Pediatric Sleep Studies with Rembrandt

This document describes the pediatric modules available for pediatric sleep studies using the Rembrandt sleep software

System Key Features

- Pediatric specific sensors with Medcare amplifiers
- Wide range of Medcare amplifiers from simple polygraphy to comprehensive polysomnography – from at home, in crib or in special sleep rooms
- Extensive and easy to use user-interface so the demanding task of pediatric review can be simplified
- Detailed behavior analysis by fully synchronized digital video
- Combination of adult and pediatric staging in one system so that effects of development can be easily taken into account
- Comprehensive analysis and reporting to enable quantification and diagnosis based on complex physiology, including:

Manual pediatric sleep staging

Automatic sleep staging for children from 6 months onward

Phase analysis and ongoing Phase plot

Respiratory Analysis with XactTrace

Sigh analysis

pH analysis

Periodic breathing

CO_2 analysis

End tidal CO_2

Transcutaneous CO_2

Blood pressure analysis

Advanced reporting

Flexible display of overview and trends

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Pediatric Patient Info

Specific patient information like birth weight, scull circumference, first day of last period of the mother and gestational age at recording (in weeks) can be registered and reported to track developmental aspects.

Pediatric Sleep Staging

In contrast to adult polysomnography, where sleep is classified into 7 stages (wake, stages 1-4, REM, MT), pediatric sleep staging uses the following stages and movement time:

- Wake
- Active sleep
- Quiet sleep
- Intermediate sleep

The pediatric hypnogram is adapted to these stages and can be printed as a trend or in reports.

Other sleep parameters like apnea, arousal etc. can be reported and summarized for pediatric sleep.

Automatic Sleep Stage Scoring from 6 months

For children 6 months and older, adult sleep staging can be used, but with a different ‘weighing factor’ for amplitude and frequency parameters of the EEG.

Paradoxical Breathing

For evaluation and analysis of paradoxical breathing, Rembrandt offers phase analysis between thoracic and abdominal effort.

In the classical sense, frank paradoxical breathing is when the phase relation between two signals is 180°. This can be reported as time spent in paradoxical breathing. In addition to frank paradoxical breathing, it is important to quantify and display the phase angle. Rembrandt offers the following:

- Dynamic phase plot as Lissajous figure
- Breath by breath calculation and display of phase along with signals
- Trends of phase values across the night

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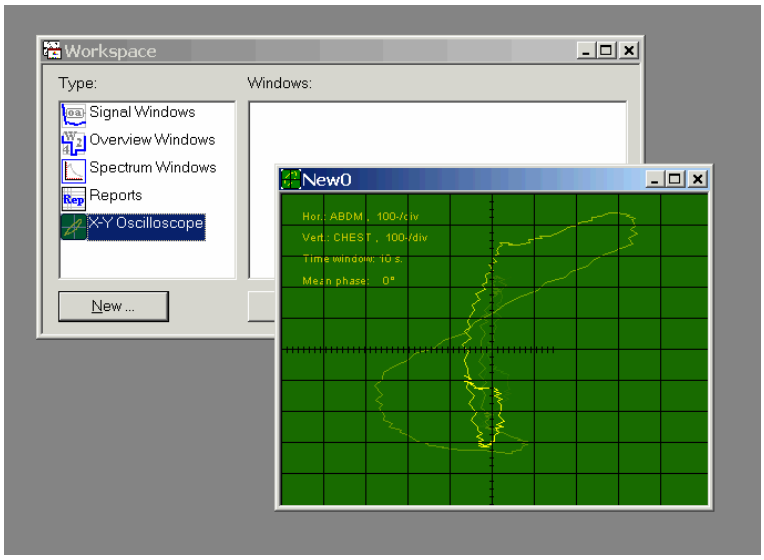
Dynamic Phase Plot

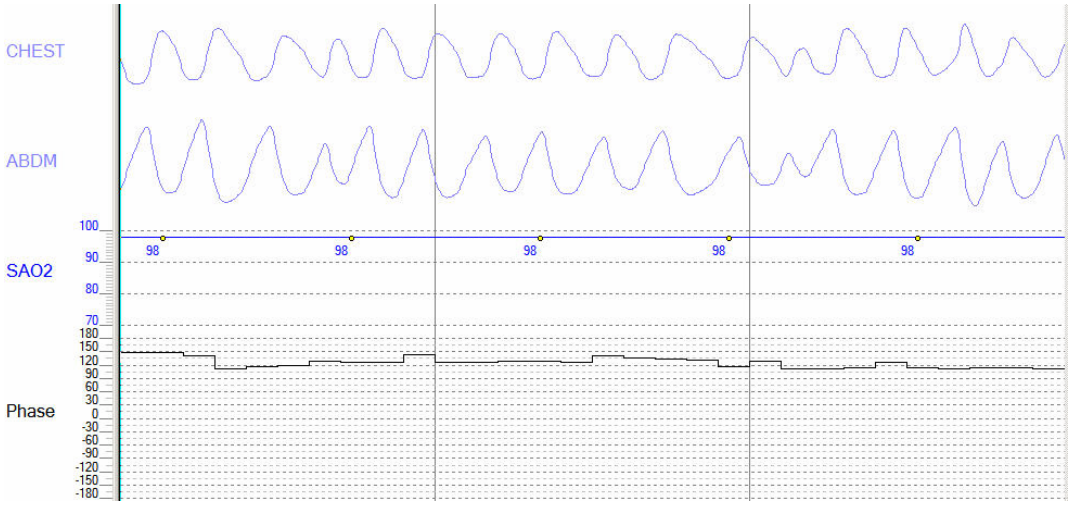
The phase relationship is shown as an X-Y oscilloscope window. Usually the abdomen signal is shown on the X-axis and the thorax signal on the Y-axis. A circle or ellipse-like shape while slanted towards the right indicates normal breathing, whereas a slant towards the left indicates paradoxical breathing.

Both 2D and 3D views are possible.



Breath by Breath Phase Calculation

The Lissajous figure is a dynamic graphical plot whereas the phase-per-breath, along with the signal, plots the actual values of the phase.



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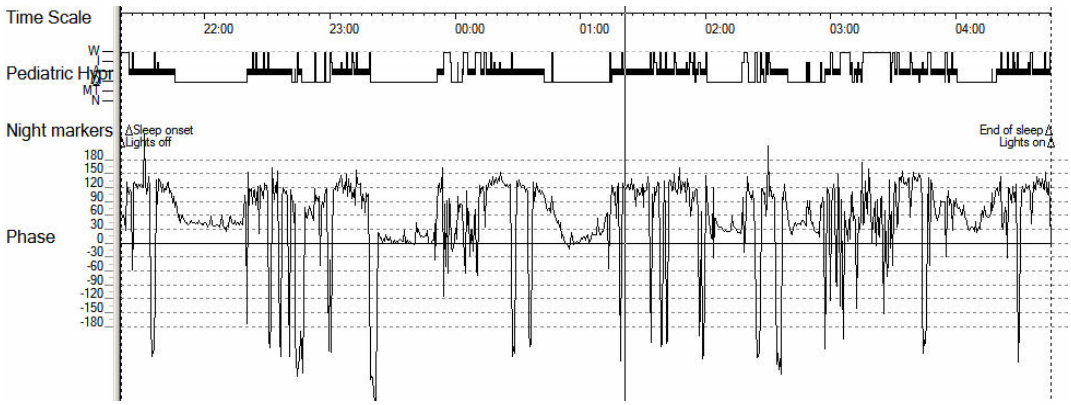
Trends of Phase Values over the Night

An overview of the whole night, together with other parameters like sleep stages, can be plotted as a trend. The phase values can be plotted either as mean or range per epoch.



Respiratory Analysis

The pediatric respiratory parameters are adjustable so that calculations can be adapted to age dependent definitions or specific pathology.

In addition, for a selected respiratory channel, respiratory rate and its variance can be calculated and reported.

In many cases, not all respiratory signals are available. The automatic analysis provides tools to choose the signals.

Sigh Analysis

Pediatric breathing is often accompanied by sighs. These can be quantified and reported separately.

pH Analysis

Rembrandt provides analysis and reporting of gastroesophageal reflux signals from a pH electrode placed in the esophagus.

The thresholds for the detection of reflux events can be set by the user. However, typically an acidotic event is defined if the pH < 4.0, while an alcalotic event is defined if the pH > 7.5. There should be at least 30 seconds between 2 reflux events.

Periodic Breathing

Periodic breathing is characterized by repeating episodes of less than 20 sec. normal breathing, followed by 3 to 10 second central apneas.

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Rembrandt allows these parameters to be adjusted:

- minimum number of events within one episode (typically at least 3)
- central apnea length range (typically 3-10 sec.)
- inter-apnea distance range (typically 5-20 sec.)

Periodic breathing episodes can be scored and reported separately.

Analysis of CO_2

Rembrandt offers the analysis and reporting of CO_2 either by analyzing expiratory airflow ($ETCO_2$) or, transcutaneously in the blood ($TPCO_2$).

From these signals, capnogram, hypercapnia, and distribution of CO_2 per breath can be calculated.

Blood Pressure Analysis

Medcare amplifiers offer the possibility of acquiring signals from other devices like Finapress or Portapress for measuring changes in continuous beat-by-beat measurement of blood pressure.

In addition, Pulse Transit Time (PTT) can be analyzed as an indirect measure of blood pressure changes. The Rembrandt PTT module is described in a separate document which can be downloaded from Medcare's Knowledge Base at www.medcare.com.

Use of Adult Analyses

The following analyses are common to adults and pediatrics. They can be used and reported in combination with the pediatric sleep stages:

- Body Position
- Desaturation
- Heart Rate
- Limb Movement
- Snoring
- User-Definable Events

Flexible Reporting and Customization

The reporting parameters and calculations can not be easily standardized over the whole range of pediatric patients and different pathologies.

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Rembrandt offers extensive flexibility to calculate and report any combination of parameters, even with different calculations, easily in the user-interface without ever writing any macros or software code.

Pediatric Sensors

XactTrace Respiratory Inductive Plethysmograph (RIP)

XactTrace is a lightweight high quality measurement of respiratory movement. The belts can be cut to size to fit any patient, including premature infants and neonates. RIP can detect paradoxical breathing patterns with increased accuracy. You can read more about the XactTrace technology on the Medcare website, www.medcare.com.

Nasal Cannulas

Infant and Pediatric sized nasal cannulas are available for recording nasal pressure

SpO_2

SpO_2 is recorded from the pulse oximeters. Different sizes and types of probes are available to fit any age and size range of patients. External SpO2 monitors can also be interfaced to the Medcare Recording System.

Body Position / Actigraph

Body position and actigraphy is recorded from an integrated sensor in the Patient/Sensor Unit that can be worn on children from ages 4 and up. Additional signals derived from the position signal include activity and rotation.

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