological indices in order to compare the clinical manifestations of sleep disorders and identify the connection of respiratory disorders with body position and limb movements.

To be viewed on any computer, study results can be recorded onto external memory devices (DVD, USB drive) in the form of a data set with a special viewer "Encephalan-EEG-Viewer" or as a simple video clip in *.avi format.

Connecting CPAP machines

When connecting an airflow sensor and CPAP-machine via T-adapter to the wireless pulseoximeter module, the polysomnogram records the pressure from the CPAP-machine simultaneously with PSG data for effective selection of CPAP therapy mode.
Reports on PSG-studies

Reports are generated in accordance with detected sleep events. Sleep statistical parameters in these reports are grouped into the following reporting forms:

- **Sleep structure**
- **Respiratory disorders**
- **Cardiogram**
  - Scoring Data
  - Apnea statistics
  - SpO2 statistics
  - Limb movements
  - Periodic limb movements statistics

The report includes the following screen form:

- **Diagrams** – trends of calculated parameters.
- **Sleep events** – list of events and their markers on the time scales.

### Preparing and printing reports on PSG-studies:

- Automatic generation of statistical reports.
- General conclusion is formed by a specialist and contains automatically obtained data that can be corrected and supplemented.
- Preparing data for printing using Print Manager.

### Conclusion

Obstructive sleep apnea syndrome was severe, AHI = 88.5/hr (n=5). Total number of respiratory events: 360, of which obstructive apnea: 345, mixed apnea: 0, central apnea: 0, hypopnea: 40. Maximum duration of obstructive apnea: 125 s. Minimum SpO2 level: 50% (n=50%). Mean SpO2 was low: 88% (n=50%). Sleep onset latency was increased: 18 min (n=6-10 min). Sleep efficiency is normal: 85.2% (n=50%), Stage N1 duration increased: 17.0% (n=3-8%), Stage N2 duration is normal: 47.1% (n=40-50%), Stage duration is normal N3: 19.1% (n=15-20%). Stage REM duration reduced: 16.8% (n=20-25%). Most arousals were related to respiratory events.

### Sleep Scoring Data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Study date</td>
<td>August 12, 2016</td>
</tr>
<tr>
<td>Lights out</td>
<td>04:47</td>
</tr>
<tr>
<td>Lights on</td>
<td>12:32</td>
</tr>
<tr>
<td>Total recording time (TRT)</td>
<td>07:40</td>
</tr>
<tr>
<td>Total sleep time (TSI)</td>
<td>07:10</td>
</tr>
<tr>
<td>Sleep onset</td>
<td>09:51</td>
</tr>
<tr>
<td>Sleep latency</td>
<td>14 min</td>
</tr>
<tr>
<td>Stage N1 latency</td>
<td>14 min</td>
</tr>
<tr>
<td>Stage N2 latency</td>
<td>16 min</td>
</tr>
<tr>
<td>Stage N3 latency</td>
<td>25 min</td>
</tr>
<tr>
<td>Stage REM latency</td>
<td>11:19 min</td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>93.9%</td>
</tr>
<tr>
<td>Sleep interruptions</td>
<td>10</td>
</tr>
</tbody>
</table>

### Sleep stages distribution

<table>
<thead>
<tr>
<th>Sleep stage</th>
<th>Duration</th>
<th>% from TRT</th>
<th>% from TSI</th>
<th>Norm (% from TRT)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W</td>
<td>00:21:10</td>
<td>8.84%</td>
<td>16.85%</td>
<td>25-25%</td>
</tr>
<tr>
<td>N1</td>
<td>01:33:20</td>
<td>10.66%</td>
<td>19.95%</td>
<td>3-8%</td>
</tr>
<tr>
<td>N2</td>
<td>01:34:30</td>
<td>43.66%</td>
<td>47.0%</td>
<td>48-50%</td>
</tr>
<tr>
<td>N3</td>
<td>01:22:50</td>
<td>17.18%</td>
<td>19.12%</td>
<td>15-25%</td>
</tr>
</tbody>
</table>

### SpO2 distribution

**Desaturation events duration/size**

**Distribution of desaturation duration**

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To get correct specification for the equipment and additional ads, contact the manufacturer or its authorized representative.