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A telemedicine solution based on a piezoelectric movement sensor for the long-term monitoring of sleep disorder patients

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Sensor with web gateway



Screening of common sleep disorders





A thin piezoelectric sensor (4 by 70 cm) is placed under the mattress



The measured signal consists of respiration and heartbeat waveforms, as well as deflections caused by movements



The sensor's signal, along with temperature, noise level and brightness, are sent to a web application with an Internet gateway

Circadian rthythm sleep disorders

Problems with circadian rthythm can be investigated by measuring the patient for weeks or months. The sleep specialist has a long-term view to the patient's measurements in the web application, where abnormalities can be spotted.



Periodic limb movement syndrome

The movement sensor can measure the patients's limb movements sensitively. The sleep specialist does not need to go through the whole signal manually, as regions of movement are highlighted automatically for closer inspection.



Sleep-related disordered breathing

A preliminary assessment of sleep-related respiratory problems can be done by inspecting the signal. The low-frequency component of the signal is very similar to the abdominal respiration effort signal in PSG. The sleep specialist inspects the signal in around 10-minute segments to detect abnormal breathing patters. Regions with suspected respiratory problems are highlighted, so it is typically not necessary to go throught the whole measurement in detail. The final classification of the disorder typically requires a PSG measurement, with oximetry and measurement of airflow.

Automatic analysis



The signal is automatically analyzed at the web application. Movements, heart rate and respiration rate as well as sleep are analyzed.

Ubobtrusive long-term tracking of sleep



Fast track to sleep disorder diagnosis

The measurement is affordable and can be prescribed in primary care if sleeping problems are suspected. The patient sets up the sensor independently and is measured for a month. After that, the sleep medicine specialist can reach the diagnosis faster, as an overview of the sleeping problem is already provided by the measurement.

Rarely occurring symptoms

Some disorders such as problematic hypersomnias occur only infrequently and in the normal sleeping environment. In those cases, a long-term measurement is set up for the patient. The sleep specialist analyzes the measurements about every week, and the measurement is continued until the symptoms have occurred sufficiently many times.

Follow-up after treatment

The effectiveness of treatment can be conveniently followed up with the system. Ideally, the patient is measured some time before diagnosis and several months after treatment, so it can be confirmed that the treatments are effective and that the symptoms do not recur. This applies to the treatment of various disorders, such as SRDB, insomnia and PLMS.

Cognitive behavioral therapy

The effectiveness of CBT can be enhanced by providing an objective assessment of the patient's sleep, alongside a traditional sleep diary. During therapy, the measurements can be accessed both by the therapeutist and the patient. After the therapy period, measurement should be continued so that the recurrence of the problems can be detected rapidly.

Web app for viewing signals



| | | | | | | ime, it might be o sleep a little N | a lext |
|----------------------|---|----------------|---------------|--------------|--------|---|---|
| 8 | 22:00 | 0:00 | 2:00 | 4:00 | 6:00 | 8:00 | Movement |
| 6 4 2 | | | 1.1 | | | | During sleep, there should be periods (more than 15 minutes) with no or few movements. Occasional movements are a part of normal, healthy sleep. |
| 90 | 22:00 | 0:00 | 2:00 | 4:00 | 6:00 | 8:00 | Heart rate |
| 80 70 60 |) | \checkmark | \sim | W_ | \sim | | During sleep your heart rate gets lower as you are resting. If you have slept long enough, your heart rate starts to climb again before wake-up. |
| 50 | 22:00 | 0:00 | 2:00 | 4:00 | 6:00 | 8:00 | Ambient noise level |
| 80 60 30 30 | | | | i k k | | ut salayanda | Ambient noise can affect your sleep. How disturbing the noise is depends, but usually noise level above 42 dB (quiet talking) can disrupt sleep. |
| 60 | 22:00 | 0:00 | 2:00 | 4:00 | 6:00 | 8:00 | Ambient light |
| | | | | | | | Sleeping can be difficult when there is too much light in the environment. |
| 26 | 22:00 | 0:00 | 2:00 | 4:00 | 6:00 | 8:00 | Room temperature |
| 24 | | | | | | | Ideally, the temperature in bedroom should be quite low. Optimum temperature for sleep is below 20° Celcius. |
| 24.6° C Ave | 4.6° C Average room temperature 40.6 dB Average noise | | | | | el | Show all about environment |
| 11% | Str | ess r | eact | ions | 5 | 5 9 | Heart rate |
| You were sig | gnificantly le | ss stressed th | nan usually ? | | Y | our heart rate w | as higher than usually ? |
| revious da | y: Thursd | ау | | | F | riday | Show/hide diary tips |
| p.m. | Exercised for 30min | | | | 7 | :55 p.m. | ad 2 drinks of alcohol |
| | There's still 30min to this weeks goal, keep going! | | | | g! | | 1 drinks until todays limit 1 1 1 4 before hitting this weeks limit 1 1 1 1 1 1 1 |
| | | | | | | | |

Geriatric care

The system is particularly suitable for measuring the quality of sleep in geriatric care, because no wearable sensors are needed, and because extensive measurement periods are affordable. In addition to quantifying sleeping problems, it can be detected if the patient is in bed or absent from bed at abnormal times, which is common with dementia.

We are looking for new collaborators here at ESRS'12! joonas.paalasmaa@beddit.com +358 505 820 100