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0364

A WIRELESS SYSTEM FOR RECORDING EEG/EMG AND BIOSENSOR MEASUREMENTS FROM GROUP-HOUSED RATS

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Introduction: Existing recording systems use radio-frequency telemetry to wirelessly record electroencephalograph (EEG) and electromyograph (EMG) signals. However, current systems cannot record from multiple animals simultaneously within a group-housed environment, a condition which reduces related stress, nor can they record biosensor measurements with the EEG signal. We have developed two telemetry systems for use with rats. One is designed for long-term, wireless recording of electroencephalograph (EEG) and electromyograph (EMG) signals (EEG/EMG) while the second is capable of recording EEG, EMG and simultaneous biosensor readings (EEG/EMG/BIO). **Methods:** Two rats were implanted with cortical and intramuscular re- cording electrodes and fitted with the EEG/EMG system. Rats were individually housed following surgery (one week) and then group housed for 24 hours. Simultaneous sleep/wake patterns were recorded from both animals. To test the EEG/EMG/BIO system, a single rat was implanted with a biosensor in the prefrontal cortex along with EEG and EMG electrodes. Following recovery, a lactate biosensor was implanted and EEG + lactate concentration was recorded for 24 continuous hours.
Results: In two rats fitted with the EEG/EMG system, the amount of time both animals were simultaneously awake increased by 121 minutes and the amount of time they were both asleep increased by 12.5 minutes compared to sleep amounts when the animals were individually housed. Recording of lactate concentration with sleep/wake state using the rat implanted with the EEG/EMG/BIO system indicated an average increase in lactate concentration of 124±18 μM during waking and an average lactate decrease of 108±8 μM during sleep.
Conclusion: When rats were recorded with the EEG/EMG system under group-housed conditions, their sleep/wake patterns show greater synchronization. Wireless recording of lactate and EEG activity demonstrated the expected lactate rise during waking and decline during sleep. These systems provide a mechanism for wireless recording of simultaneous EEG and biosensor signals from multiple, group-housed animals.
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DEVELOPMENT AND VALIDATION OF A CONTINUOUS EEG-BASED MARKER FOR SLEEP DEPTH

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Introduction: Physiologically-based markers that represent sleep depth on a continuous time scale are needed. Attempts to develop such markers based on EEG amplitude/frequency properties have been unsuccessful. We developed a novel nonlinear method based on quantification of the dynamical pattern (recurrence) in the EEG. This work establishes and validates the new marker's normal phenotype, and shows that it was altered in patients with a sleep disorder.
Methods: Scored PSGs (R&K) from 8 healthy medication-free subjects and 8 subjects with OSA were obtained from the PhysiBank archive. The recurrence marker percent R (%R) was used to quantify the EEG pattern (extent to which it was governed by law rather than chance). %R is lowest during wakefulness (EEG most complex) and highest during N3 sleep. %R was calculated second-by-second and then averaged epoch-by-epoch, resulting in one %R value for each 30-sec epoch. Spectral analysis (a linear method) was used as a control.
Results: In each group, the known R&K sleep structure was directly reflected in the epoch-to-epoch changes of %R; in the normals the changes followed typical cyclic macroarchitectures (3–5 cycles) not usually present in the OSA subjects. In both groups, %R(N2) >%R(N1) and %R(N3)>%R(N2). In both REM and non-REM sleep, %R was significantly lower in OSA subjects ($P<0.05$), indicating that brain electrical activity was more complex (less sleep-like) in the OSA subjects. Significant correlations between spectral markers and R&K structure were not found.
Conclusion: %R computed over 1-sec intervals and averaged over 30- sec epochs exhibited the characteristic R&K macroarchitecture in health and OSA, indicating %R's criterion validity as a continuous marker for normal sleep. %R was decreased in OSA subjects, evidencing its association with sleep quality. %R, which emphasizes the continuous nature of sleep, may be a useful complement to sleep staging, which emphasizes sleep discontinuity.

0366

CORRESPONDENCE BETWEEN ACTIGRAPHY AND PSG MEASURES OF SLEEP ONSET LATENCY IN YOUNG CHILDREN

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Introduction: Actigraphy is a non-invasive tool providing objective measurement of sleep onset, offset, and efficiency for extended periods of time based upon wrist-activity levels. Whether actigraphy may also provide an adequately-valid estimate of sleep-onset latency (SOL) in young children is not well-established. This study examined concordance between the gold standard of SOL, polysomnography (PSG), and actigraphy in a cohort of 2–5 year-olds studied at five different levels of prior wakefulness.
Methods: Participants were 8 healthy children (3 males) studied at three longitudinal time points (2.5-3.0y, 3.5-4.0y, 5.5-6.0y). Children followed a strict sleep schedule for at least 5 days before each of five home-based, PSG recordings in which they also wore an actigraph (AW64). Sleep assessments occurred after 4h, 7h, 10h, 13h, and 16h of prior wakefulness, reflecting different levels of sleep pressure. Visual stage scoring used 30-sec epochs from C3/A2. Lights-out time was simultaneously marked on PSG and actigraphy with event markers. Sleep-onset was the first epoch of stage 2 sleep (PSG) and the first of three consecutive epochs of scored sleep after lights-out (actigraphy).
Results: Analyses included 9–14 sleep assessments per child of SOL (concurrent PSG and ACT). Averaged SOL varied across sleep assess- ments and age (PSG range: 4.9+3.1 to 26.9+13.7; ACT range 4.2+3.1 to 19.3+15.9). We performed a nested correlation between PSG- and actigraphy-derived measures of SOL, covarying sleep pressure and age of assessment, nested within subject. The median partial correlation was $r=.874$ ($p<.001$), with a range of $r=.243$ to $r=.969$. Two children had very-low, non-significant correlations resulting from an outlier in which actigraphy underestimated SOL.
Conclusion: Overall, these findings suggest actigraphy has adequate validity for estimating SOL in young children when using tightly-controlled data collection and analysis procedures. Future analyses should address methods for establishing the minimum number of nights for a reliable estimate of SOL.
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