study. Three were referred due to snoring and suspected sleep apnea syndrome and six were referred from a temporomandibular disorders (TMD) clinic. All were suspected of sleep bruxism based on subjective reports. To record the BiteStrip signal online, the BiteStrip software was programmed to emit a red blink of light for each detected bruxism event. Output was transmitted via an optical interface and displayed as an all-or-none signal on a PSG channel. Bilateral recordings were performed both for masseter EMG and for BiteStrips, in addition to traditional PSG signals. An experienced scorer scored each EMG and each BiteStrip channel blinded to other channels. Bruxism events were scored as such if a phasic and / or tonic increase of EMG tonus exceeded 30% of the maximal voluntary clench (MVC) (determined before subject fell asleep) and lasted >0.25 second. Bilateral comparisons were made between left and right EMG bruxism events and left and right BiteStrip signals. For measures of accuracy of BiteStrip signals against EMG bruxism events, the number of true positives, false positives and false negatives were counted, and sensitivity and positive predictive value (PPV) computed.

Results: Data was obtained from nine subjects (6 males) aged 33.4 (range: 18-65). Means (and standard deviations) of the EMG and BiteStrip scores of sleep lab vs. TMD clinic patients were 38.7 (11.6) and 60.2 (22.7) (sleep lab) and 208.0 (161.1) and 176.0 (115.8) (TMD clinic) respectively. Nonparametric Mann Whitney tests were significant for both EMG and BiteStrip between-group differences ($p<0.01$). Means (and standard deviations) for left and right EMG scores: 156.9 (158.7) and 146.2 (157.8); BiteStrip scores: 144.2 (114.8) and 130.6 (110.3) respectively. Nonparametric paired tests (Wilcoxon) showed no significant bilateral differences for EMG or BiteStrip scores. Bruxism patterns (graphs not shown), based on visual inspection, were concomitant for left and right masseters. Spearman's rho correlations were significant for left and right EMG scores ($r=0.93$, $p<0.001$) and BiteStrip scores ($r=0.83$, $p<0.01$). Spearman's rho correlation between all EMG and BiteStrip scores was significant ($r=0.88$, $p<0.001$). Average sensitivity was 0.75. Average PPV was 0.73.

Conclusion: Bilateral differences in bruxism are small. EMG and BiteStrip scores show a strong positive relationship. Sensitivity and PPV of the BiteStrip are good.

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The Role of Actigraphy in the Study of Sleep and Circadian Rhythms

Orgill JC, Bath J, Ebrahim IO, de Lacy SF, Williams AJ
Sleep Disorders Centre, St Thomas' Hospital, London, United Kingdom

Introduction: Several review papers have concluded that wrist actigraphy is reliable and valid for detecting sleep in normal, healthy adults. Although it is not indicated for the routine diagnosis, assessment of severity, or management of any of the sleep disorders it may be useful in characterising and monitoring of insomnia, circadian rhythm disorders, restless legs syndrome/periodic limb movement disorder and excessive sleepiness.

Methods: For this study 100 consecutive, non-dominant wrist, actigraphy studies (Cambridge Neurotechnology) are grouped into bands that describe their reason for referral. The final diagnosis of each study was noted and related to referral band.

Results: The group included 44 females and 56 males, with age ranging from 15 to 75 yrs. The six referral bands include insomnia 36% (I), excessive daytime sleepiness 34% (EDS), circadian disorder 15% (C), periodic leg movement disorder 4% (PLMD), sleep hygiene issues 5% (H) and others 6% (O). The outcomes were divided into seven categories: fragmented sleep (fr), inadequate sleep opportunity (iso), hypersomnolence (h), circadian disorder (c), poor hygiene (hy), insomnia (i) and sleep state misperception (ssm). Of the insomnia band 41% were confirmed as having insomnia or other related sleep disorder (fr, c and i) and the remaining 59% were diagnosed as iso, hy and ssm. Sixty five percent of the referral band EDS were accounted for by fr, h and c with the residual 35% in iso and hy. Ninety three percent of the referral band C were confirmed as either c, i, or fr with the resulting 7% diagnosed as hy.

Conclusion: Clinical actigraphy with simultaneous completion of a sleep log is very useful in characterising I and C and assessing EDS. The ability to distinguish in band I those patients with iso, hy and ssm enables appropriate treatment of these groups. Similarly confirmation of circadian disorders in C guides pharmaco or phototherapy, while reduced sleep opportunity (iso and hy) is clearly important to identify in EDS. This relatively in-expensive home based tool can help provide efficient and effective management of a broad range of sleep disorders.

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SleepXML - Extensible Markup Language (XML) Application For Polysomnographic (PSG) Data Storage And Exchange

Ivanov VG,[1] Ayappa I,[2] Norman RG,[2] Rapoport DM[2]
(1) Pro-Tech Services, Inc., Mukilteo, WA, USA, (2) Div Pulm Crit Care Med / Sleep Disorders Center, New York University School of Medicine, New York, NY, USA

Introduction: Although several standards (eg EDF - European Data Format) exist for PSG data interchange that deal adequately with raw data, processed data (e.g. sleep stage scores, respiratory scores, tabulations and reports), which are necessary for a complete description of a polysomnogram, are handled less well. XML (eXtensible Markup Language) is a standard defined by the World Wide Web Consortium (W3C) that provides a flexible, extensible, non-proprietary, open electronic format capable of describing both data and meta-data in the same document and is well suited to use in polysomnography. Much the same way browsers allow cross platform display and processing of a web page, this approach allows interchange and display of data while preserving existing inter-lab and inter-PSG system differences in defined event sets. This abstract proposes an XML dialect for PSG purposes (SleepXML). We demonstrate its feasibility by creating a simple program to utilize a SleepXML file and reproduce many of the functions needed for PSG analysis. We demonstrate its flexibility by converting a file of SleepXML PSG events (as might be generated from collection and scoring done in a proprietary system which exported its data in this format) to a different set of events (as might be used by a different PSG system).

Methods: In the SleepXML dialect, raw data is left unchanged and PSG events are fully defined by the XML Schema. SleepXML schema defines PSG channel types (such as Airflow, Snore, SaO2) and PSG events on those channels. Event parameters (start time, duration, type, etc.) are defined via XML child elements or XML attributes. Event characteristics, such as SaO2 drop for a hypopnea, can be defined for specific events. Characteristics of event display, such as screen color, and scoring preferences (e.g. shortcut keystrokes) are also defined via the SleepXML attributes. For report purposes graphics (e.g. PSG hypnogram and SaO2/Pulse trend) are saved to XML-based Scalable Vector Graphics (SVG) format and presented in a browser-compatible HTML report. Calculated statistics such as sleep stage specific AHI are stored as a hierarchical XML document. Data presentation on the computer screen is defined via another W3C standard - XSLT, which is used to transform XML data to HTML display tags. Because XML is compatible with existing database systems, all SleepXML data can be readily imported into existing databases (e.g. an SQL database containing patient information and questionnaire data). In order to test transformation of one PSG system's event types to those used in another system, an XSLT transformation was written.

Results: To evaluate feasibility, software was written that can display, score and tabulate a set of PSG events based entirely on the information contained within the SleepXML data definitions contained in the PSG. To evaluate flexibility, several different event set definitions from different sleep labs were presented in XML Schema format and XSLT transformations were created for conversion of score files from one event set definition to another. Sleep records were scored based on different event definitions and later the score files were successfully converted from one format to another, allowing for different lab scores to be reviewed with a single SleepXML-aware software package.
Conclusion: The obtained results show that SleepXML has the potential to provide a useful platform for describing, storing, and transforming/exchanging polysomnographic data and events.

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An Analysis of Variance Between Three Methods of Monitoring Oral/Nasal Airflow for the Detection of Apneas, Hypopneas and Hypoventilation During Nocturnal Polysomnogram

Barreto DL, Keller S
Sleep Disorder Center, Wellstar Health System, Marietta, GA, USA

Introduction: Thermocouple, which is a measurement of respiratory gas temperature and differential pressure transducer are both used to identify degrees of airway obstruction during diagnostic polysomnograms. Capnography (EtCO2), the measurement of respiratory gas concentration of CO2, generates a waveform as a function of respiratory gas concentration as well as a quantitative value reflective of arterial CO2. The objective of the current study was to assess the sensitivity and specificity of capnography as compared with oral/nasal thermocouple and pressure transducer in the detection of apneas, hypopneas and hypoventilation in the sleep laboratory environment.
Methods: 82 subjects, 49 males and 33 females, mean age 44.7 years, and mean BMI 33.8 kg/m2, were studied in an American Academy of Sleep Medicine (AASM) accredited Sleep Disorder Center and scored per AASM Guidelines. Data collection included the following channels: EEG, EOG, submental chin and leg EMG, ECG, Oral/Nasal Airflow (thermocouple, pressure transducer and EtCO2), Thoracic Effort, Abdominal Effort and Pulse Oximetry. Eight Polysomnographic Technologists performed blind respiratory event analysis, with inter-scorer reliability of 95%. Each scoring team was assigned to score using one of three flow channels.
Results: Data was analyzed using repeated measures analysis of variance (ANOVA). No significant differences were found between EtCO2, thermocouple and pressure for identification of apnea, hypopnea or respiratory disturbance index. Analysis supported the hypothesis: no significant differences were found between capnography, thermocouple and/or pressure transducer monitoring techniques. Capnography did detect hypoventilation (EtCO2 > 50 mmHg > 10% of total sleep time) in 3 subjects.
Conclusion: This study demonstrates that capnography is able to identify apneas and hypopneas in a sleep laboratory environment with the same sensitivity and specificity as thermocouple and pressure monitoring techniques. Additionally, quantitative EtCO2 monitoring has the potential to identify clinically significant hypoventilation not apparent using qualitative airflow monitoring techniques. Capnography may be more useful than thermocouple or pressure for noninvasive monitoring during sleep.

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Analysis Of MSLT Using 10 Compared With 30-Second Epochs Changes The Test Conclusion In 3/10 Patients Referred With EDS

Cresswell PW, Foy T, Hart IK
Neurological Science, University of Liverpool, Liverpool, United Kingdom

Introduction: The multiple sleep latency test (MSLT) is useful in the assessment and diagnosis of disorders of excessive sleepiness. Sleep stages during the MSLT are analysed by the standard Rechtschaffen and Kales criteria using 30-sec epoch lengths, mainly for convenience. The results of the MSLT can be placed in one of three categories: 1. Sleep onset <5mins indicates pathological sleepiness, 2. Sleep onset between 5 - 10 mins is equivocal, 3. Sleep onset >10mins is normal (Carskadon et al 1986). An equivocal result is the most difficult to interpret, clinically. We looked at equivocal MSLTs to determine whether using a shorter epoch would affect the test conclusions.
Methods: We studied 10 consecutive equivocal MSLT results from patients referred with excessive daytime sleepiness. All patients had overnight polysomnography followed by an MSLT. Four trials were conducted at two-hour intervals starting at 9:00am, about two hours after waking. The same scorer scored each trial manually using standard 30-sec epochs. The results were then reanalyed using 10-sec epochs.
Results: The use of 10-sec epochs changed the test conclusions in 3/10 patients: 2 patients' results went from equivocal to pathological sleepiness and 1 patient's result became normal. However, there was no statistical difference ($p = 0.23$) when the sleep onset scores from the 10-sec and 30-sec epoch groups were compared using a paired Students t-test.
Conclusion: Our results suggest that the use of a short, 10-sec, epoch in the analysis of MSLTs allows more clear-cut conclusions with substantially fewer equivocal results. However, this analysis is more time consuming than the standard 30-sec method and it does not make a statistical difference to sleep onset scores.

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The Maintenance of Wakefulness Test is the Principal Measure of Excessive Daytime Sleepiness in Narcolepsy/Cataplexy Using Principal Component Analysis

Cresswell PW, Hart IK
Neurological Science, University of Liverpool, Liverpool, United Kingdom

Introduction: There is debate about the best test for detecting excessive daytime sleepiness. Objective measures include the Maintenance of Wakefulness Test (MWT) and Multiple Sleep Latency Test (MSLT). Subjective measures include the Epworth Sleepiness Scale (ESS), the Stanford Sleepiness Scale (SSS), and the Visual Analogue Sleepiness Scale (VASS). The aim of this study was to determine which of these tests is the principal measure of excessive daytime sleepiness (EDS) in patients with narcolepsy/cataplexy using the statistical technique of principal component analysis (PCA).
Methods: We studied the sleep test results of 20 patients with narcolepsy/cataplexy attending the Walton Centre Sleep Clinic. Each patient had previously completed an ESS followed by nocturnal polysomnography and a standard four trial MWT and MSLT test protocol, on the same day, 2 hours after waking. The SSS and VASS were obtained after each MWT trial. The same technician scored each MWT and MSLT trial manually. Mean scores were calculated for the MWT, MSLT, SSS, and VASS. All scores were entered into a database (SPSS 11.0) and analysed using a