European Pediatric Sleep Club
13th Meeting

November 22-23, 2003
Rome (Italy)

ABSTRACT BOOK
PROGRAM

November 22 - Saturday

8.30 - 11.00 Sleep stability and sleep instability during development
Chairmen: GUILLEMINAULT C, TERZANO MG
  - TERZANO MG (Italy). Cyclic alternating pattern (CAP) during life-span
  - BRUNI O (Italy). CAP in normal preschool age children
  - FERRI R (Italy). Non linear analysis of sleep during development
  - GUILLEMINAULT C (USA). Activation versus arousal secondary to peripheral events during sleep
  - SALZARULO P, FAGIOLI I, GIGANTI F, ZAMPI C (Italy). Individual variables and behavioral states across the sleep episodes in babies

11.00 - 11.30 Coffee break

11.30 - 13.30 Arousalability in infant and child pathology
Chairmen: KAHN A, SALZARULO P
  - FRANCO P (Belgium). The influence of environmental factors on arousalability
  - DONZELLI GP, PRATESI S (Italy). Cerebral oxygenation in infants at risk of SIDS
  - HORNE R (Australia). Consistency and consequences of infant arousability
  - GIGANTI F, FICCA G, SALZARULO P (Italy). Features of spontaneous awakenings from preterm to term born infants
  - CHERVIN R (USA). A novel approach to EEG spectral analysis in the identification of clinically significant sleep disordered breathing in children

13.30-15.00 Lunch

15.00-16.00 Lecture
   CURZI-DASCALOVA L, CURZI L (France). Infant and children sleep in fine arts

16.00-17.00 Sleep and neurological diseases in children
Chairmen: NEVSIMALOVA S, ZUCCONI M
  - NEVSIMALOVA S, KEMLINK D, SONKA K, STEPANOVA I (Tchech Rep.). Narcolepsy in children and adolescents
  - STORES G (England). REM sleep behaviour disorder in young patients
  - GIANNOTTI F, CORTESI F (Italy). Sleep disorders in children with pervasive developmental disorders. A 2 year follow-up study

17.00-18.30 Sleep and epilepsy
  - PERAITA-ADRADOS R (Spain). Video-monitoring of night seizures in children
  - NOBILI L (Italy), PLAZZI G (Italy) - Video session
November 23 - Sunday

8.30-10.30 Attention Deficit Hyperactivity Disorders (ADHD), Periodic Leg Movements (PLMs) and sleep disordered breathing
Chairmen: BRUNI O, CHERVIN R
- CHERVIN R (USA). Sleep-disordered breathing, PLMs, and ADHD: cause and effect?
- SCHOLLE S (Germany). Sleep-disordered breathing and motoric arousals in children
- LECENDREUX M (France). Sleep and alertness in ADHD children
- VILLA MP (Italy). Hyperactivity and inattention in OSAS children

10.30-11.00 Coffee break

11.00-12.30 Sleep scoring rules across development: How, when and why to apply the Rechtschaffen and Kales (R&K) criteria in infancy and childhood
Chairmen: CURZI-DASCA LOVA L, GUILLEMAULT C.
- GUILLEMAULT C (USA). Scoring sleep, arousals and respiratory events in children.
- VECCHIERINI MF, CURZI-DASCA LOVA L (France). Scoring sleep in the first year of life, in relation to R&K criteria
- SCHOLLE S (Germany). Scoring of sleep and wakefulness in infancy and childhood in dependency on age

13.00-15.00 Lunch

15.00-16.00 - Poster presentations
ZOTTER H, KERBL R, MUELLER W, URLESBERGER B. (Austria) Cerebral hemodynamics during arousals in preterm infants: preliminary data
SPRUYT K AND CLUYDTS R (Belgium) Relationships between pediatric sleep problems: a statistical point of view
BARONI E, CECCHINI M, MENGHETTI E. (Italy) Tactile communication, sleep and emotional expression in the first hours of life
BRUNI O., MIANO S., VERRILLO E. FERRI R. (Italy) Treatment Of Sleep Terrors In Children With L-5-Hydroxytryptophan
PRADELLA-HALLINAN M, MOREIRA GA, BRITO MF, ALVES GR, TUFIK S. (Brasil). Epileptic discharge during sleep
PRADELLA-HALLINAN M, MOREIRA GA, BRITO MF, ALVES GR, TUFIK S. (Brasil) Neuromuscular diseases, sleep and non-invasive ventilation

16.00-17.00 - Posters
CONTARDI S., LA MORGIA C., MONDINI S., CIRIGNOTTA F. (Italy). The use of nasal cannulas in children screened for OSA: limits due to technical problems
TESSE R, LOSPALLUTI ML, LORÈ M, DE SARIO V, ARMENIO L AND BRUNETTI L. (Italy) Association between Sleep Disordered Breathing (SBD) and Neurobehavioral Disorders in Children: a Case Report and Practical Implications
GIGLIOTTI A, LAURIA F, DI BIASI S, SOGOS C. (Italy) Sleep disturbances in depressed and traumatized children.
LAURIA F, GIGLIOTTI A, CAPRIOTTI N, MAZZONCINI B (Italy) Depression and trouble sleeping in childhood
ORAL PRESENTATIONS
Cyclic alternating pattern (CAP) during life-span

Terzano MG, Parrino L, Smerieri A, Bruni O, Miano S, Ferri R, Verrillo E

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2 Centro del Sonno, Dip. Scienze Neurologiche e Psichiatriche Età Evol., Univ. of Rome "La Sapienza", Italy
3 Centro del Sonno, U.O. Neurologia I.C., IRCCS Oasi Maria SS, Troina (EN), Italy

Introduction. CAP (cyclic alternating pattern) is a spontaneous rhythm detectable during NREM sleep in the form of EEG oscillations corresponding to periods of cyclic activation and unstable sleep depth. Each oscillation is composed of an EEG descriptor of partial cerebral activation (phase A of the cycle) separated by intervals of background activity translating a deactivation process (phase B of the cycle). Sequences of CAP are orderly distributed in NREM sleep and the percentage of CAP time to NREM sleep time, i.e. CAP rate, is the physiological marker of sleep instability. Three main EEG descriptors of partial cerebral activation have been described according to the prevalence of EEG synchrony (subtype A1), prevalence of EEG desynchrony (subtype A3), or a balanced combination of both (subtype A2). The three phase A subtypes appear to be involved in the structural organization of sleep with specific distribution within the single NREM stages. CAP rate, the amount and percentages of the phase A subtypes undergo specific age-related variations.

Methods. To evaluate the age-related changes of CAP variables across the life span, 90 normal gender-balanced subjects, ranging between 3 and 80 years of age, were investigated. All subjects underwent PSG recordings for 2 consecutive nights in standard laboratory setting. Sleep data were stored on computer using a polysomnography digital system. Conventional sleep staging was carried out following the standardized rules (Rechtschaffen and Kales, 1968), while CAP was visually scored according to the criteria by Terzano et al. (2001).

Results. Combining the results of pre-school children, school children, adolescents, young adults, middle aged and elderly subjects we found a percentage of CAP rate of 26%, 33.4%, 43.4%, 32%, 37.5%, 55.3, respectively. The highest percentage of phase A1 subtypes prevailed in the school children (84.4%), in adolescents (71.3%), and in pre-school children (63.2%) followed by plateau values between 30 and 60 years (mean: 61.6%) and a final decline after the age of 60. The A2 and A3 subtypes show a linear increase from the pre-school children to the old age, similar to the arousal trend across the life span.

Conclusions. Sleep is a biological function which is deeply influenced by age. Progressive reduction of total sleep time, of deep sleep and partially of REM sleep, are known to occur from young to old age. Sleep fragmentation is another age-related variable as indicated by the evolution of arousals. A similar linear behavior is expressed by subtypes A2 and A3. In contrast, phase A1 subtypes and CAP rate undergo a complex development in association with topical maturational epochs showing a peak in the pre-adolescents and adolescents. These changes are probably associated to specific metabolic age-related variations especially the growth hormone secretion.
References
Cyclic alternating pattern in normal preschool-age children

Bruni O¹, Miano S², Ferri R², Smerieri A³, Parrino L³, Verrillo E¹, Farina B¹ and Terzano MG³

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²Centro del Sonno, U.O. Neurologia I.C., IRCCS Oasi Maria SS, Troina (EN), Italy
³Centro di Medicina del Sonno, Istituto di Neurologia, Univ. of Parma, Italy

Introduction. During development the disappearance of the tracé alternant and the appearance of K complexes and sleep spindles lead to the individuation of the NREM sleep stages reflecting the maturation of the thalamo-cortical pathways and rostro-caudal pons-thalamus connections. (Louis, 1998). During NREM, sleep maintains an oscillating pattern that reflects different levels of arousal than has been coded as cyclic alternating pattern (CAP) (Terzano et al., 2001). Few data are available on CAP in adolescent and children (Parrino et al. 1998, Bruni et al., 2002). Our study addresses this deficiency in preschool-age children as usage of CAP would be an important adjunct to investigation of normal and pathological sleep in this age group.

Methods: CAP parameters were quantified in 10 normal healthy subjects (6 F and 4 M, mean age 4.6 years; range 3–6 years). All subjects underwent PSG recordings for two consecutive nights in a standard laboratory setting. Sleep data were stored on computer using a polysomnography digital system (Embla N7000, Medcare). Sleep macrostructure was visually scored according to the criteria by Rechtschaffen and Kales (1968); CAP was visually scored following the criteria by Terzano et al. (2001). Sleep macrostructure parameters and CAP parameters were compared with data obtained from a group of prepubertal school-age children previously published (Bruni et al., 2002). Statistical analysis was carried out using the Mann-Whitney non-parametric test.

Results. Main results are summarized in table 1. CAP rate in preschool children showed a progressive increase with the deepness of sleep, with high values during Slow Wave Sleep (SWS). Phases A1 were the most numerous (63.2%) followed by A2 (21.5%) and by A3 (15.3%). The distribution of phases A subtypes across NREM stages showed differences for the A1 subtypes that occurred more frequently during SWS than in S2 and S1. Duration of A1 phases was shorter and of A2 longer.

Comparing with the older age group we found that CAP rate was lower (25.9% vs. 33.4%) mainly in NREM stage 2, while no differences have been found in NREM SWS. A1 percentage was lower while A2 (mainly) and A3 percentage was higher. We found similar values for CAP rate in SWS and for number of CAP sequences. Duration of B phases and of CAP cycles was similar to older children.

Conclusions. In the analysis of CAP and EEG arousals the maturation of EEG must be considered. In younger children the most common pattern of EEG frequency changes associated with an arousal is a shift to a more rhythmic pattern, primarily in the theta-range of EEG-frequency or, with maturation, also in the alpha range (Scholle and
Schaefer, 1999; Kahn et al., 1996). Taking this into account, we considered as A2 phases also the frequency shifts > 2 seconds towards the theta range (associated or not with EMG activities). We found this EEG pattern in all preschool children analyzed and it should be considered as a stable arousal pattern typical of this age range. We suggested that A1 subtypes can have a protective role for sleep continuity and that their higher percentage in SWS could be related to restorative value of sleep, while A2 and A3, involved in the REM-on activity, could have the role of maintaining the subject arousability. The higher prevalence of A2 phases could represent a signal of higher sleep instability in this age range.

Table 1. Comparison of main CAP parameters between preschool and school-age children

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Preschool</th>
<th>School</th>
<th>Mann-Whitney p</th>
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</thead>
<tbody>
<tr>
<td>Age in months</td>
<td>Mean 54.6 ± 12.9</td>
<td>Mean 99.6 ± 17.1</td>
<td>0.000</td>
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<tr>
<td>CAP rate (%)</td>
<td>25.9 ± 13.51</td>
<td>33.4 ± 5.27</td>
<td>0.045</td>
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<tr>
<td>CAP time (mins)</td>
<td>105.1 ± 49.08</td>
<td>131.0 ± 29.91</td>
<td>0.151</td>
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<tr>
<td>CAP rate in S1 (%)</td>
<td>25.5 ± 22.02</td>
<td>16.8 ± 18.88</td>
<td>0.226</td>
</tr>
<tr>
<td>CAP rate in S2 (%)</td>
<td>17.3 ± 10.18</td>
<td>28.7 ± 6.61</td>
<td>0.008</td>
</tr>
<tr>
<td>CAP rate in SWS (%)</td>
<td>44.2 ± 22.01</td>
<td>45.7 ± 6.93</td>
<td>0.545</td>
</tr>
<tr>
<td>Percentage of A1</td>
<td>63.2 ± 10.07</td>
<td>84.4 ± 3.39</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage of A2</td>
<td>21.5 ± 7.01</td>
<td>6.4 ± 1.83</td>
<td>0.000</td>
</tr>
<tr>
<td>Percentage of A3</td>
<td>15.3 ± 6.01</td>
<td>9.1 ± 3.93</td>
<td>0.028</td>
</tr>
<tr>
<td>N° of CAP sequences</td>
<td>35.1 ± 8.40</td>
<td>37.0 ± 6.68</td>
<td>0.678</td>
</tr>
<tr>
<td>Mean duration of A1 phases (sec.)</td>
<td>6.5 ± 1.43</td>
<td>4.7 ± 0.30</td>
<td>0.002</td>
</tr>
<tr>
<td>Mean duration of A2 phases (sec.)</td>
<td>8.2 ± 1.75</td>
<td>9.6 ± 1.36</td>
<td>0.028</td>
</tr>
<tr>
<td>Mean duration of A3 phases (sec.)</td>
<td>16.2 ± 3.68</td>
<td>18.7 ± 4.58</td>
<td>0.406</td>
</tr>
<tr>
<td>Mean duration of B phases (sec.)</td>
<td>24.1 ± 2.85</td>
<td>24.7 ± 1.10</td>
<td>0.345</td>
</tr>
<tr>
<td>Mean duration of CAP cycle (sec.)</td>
<td>32.4 ± 3.07</td>
<td>30.5 ± 1.17</td>
<td>0.131</td>
</tr>
</tbody>
</table>

Legenda: S1= NREM stage 1; S2= NREM stage 2; SWS= NREM stage Slow Wave Sleep.

References
Non-linear analysis of sleep EEG during development

Ferri R. (Italy).

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In young and adult humans, phasic events during NREM sleep show a peculiar arrangement which has also been described as "cyclic alternating pattern" or CAP (Terzano et al., 1985, 1988). CAP consists of transient arousal complexes (phase A) that periodically interrupt the tonic theta/delta activities of NREM sleep (phase B). Functionally, CAP translates a condition of sustained arousal instability oscillating between a greater arousal level (phase A) and a lesser arousal level (phase B). The absence of CAP coincides with a condition of arousal stability, which is characterized by the lack of phasic events, and is defined as non-CAP.

We have assessed the dynamic properties of the EEG during adult sleep (Ferri et al., 2002) by means of the Nonlinear Cross Prediction (NLCP) test, introduced by Stam et al. (1998), which uses 3 different "model" time series in order to predict non-linearly the original data set (Pred, Ama, and Tir). Pred is a measure of the predictability of the time series, and Ama and Tir are measures of asymmetry, indicating nonlinear structure.

These nonlinear measures indicated that sleep EEG tends to show nonlinear structure only during CAP periods, both during stage 2 and slow-wave sleep. Moreover, during CAP periods, non-linearity could be detected only during the phase A1 subtypes (and partially A2) of CAP (Ferri et al., 2002). Based on these results, sleep might be considered as a dynamically evolving sequence of different states of the EEG, which we could track by detecting nonlinearity mostly in association with CAP.

In contrast with the findings we obtained in adults (Ferri et al., 2002), we were unable to find clear indications of nonlinear structure in the sleep EEG of neurologically normal premature and full-term newborns (Ferri et al., 2003). This finding might be due to a significant difference in the mechanism generating sleep EEG at different ages, during and after development.

Nonlinearity can also be connected with dimensional complexity and might become detectable when such a complexity assumes low values; this is possible in the mature brain because of the fully developed synaptic pattern. Synaptogenesis, in humans, takes place mostly before birth and during early infancy; by 1 year of age, the maximum synaptic density is reached; subsequently, synapses are progressively eliminated, most rapidly during the preschool period (Huttenlocher, 1990).

We can hypothesize that the developing brain expresses, during sleep, EEG signals with a structure similar to that of high-dimensional noise because important developmental changes still need to take place or are just at their initial stages. Our study shows that the structure of sleep EEG in newborns is significantly different from that of adults, it can not be distinguished from that of high-dimensional noise in the majority of epochs, and shows a tendency to become nonlinear in nature mostly during QS, in a small percentage of the epochs analyzed.
Finally, beside the normal sleep EEG, we have also applied the same measures to study the nature of the dynamics underlying electrical status epilepticus during slow-wave sleep (ESES) (Ferri et al., 2001). The results obtained clearly showed that ESES, like other types of epileptic EEG activity described in the literature, seems to reflect highly nonlinear and possibly low dimensional dynamics, whereas nonESES sleep and wakefulness EEG seems to correspond with linear stochastic dynamics. Thus, our results seem to indicate that patients with ESES show a profound modification of their sleep EEG structure, in comparison with that of normal subjects, with the presence of long lasting highly nonlinear and possibly low dimensional dynamics. It is now accepted that different important neuropsychological cognitive processes take place during sleep, such as memory consolidation, forgetting, stimulation of brain maturation, etc. (Giuditta, 1994; Jouvet, 1998). The profound changes in brain dynamics we found in ESES might be considered able to disrupt normal brain functioning during sleep of these patients and to be one of the possible mechanisms of their cognitive deficits.

References
Activation versus arousal during sleep

Guilleminault C, Leger D, Arias V

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Peripheral events during sleep are perceived integrated and responded to. Continuous information is sent by peripheral receptors. This information can trigger an immediate response: a spinal cord reflex; or a polysynaptic reflex involving different levels of brain stem depending of intensity and amount of recruitment of sensory afferences, It may arrive at the thalamus and or basal forebrain. The thalamic-basal forebrain gate will let the afferent input reach the cortex only when the sub-cortical gate has been overcome. Initially the cortex will try maintaining sleep with reinforcement of its gates, that are indicated by occurrence of K-Complexes and/or burst of delta frequencies in the sleep EEG. When the thalamic/basal forebrain gate cannot control the afferent inputs, a cortical change is seen translated by an alpha, or a mixed of alpha and beta EEG frequency burst. At each stimulation reaching at least the brainstem, there will be information of the autonomic controlling structures. This implies the nucleus tractus Solitarius. There will be always autonomic nervous system activation, but this activation will occur often without cortical EEG arousal. The indices of the brain stem stimulation: heart rate, increase in BP, change in pulse transit time and peripheral arterial tonus will be activated and autonomic response will be seen using the peripheral organ to study the response related to brain stem activation versus cortical arousal. Experimental data using repetitive auditory stimulation at different intensity threshold, indicate that depending of tone intensity, an EEG arousal will or will not be obtained but an ECG activation will be noted in both cases. Usage of the MSLT indicates that if the stimulation is sufficient to trigger an arousal response at least once every 2 minutes as a mean during total sleep time, there will be abnormally lower MSLT score than at baseline. But with low intensity tone without demonstration of EEG arousal but ECG increase will be seen indicating a brain-stem activation with increase sympathetic discharge.
Individual variables and behavioural states across the sleep episode in babies

Zampi C, Giganti F, Fagioli I and Salzarulo P

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Sleep can be described in two ways: by combining different variables into coherent states according to specific scoring procedures (1) or by studying each variable separately (EEG, EMG, EOG, ECG etc.). States have been defined as the constellations of certain functional patterns of physiological variables which may be relative stable and which seems to repeat themselves (2) leading to stepwise separation across time, whereas the time course of individual variables gives a continuous representation of physiological activities across time (3). Studies of the time course of individual variables during development 4,5 showed that the stability of the behavioural state could be associated with different levels of physiological activities, which change across the first year of life. Moreover, also the modality of the transition from one state to another one, and from sleep to wake, differs as a function of age (4,5,6,7).

Whether it is more useful to take into account the state or the level of an individual physiological activity is an open question. An example showing the priority of state is given by the analysis of the condition preceding the awakening in the second semester of life (8). On the other side, an individual physiological variable, like EEG, has been used to show changes in the S process level in infants nocturnal sleep (9,10) in the frame of early development of sleep regulation.

References
The influence of environmental factors on arousability in infants

Franco P, Groswasser J, Scaillet S, Kahn A.

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**Objective.** To review the major confounding factors that influence the determination of arousal thresholds in infants.

**Review of confounding factors.** The determination of arousal thresholds in infants measures their arousability from sleep. The evaluation is influenced by various conditions. The levels of arousal thresholds depend on experimental conditions (type and time of administration of the arousal challenge, sleep stage). Spontaneous arousals can also occur and modify infants’ response to external arousal challenges.

The infant’s arousability is decreased by maternal factors, such as exposure to cigarette smoke or illegal drugs. The levels of arousal thresholds also depend on the infant’s characteristics (age, previous sleep deprivation, infection, type of feeding, use of pacifier) and on infant’s sleep conditions (room temperature, body sleep position, face covered by a sheet, bedsharing or swaddling). Some factors could also occur together and influence the arousability.

**Conclusion.** Factors known to modify infants’ arousability from sleep should be controlled during studies designed to determine arousal thresholds.
Cerebral oxygenation in infants at risk of SIDS

Pratesi S, Piumelli R, Donzelli Gp, (Italy).

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Cerebral oxygenation monitoring during the prone and supine sleeping position. It has recently been reported that much of the progress in neuromonitoring over the next decade will consist of an improvement in the clinical data obtained from near-infrared spectroscopy (NIRS) in neonatal care (Annals of the New York Academy of Sciences 939:101-113;2001). This relatively new technology is able to measure the concentrations of oxy-haemoglobin, deoxy-haemoglobin and haemoglobin oxygenation in the optically probed volume of cerebral tissue in a non-invasive and continuous manner. Pulseoximetry has become a standard and useful monitoring tool in assessing systemic oxygen delivery. However, parameters such as SaO2 and PaO2 fail to indicate the adequacy of supply in relation to specific tissue oxygen demand. The prone sleeping position has been shown to be associated with an increase in the risk of the Sudden Infant Death Syndrome (SIDS). Airway obstruction, rebreathing of expired air or position dependent hypoperfusion of the brainstem have been proposed as possible causes of SIDS in the prone position. No data is available in literature regarding the sleeping position-dependent effects on cerebral absolute oxygenation in infants. To this end, we performed measurements of cerebral tissue on 20 neonates hospitalised at our NICU, both lying prone and lying supine. Each measurement took about 1 hour. At the beginning of the measurement the newborns were placed supine and following their position changed every 10 minutes. In order to compare the absolute StO2 and SaO2 in the prone and supine position, a 30sec period was analysed before each position change. The results showed no significant differences in either the StO2 or SaO2 values between the prone and supine sleeping positions with the exception of 1 newborn (34 weeks of gestational age, 8 days of postnatal age) in whom the prone position induced a significant and reproducible increase in StO2 with respect to the supine position. In this patient no differences were found in SaO2 values between the two different positions. This preliminary data does not indicate sleeping position-dependent effects on cerebral absolute oxygenation infants.

Moreover, in order to assess the effects of apnea on the cerebral SatO2 and peripheral SaO2, 15 preterm newborns were studied with frequent spontaneously-resolved episodes of apnea not associated with bradycardia. Cerebral SaO2 showed an earlier and more rapid reduction than peripheral SaO2 (27% vs. 13%).

This preliminary data suggests that short episodes of even slight peripheral desaturation could be associated with more pronounced episodes of cerebral desaturation.
Consistency and consequences of infant arousability.

Horne R, Parslow PM, Adamson TM, Harding R.

Ritchie Centre for Baby Health Research and Department of Paediatrics, 1Department of Physiology, Monash University, Melbourne, Australia.

Arousal from sleep serves as a vital protective mechanism against cardio-respiratory failure. In infants, failure to arouse (FTA) from sleep has been postulated to be involved in the sequence of events leading to SIDS. To avoid ethical and technical concerns associated with the administration of cardio-respiratory stimuli, arousal responses of sleeping infants have predominantly been assessed using somatosensory stimuli, mechanical stimuli or body tilting. These studies have consistently demonstrated that infants are more arousable in AS than in QS. In contrast to the findings of infant studies, studies in newborn animals have depressed in AS. To date in infants there have been few studies contrasting arousal responses in AS and QS to cardio-respiratory stimuli and none comparing cardio-respiratory with somatosensory stimuli. We aimed to compare arousal responses to mild hypoxia in both AS and QS, to contrast arousal responses between somatosensory and cardiorespiratory stimuli and to examine the effects of postnatal age and maternal smoking, a major risk factor for SIDS, on these responses. Using daytime polysomnography at 2-5 weeks, 2-3 months and 5-6 months post-term we studied 11 infants to compare hypoxic arousal responses between sleep states, 10 infants to compare arousability between stimuli and 48 infants to compare the effects of maternal smoking. Somatosensory stimulation was induced with a nasal air-jet. Nasal airflow was monitored using a purpose-built pneumotachograph for hypoxia/normoxia studies. Hypoxia tests were terminated at either arousal, oxygen saturation (SpO₂) falling below 85% or at 5 minutes (failure to arouse). Tests terminated due to SpO₂ falling to 85% were excluded from analyses. The probability of arousal in each sleep-state was determined using chi-square analysis. Paired t-tests were used to investigate sleep-state effects at each study age. One-way ANOVA for repeated measures with Student-Newman-Keuls post-hoc analysis was used to investigate age effects in each sleep-state. Infants aroused more frequently under hypoxic conditions than under normoxic conditions. Overall, arousal latencies were shorter during hypoxia compared to normoxia, in both sleep-states at each age. Arousal latencies were longer in QS compared to AS in both hypoxic and normoxic conditions. Arousability to both air-jet and hypoxic stimuli was significantly depressed in QS compared to AS at each age ($p < 0.05$), except at 2-4 weeks for the air-jet. Arousal latency to hypoxia did not change with age. In AS, arousability to the air-jet was greater at 2-3 months compared to 2-4 weeks ($p < 0.05$); in QS it was lower at 5-6 months compared to 2-4 weeks ($p < 0.05$). Maternal smoking depressed arousability to both forms of stimuli. In sleeping infants mild hypoxia serves as a stimulus for arousal in both AS and QS. Of particular significance is our finding that arousal from AS is readily elicited by mild hypoxia. In addition, arousal responses to somatosensory and respiratory stimuli are similarly affected by sleep-state, postnatal age and maternal smoking.
Features of spontaneous awakenings from preterm to term born infants

Giganti F*, Ficca G** and Salzarulo P.*

* Department of Psychology, University of Florence, Italy  
** Department of Psychology, II University of Naples, Italy

This contribution summarizes the development of the features of spontaneous awakenings from preterm infants to term born infants up to the first year of life. In the periods preceding and following the term, changes in the number and duration of awakenings can be observed. Before term, the duration of awakenings progressively increases, whereas the number remains stable (Giganti et al., in preparation); after term up to the end of the first year of life the frequency of awakenings decreases while the duration does not change (Ficca et al., 1999). As far as the temporal distribution of awakenings is concerned, preterm infants show a greater number of awakenings during the night than during the day. The difference becomes smaller in term born infants and the proportion is reversed after the third month.

The process leading to awakening at early ages is poorly understood. Both in preterm and in full term born infants (Ficca et al., 1999) REM sleep precedes awakenings more frequently than NREM sleep. The analysis of physiological and behavioural variables preceding awakenings in term born infants showed that awakening is not an abrupt event, and that it is preceded by progressive modifications of several variables (Zampi et al., 2002 and 2003; Thach and Lijowska, 1996).

References
A novel approach to EEG spectral analysis in the identification of clinically significant sleep-disordered breathing in children

Chervin RD, Burns JW, Subotic NS, Roussi C, Thelen B, Ruzicka DL

Introduction. Sleep-disordered breathing (SDB) is associated with neurobehavioral morbidity, such as sleepiness and hyperactivity, but neither is predicted well by laboratory measures of SDB severity. Snoring may predict morbidity even after standard SDB measures are taken into account. We proposed and tested a new hypothesis, that the many respiratory cycles between apneic events could affect brain function on a breath-to-breath basis.

Methods. Subjects were 10 children aged 6 to 10 years, 4 boys and 6 girls. They were scheduled to have adenotonsillectomy or hernia repair (one subject) for clinical indications, and participated in a research protocol that included nocturnal polysomnography and behavioral evaluations both before and one year after surgery. Before surgery, five subjects had obstructive sleep apnea, as defined by an obstructive apnea index (events per hour of sleep) > 1, and five did not. A computer algorithm divided each non-apneic respiratory cycle in the first 3 hours of recorded sleep into four time segments based on airflow maxima, minima, and their midpoints. The short-time Fourier transform was used to compute, for each time segment, the time-evolved spectral EEG power at one central lead within delta (1-4 Hz), theta (5-7 Hz), and alpha (8-12 Hz) frequency ranges. Segment powers were normalized by division by the power for the entire respiratory cycle. Normalized segment powers were averaged over about 2,500 respiratory cycles to produce mean values for each of the four respiratory cycle segments. The maximum difference between segment powers was defined as the respiratory cycle-related EEG changes (RCREC) for any given subject and frequency range. Differences between mean segment powers were tested for significance within each subject by ANOVA. Among all subjects, the RCREC were compared to sleepiness, as measured by the Multiple Sleep Latency Test, and to inattention, as assessed by a well-validated auditory continuous performance test.

Results. Pre-operative delta, theta, or alpha RCREC was statistically significant (p<0.01) in every subject except the one control and one child without SDB by standard measures. The RCREC could be demonstrated (p<0.001) even in a polysomnographic fragment of only 101 respiratory cycles with no scorable apneas or hypopneas. Among the 10 children, theta RCREC correlated with the apnea/hypopnea index (p = 0.01). Pre-operative alpha RCREC predicted sleepiness (p=0.02), whereas rates of apneic events did not (p = 0.83). The RCREC values tended to decrease in apneics after adenotonsillectomy, but not in non-apneics. After surgery, the change in delta RCREC but not the change in the apnea/hypopnea index predicted the change in sleepiness (p = 0.002). The change in theta RCREC also had predictive value (p = 0.05). Post-operative changes in delta RCREC showed more promise than rates of apneic events as predictors of attention scores, though none of these associations reached significance.

Conclusions: The EEG activity during sleep can vary with non-apneic respiratory cycles, to a degree reflected by RCREC. We speculate that RCREC may represent brief but numerous microarousals that contribute to neurobehavioral morbidity in pediatric SDB.
Sleep of infants and children in fine arts.

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Humans have never been indifferent to sleep. Sleep is, and continues to be, a big mystery for them. Our daytime alertness and activities always lead to sleep. Each night, billions of humans go to bed, or lie to sleep in mats or hammocks or simply on the ground. This ritual has been repeated for millions of years. “Our little life is rounded with sleep”. (Shakespeare, The Tempest). The mystery of sleep has been and continues to be, a more or less permanent theme of artistic creativity.

The aim of our topic is to understand for each example a) Why this particular work of art has had to be done, what does the artist want to imply? b) Is the artist aware of what we now know about sleep (state of sleep, pathology of sleep)? c) What are the methods of representation used in relation to the personality of the artist or artistic school, in different periods in history?

Our study is based on a database including more than 1600 replicas of paintings, sculptures and engravings on the subject of sleep. The more representative (about 25) examples spanning over a period from the year 2000 B.C. to date, will be discussed. The choice is strictly subjective and limited.

Compared to that of adults, infant and child sleep is a subject of less rich and varied representation in art. However, infant sleep representation seems to be chronologically older, the oldest actually (cf the votive figurines from 20 c B.C). Contemporary art usually ignores the subject of infant and child sleep, while the sleep and dreams of the adults are kept on the agenda.

Historically, infant sleep representation has been related to religion with themes specific for the epoch:

a) the oldest votive figurines;
b) mythology representations of sleeping Cupid or the infancy of the gods (Hypnos, Thanathos etc);
c) The Mother - goddess and the child in the religions of the Far East;
d) Numerous themes from Christianity such as the Nativity, the Virgin and Child, the Flight from Egypt.

Child sleep representation can also be found in ancient mythological scenes (Eros, Bacchus Fiesta) but mainly in lay scenes where the artist usually concentrates on the representation of children.
Narcolepsy in children and adolescents

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Introduction. Narcolepsy is a chronic disease that is commonly diagnosed during middle adulthood. However, the first symptoms appear often during late childhood and/or adolescence. This fact arises questions what are reasons for diagnostic delay from the clinical point of view, and what kind of help can be expected from auxiliary diagnostic examinations.

Patients and methods. Survey of 23 patients (14 boys, 9 girls) is presented. The mean age of clinical diagnosis was 13.8 years (age range 2–18.5 years), first symptom appears at the age of 11 years (age range 0.6–17 years), the latency of diagnosis was 2.2 years (range 0.3–5 years), mean follow-up period lasts 6.9 years (range 1–20 years). The diagnosis was proved by MSLT and/or age corresponding PSG examination; in all patients HLA oligotyping was done. 10 cases from this group underwent CSF hypocretin/orexin examination and a questionnaire study devoted to psychological and social aspects was done.

Results. In 11 out of 23 patients the disease was clinically expressed by narcolepsy cataplexy, in 6 cases by narcolepsy, cataplexy, sleep paralysis/or hypnagogic hallucinations, and only 1 patient suffered from fully expressed tetrad of symptoms. In 4 patients narcolepsy without cataplexy is diagnosed at the present time and 1 girl with questionable diagnosis suffers from sporadic cataplectic attacks, frequent states of sleep paralysis and hypnagogic hallucinations, but EDS is not contemporary present. The most common first symptoms of the disease were EDS (52.3%) and EDS combined with cataplexy (30.4%). Isolated cataplexy and/or sleep paralysis appeared as the first symptom of the disease only exceptionally (13% resp. 4.4%). MSLT showed a shorter mean sleep latency in patients suffering from narcolepsy with cataplexy (n=18) compared to cases narcolepsy without cataplexy (n=4), while mean number of SOREMs in both groups does not differ. In all examined patients undetectable level of hypocretin-1 in CSF was found, however 2 cases were HLA-DQB1*0602 negative. History and auxiliary examinations of several atypical children cases are presented and discussed. Attention is devoted also to secondary cases of narcolepsy-cataplexy and EDS in Niemann-Pick disease, type C and Prader-Willi syndrome. A clinical picture of these patients is correlated with MSLT findings and with results of HLA oligotyping and CSF hypocretin-1 level.

Conclusion. The aim of presentation is to stress some atypical features of children's clinical picture, to discuss the role of auxiliary examinations at the very onset of the disease, to present the most common incorrect diagnosis presumed by pediatricians, to mention the latest therapeutical possibilities and to draw attention to hypocretin/deficiency in secondary cases of narcolepsy-cataplexy or EDS.
REM Sleep Behaviour Disorder in young people

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REM sleep behaviour disorder (RBD) is a relatively recently described parasomnia of much interest to neurologists and psychiatrists. Originally considered to occur only in elderly males, it has now been described in both sexes and all ages.

A case is described with onset of RBD at age 14 with increasingly violent manifestations in subsequent years. Following correct diagnosis, based on clinical features and PSG findings, the patient was successfully treated with clonazepam. He has remained well for the last 5 years with no evidence of any underlying disorder.

The literature on RBD in children and adolescents is reviewed in relation to this case. Important issues include the differential diagnosis of RBD and the need for comprehensive evaluation and follow up in view of the various conditions with which early onset RBD has been associated.
Sleep disorders in children with pervasive developmental disorders. A 2 year follow-up study

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General high rates of sleep disturbances have been estimated for approximately 34 to 89% of children with Pervasive Developmental Disorders (PDD). However, the majority of studies have been carried out on heterogeneous groups. Therefore, we undertook this study to evaluate the prevalence of sleep problems in a selected sample of children with PDD without other coexisting pathology and current other medication, and to determine the effect of long-term controlled-release melatonin (CR) treatment on sleep disorders. The current study was designed to systematically and prospectively evaluate the effectiveness and of CR melatonin administered openly over a period of up to 24 months. Twenty-nine children (25 males and 4 females; mean age 52 months, range 30-110, SD 24) meeting inclusion criteria were enrolled in a 2-y open-label study.

Assessment included neurological and cognitive evaluation, Childhood Autism Rating Scale (CARS) Diagnosis was based on DSM IV criteria and Childhood Autism Rating Scale score above 29.5. To assess baseline sleep related problems, we used the Children’s Sleep Habits Questionnaire (CSHQ) completed by parents. It yields both total and 8 subscales scores, reflecting key sleep domains. Furthermore, a clinical interview inquiring previous and current child’s sleep problems was carried out. Moreover, parents were asked to complete a diary of child’s sleep. Baseline sleep variables, CSHQ scores were compared with sex- and age-matched controls. Children were rated by CSHQ at baseline (before treatment) and after scheduled intervals: 1, 3, 6 months (end of treatment), 7 months (1 month after discontinuation), 12 months and 24 months (reintroduction of treatment, if necessary). Seven sleep diary data collection periods during the 2-year study were reported. After the baseline assessment, children were given a 3 mg CR dose taken 30-40 minutes before the desidered bedtime. For longitudinal analyses, we used the general linear model for repeated measures with a factor for comparisons within subjects. Twenty children completed the study. Clinical interview confirmed a high prevalence of sleep problems with PDD, including difficulty settling to sleep (18/20), lengthily episodes of night waking (13/20), shortened night sleep duration (10/20) and seasonal changes in sleep problems (3/20). No significant irregularity of sleep/wake pattern was found. Moreover, cosleeping, the practice of parents and children sleeping together in body contact for the whole night, was reported by 65% of children with PDD compared to 5% of controls (chi square <.001). Children with PDD scored significantly more than controls at CSHQ (66.9 vs. 38.4; p<.001). Bedtime was significantly later (23.15 vs 22; p<001), while no significant differences were found regarding risetime. Moreover, children with PDD slept significantly less (410 vs 610; p<.001) showing a significant number of long lasting nightwakings.
Repeated measures ANOVA results in CSHQ total and subdomains scores revealed long lasting positive melatonin effect. During treatment sleep patterns of all the children improved. In particular, rm-ANOVA results showed a significant reduction of bedtime resistance (p<.001) an increase of sleep duration (p<.001), a decrease of number and duration of nightwakings (p<.001) across time. One month after discontinuing treatment, 16 children had returned to pre-treatment sleep scores, whereas in 4 cases a slight improvement of CSHQ scores persisted (baseline vs discontinuing follow-up score 57 vs 47 p<.001). On the basis of these results, we decided to prescribe 6 months of melatonin treatment periods with two weeks interval free in 16 patients, whose sleep problems returned to baseline conditions, while the other 4 patients were told to remain without therapy. All twenty patients were reevaluated at 12, and 24 months from the beginning of the study. In 1 and 2-yr follow-up visits the continues showed a significant and long lasting improvement of sleep pattern (discontinuation vs 1- and 2 yr: 63 vs 44; < .001), the others maintained the improvement already obtained. No adverse side effects were reported or observed. In conclusion, results of our study highlights that assessment of sleep in PDD children need particular attention, because of the high prevalence, persistence and severity of the problem; Our long term follow up study underlines that CR melatonin may provide an interesting safe and well-tolerated treatment for sleep disorders in children with PDD.
Video-monitoring of night seizures in children

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The video-EEG-polysomnographic recording is the methodology in the study of different types of night seizures and sleep disorders in pediatric patients. The selection of the parameters to be recorded depends on the clinical questions to be addressed during monitoring (seizures, abnormal movements in wakefulness or sleep, apneas, gastroesophageal reflux (GER), etc. The parameters required for sleep staging are recorded in order to characterize events that may be associated with normal sleep or which may be abnormal events best categorized as sleep disorders.

There are age-dependent features of the EEG from the premature infant through adolescence including background activity during wakefulness and different sleep stages, the significance of interictal sharp transients, the characteristics of electrical seizure discharges and the electroclinical correlations.

The indications of video-monitoring for differential diagnosis of night seizures in pediatrics (age-specific) can be summarized as follows:

1. Diagnosis and differential diagnosis of abnormal clinical paroxysmal events:
   a. Neonatal monitoring: normal movements in wakefulness and sleep, non-epileptic apnea and bradycardia, obstructive or central apnea, GER, jitterings, epileptic seizures and non-epileptic seizures.
   b. Childhood monitoring: movement disorders, disorders of arousal and other parasomnias, behavioral disorders, unusual behaviors, reflex behaviors, pseudoseizures and syncopal seizures.

If the epileptic seizures are exclusively nocturnal, a differential diagnosis with parasomnias such as enuresis, nightmares, confusional arousals, night terrors, somnambulism, rhythmic movements during sleep, bruxism, etc. is of major importance.

Most of the children with unusual nocturnal arousals have disorders of arousal, and in these children video-monitoring generally is not indicated unless one is concerned regarding a pathological precipitating factor for the disorder of arousal such obstructive sleep apnea, GER or periodic movements of sleep.

2. Prognostic evaluation
   This is based on nocturnal sleep organization and sleep microstructure integrity. Epileptic seizures provoke nocturnal sleep disruption with high fragmentation, increased number of stage shifts, arousals, percentage of light sleep stages and decreased percentages of SWS and PS. The efficiency and continuity indexes decrease. Chronic sleep deprivation as a consequence of sleep disorder increases sleep fragmentation and is the cause of excessive daytime hypersomnolence and cognitive and behavioral disturbances. Furthermore, sleep deprivation could decrease the convulsive threshold in epileptic patients.

3. Assessment of therapy.
Antiepileptic drugs have an influence on sleep organization and architecture especially in cases of severe epilepsies treated with polytherapy. Sedatives or hypnotic drugs do not usually help to resolve sleep disorders during infancy and may even have adverse and paradoxical reactions. Benzodiazepines can be administered with caution in some parasomnias and other sleep disorders. Both, these drugs and antiepileptic drugs have an influence on sleep structure and architecture.

**Conclusions.** Long-term video monitoring during wakefulness and sleep is strongly recommended in the study of night seizures in children. The differential diagnosis between nocturnal epileptic seizures and parasomnias and other sleep disorders is of major importance and requires the use of this methodology.
Sleep-disordered breathing, PLMs, and ADHD: cause and effect?

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Introduction: Children referred to sleep disorders centers and found to have sleep-disordered breathing (SDB) or periodic leg movements during sleep (PLMS) often have inattention, hyperactivity, or attention-deficit/hyperactivity disorder (ADHD). Some children with these sleep and behavioral problems experience improved behavior when their sleep disorders are treated. However, the extent to which SDB and PLMS may cause or contribute to hyperactive behavior is not well known.

Methods: Although a prospective, placebo-controlled, randomized and double-blind trial might be the most effective strategy, an ethical barrier exists in that many clinicians and families of subjects would not accept placebo treatment for SDB, or for PLMS if associated with restless legs syndrome. We have taken other approaches, including surveys at child psychiatry and general pediatric clinics; assessment of behavior in referred sleep laboratory patients; and prospective examination of sleep and behavior in children already scheduled, for clinical purposes, to undergo adenotonsillectomy or unrelated surgical procedures.

Results: Surveys have shown clear associations between parent ratings for hyperactivity and symptoms of both SDB and PLMS. Referred children found to have SDB are rated as hyperactive, but not more hyperactive than referred children found to have no SDB. Furthermore, laboratory measures of SDB severity do not predict hyperactivity in referred patients. In contrast, the presence of PLMS does predict hyperactivity in these children, especially if the sample is narrowed to those who do have SDB, suggesting that SDB may modify an effect of PLMS on hyperactive behavior. Finally, standard pediatric polysomnographic measures in children scheduled for adenotonsillectomy do not predict hyperactivity well. The surgery does reduce hyperactivity and eliminate eligibility for a diagnosis of attention-deficit/hyperactivity disorder in a substantial number of patients. However, initial polysomnographic results do not predict effectively which children will experience improved behavior after surgery.

Conclusions: Evidence suggests, but has not proven, that untreated SDB and PLMS cause or contribute to ADHD or ADHD-like behavior in substantial numbers of children. Standard polysomnographic measures of SDB do not predict behavioral comorbidity or surgical outcomes well. Development of SDB measures that better reflect the clinical significance of the condition could improve patient care and shed light on underlying mechanisms by which sleep disorders affect brain function and daytime behavior.
Sleep-disordered breathing and movement arousals in children

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Introduction. Children with sleep-disordered breathing have a restless sleep reflected for example by an enhanced number of leg movements. To answer the question whether the enhanced number of leg movements in sleep is a own entity or these are movement arousals in response of an upper airway obstruction we investigated the prevalence of leg movements in sleep in OSAS patients before and after/under treatment (intraindividual comparison) as well as in OSAS patients and age matched children (interindividual comparison to exclude influence of age)

Methods. 25 children who had no OSAS (controls) (age 3.3 to 14.1 years, median 7.5 years) were examined polysomnographically (group 1). As well 25 age-matched patients with clinically confirmed OSAS and an apnea/ hypopnea index (AHI)>=5/h TST (total sleep time) were examined polysomnographically during one night before treatment (diagnostic night - baseline) (group 2) and one night after/under receiving therapy (group 3).

EEG frequency shifts greater than 1s in theta/alpha-range were scored as EEG arousals. Movement arousals (definition by Rechtschaffen & Kales 1968) were counted by leg movements (tibialis anterior EMG) together with an activation in another polygraphic parameter, for example heart rate, chin EMG or EEG. Furthermore the n° of periodic leg movements (ASDA definition 1992) were counted in the total sleep time (PLMS).

Results. Patients with clinically and polysomnographically confirmed OSAS had significantly more EEG-arousals (median 20.2/h TST, quartile range qur 10.1) and movement arousals (20.0/h TST, qur 12.6) before therapy than after/under therapy (EEG 8.6/h TST, qur 5.0, movement 9.8/h TST qur 4.2). The frequency of arousals was comparable in OSAS children after/under treatment and controls (EEG: 9.5/h TST, qur 3.7, movement: 8.9/h TST, qur 2.5). There is a high coincidence between EEG and movement arousals. 92% of OSAS patients had an enhanced PLMI>5/h.

Conclusions. OSAS in children is characterized by a restless sleep, characterized by a enhanced number of leg movements and a significantly enhanced number of movement and EEG-arousals. There is a significant diminition of movements and arousals under treatment. In controls and treated OSAS-patients the number of arousals is comparable.

The reduction of movements and so the normalization of the microstructure of sleep under treatment may be responsible for the significant improvement in behavoir and psychological function after therapy of sleep-disordered breathing in children. OSAS patients in childhood have a PLMD per definitionem (PLMS >5 per hour TST, changed daytime behavior) resolving by the therapy of sleep disturbed breathing. Because of the overlap of the symptoms sleep-disordered breathing should be considered in the differential diagnosis of children with PLMD, RLS (restless legs syndrome) and ADHD (attention deficit hyperactivity disorder).
References
Sleepiness in ADHD children: impact of clinical subtype on MSLT profile

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Introduction: Polysomnographic studies conducted in ADHD children failed to show striking abnormalities in sleep architecture and continuity. Combined measurements of sleep and daytime sleepiness may provide more information and may lead to a better understanding of the syndrome. Sleepiness is an important physiological variable, rarely addressed in ADHD studies (Palm et al., 1992). The multiple sleep latency test (MSLT) is an appropriate test to measure sleepiness in normal children, seven years of age and older (Carskadon and Dement, 1982). The aim of the present study was to measure sleepiness in ADHD children and to compare MSLT profiles according to the clinical subtype.

Methods: 30 ADHD boys (DSM IV), mean age 7.8 ± 1.6 years, underwent all-night PSG followed by 4 MSLT (10 am to 4 pm) in the sleep laboratory. The clinical subtypes (DSM IV) were as follows; combined type (n=16), predominantly inattentive (n=9) and predominantly hyperactive-impulsive (n=5). All subjects were unmedicated. Subjects were also evaluated using Conners Parent Rating Scales (CPRS), Conners Teacher Rating Scale (CTRS) and Abbreviated Conners Rating Scale (ACRS).

Results: PSG findings did not differ significantly from those of a control group sex and age-matched. Mean sleep latency at MSLT was (16.7 ± 5.4 min). ADHD children who fell asleep more than three times at MSLT had predominantly inattentive type. Children from the predominantly hyperactive-impulsive subgroup were more opposant to the test but once in bed could fall asleep very rapidly (less than 5 minutes in 2 MSLT for 2 subjects). Most of the children belonging to the predominantly inattentive subgroup fell asleep on 3 or 4 occasions.

ADHD children with moderate inattentive-passivity indice at CTRS (40-50) had sleep-onset latency values distributed around the 15 minute value where children with high indice (>50) had shorter sleep-onset latencies. Sleep-onset latencies were more spread out (10-50 minutes) in children with moderate Conners hyperactivity-impulsivity indice (<70 at CPRS and <60 at CTRS) and were very short (<10 minutes) in children with severe indice (>80). We report a negative correlation between sleep-onset latencies and hyperactivity-impulsivity indice at CPRS (p<0.001) and at CTRS (p<0.002). A positive correlation was found between the number of sleep-onsets at MSLT and the inattentivity-passivity indice at CTRS (p< 0.008).

Conclusion: Children with ADHD have an abnormally strongest tendency to fall asleep during the day. In the present study, the number of daytime sleep-onsets and the rapidity of sleep-onsets measured by MSLT were pertinent physiological indices to discriminate between ADHD subtypes.

References
Hyperactivity and inattention in OSAS children

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Children with OSAS (Obstructive Sleep Apnea Syndrome) have been often described to manifest nonspecific behavioral difficulties: hyperactivity, irritability, aggressiveness, restlessness, bedtime resistance, morning headaches and learning disabilities and they can be inaccurately diagnosed as attention deficit hyperactive disorder (ADHD). Externalizing behaviors problems are frequently reported symptoms of OSAS children, but none is patognomonous for OSAS and the reported prevalence of these symptoms is usually well below 50% (Nieminen, 2002). Furthermore, inattention and hyperactivity are common daily behaviors in children, especially in preschool-aged children, and are often transient and generally remit within 3 to 6 months (Connor et al, 2002). It is likely that inattention and hyperactivity have multiple causes and, when they don’t submit criteria for ADHD diagnosis, can be associated or due to cognitive impairment, language and learning disabilities, psychological and psychiatric disorder, family environment, medical conditions.

Few data are available from population-based studies on the behavioral and neurocognitive consequence of OSAS in children and the reported data often did not control for potentially important confounding factors. Most of the studies concerning neurocognitive and behavioral functions in sleep-related breathing disorders (SBD) in children lack objective measurements and are mainly based on parental reports. However, the only approach used to establish if hyperactivity and inattention rise to the level of behavioral disorders are parent’s and teacher’s checklist (the same used for ADHD diagnosis: CBCL, Conner’s Teacher and Parent Rating Scale, ADHD Rating Scale DSMIV), while attention deficit can be evaluated with tasks for assessment of sustained attention (parameter of daytime sleepiness) and selective attention. Using above-mentioned questionnaire, Ali et al. (1993) reported that children aged 4-5 years, whose parents report snoring, showed more behavior problems (hyperactivity and inattention) than control. Also Lewin et al. (2002) confirmed that children with OSA had significantly more behavior problems than controls. Children diagnosed with moderate to severe OSA had significantly lower scores on a task that assesses sustained attention. A significant association was found between OSA severity and measures of verbal ability.

In a recent study, Chevin et al. (2003) concluded that bullying and other specific aggressive behaviors were generally 2 to 3 times more frequent among 114 children at high risk for SDB than among the remaining children. A strong association between SDB symptoms and problem behaviors (inattention,
hyperactivity and aggressiveness) has been recently confirmed (Owens et al., 1998; Gottlieb et al., 2003). Blunden et al (2001) underline the emerging evidence that children with SBD show increased problematic behaviour, impaired school performance and reduced neurocognitive functioning especially in the inter-related areas of attentional capacity, memory and cognitive function. Rhodes et al. (1995) in obese children had been previously found a significantly and inversely correlation between AHI and memory and learning abilities. Gozal et al. (2001) compared the top 25th percentile of 13-14 years olds in a grade to the lowest quarter percentile of the grade and evaluated symptoms of OSAS like snoring: results showed that children who had a lower ranking were more likely to have snored as younger and to have required adenotonsillectomy procedures. This is suggestive that the OSAS created a learning deficit that could not be recovered.

Early reports suggest that appropriate treatment of OSAS seems to improve associated behavioral problems. Aggression, inattention and hyperactivity have been found to improve after adenotonsillectomy, along with a positive effect on vigilance, reflectiveness and impulsivity, in children with mild forms of OSAS (Ali et al, 1998); but on Conner’s Behavior Scale only parents reported significant improvements in all 3 behavior subscales, while teachers had not observed any obvious changes postoperatively. The improvement was confirmed in a group of patient aged 2 to 18 years with symptoms of nighttime snoring, observed apneas and daytime mouth breathing (Goldstein et al., 2000) following tonsillectomy and adenoidectomy.

Therapeutic intervention determines short-term effects and long-term effects also on academic performance. The children who had OSAS and had tonsillectomy and/or adenoidectomy had a significant increase in their grades; the students with OSAS who had no intervention and the students without OSAS did not have any significant improvements in their grades (Gozal et al, 1998). Some authors, instead, did not find that treatment of OSAS could lead to reduction of behavioral symptoms (Harvey et al., 1999).

In conclusion, OSAS can lead to mild ADHD-like behaviors that can be readily misperceived and potentially delay the diagnosis and appropriate treatment. The nature of this association is still unknown. Data obtained from adult patients with OSAS correlated neuropsychological deficit to hypoxemia or sleepiness or damage of frontal cortex. Beebe and Gozal (2002) have recently proposed a model to explain how sleep disruption and blood gas abnormalities that occurs in OSAS children prevent sleep-related restorative processes, and further induce chemical and structural central nervous system cellular injury. This, in turn, leads to dysfunction of prefrontal regions of the brain cortex (PFC), manifested behaviourally in what neuropsychologists have termed ‘executive dysfunction. Executive dysfunction is proposed to markedly affect the functional application of cognitive abilities, resulting in maladaptive daytime behaviors.
Scoring sleep, arousals and respiratory events in children. Is it time to change?

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Polysomnography has been performed from premature infants till 18 years of age. The scoring criteria are different with age, but starting 6 months of age the Rechtschaffen and Kales basic criteria can be considered. However this criteria have not been changed for more than 30 years. Similarly to adults there have been adjunctions to the scoring of sleep and its disorders in children compared to the basic scoring of Rechtschaffen and Kales. Often the integrations of changes made in adults has been the trend.

**Sleep scoring**
- Sleep: A minimum time of recording is requested, it is usually not less than 8 to 8 ½ hour
- Basic scoring in 5 stages (1/4 and REM) follows the rules outlined in Rechtschaffen and Kales.
- Addition: short alpha or alpha/beta arousal: follow the rules published in *Sleep* 1992 by ASDA.
- Definition of sleep onset follows Rechtschaffen and kales and 16 seconds of sleep during a 30 second epoch is requested
- REM sleep is scored following Rechtschaffen and Kales, identification of a rapid eye movement and back tracking from there is the rule
- Body movement: as in Rechtschaffen and Kales

**Sleep Disorder Breathing (SDB)**

Apnea and Hypopnea are defined as lasting longer than two breaths. Based on this definition, apnea is the absence of airflow for longer than 6 seconds in young children and 10 seconds or longer in older children. Scoring criteria of SDB were established before scoring

**Apnea**
- the absence of airflow at nose and mouth for longer than 2 breaths, independent of O₂ desaturation or EEG arousal. Subdivision into central, mixed or obstructive was based on airflow and Pes recording.
**Hypopnea**
- A reduction by at least 50% in nasal flow signal amplitude for a minimum of 2 breaths. Scored independent O₂ desaturation or EEG arousal. Often but not always associated with snoring.

**Abnormal Respiratory Effort**
- A reduction in nasal flow of less than 50% with flattening of nasal cannula signal:
  - Flow limitation and decrease in the mouth signal (thermistor).
  - Often seen with snoring
  - Increased effort shown on Pes signal called Pes Crescendo and Continuous Sustained Effort

**Pes Crescendo.**
- A sequence of 4 or more breathes that show increasingly negative peak end inspiratory pressure. May be seen with flow limitation on nasal cannula.

**Continuous sustained effort**
- Repetitive, abnormally negative peak end inspiratory pressures, ending at same negative inspiratory pressure without a crescendo pattern. Associated with discrete flow limitation on nasal cannula/pressure transducer signal, with “flattening” of the breath signal curve for at least 4 successive breaths.

**Pes reversal**
- The termination of an abnormal increase in respiratory effort with abrupt switch to a less negative peak end inspiratory pressure.

**Tachypnea**
- Increase in respiratory rate, above that seen during quiet unobstructed breathing, by a minimum of 3 breaths/minute in NREM sleep, or 4 breaths/minute in REM sleep, for 30 seconds or more. No changes in oxygen saturation, Pes or EEG were required.

**RERAs and Arousals**
- Respiratory Event Related Arousals (RERAs) as defined by the American Academy of Sleep Medicine.
- Arousals as defined by the American Sleep Disorders Association Atlas.

**Other Scoring Criteria**
- An abrupt, short burst of high amplitude slow waves in the slow theta or fast delta range (2.5 to 4.5 Hz), which may be seen with a breathing event
- Sleep/wake according to Rechtschaffen and Kales international manual.
Sleep stages scoring in infants: Rechtschaffen and Kales?

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The international consensus published by Rechtschaffen and Kales (1968) in “A manual of standardized terminology, techniques and scoring system for sleep stages of human subjects”, is still used for sleep stages scoring in adults. Some authors have applied these scoring rules in very young infants and sometime in newborns. The aim of our analysis is to point out on differences and some similarities of polysomnographic characteristics of sleep stages during the first year of life, as compared with the adult criteria. Recordings taken into account were performed using similar techniques and measurement of polysomnographic patterns as those described by Rechtschaffen and Kales.

We concluded that Active Sleep is very similar to REM stage pattern as soon as the first month of life, except of the slower EEG. Saw tooth rolandic waves can be observed beyond about 2-3 months. Infants are normally falling asleep in Active Sleep at least during the first few months of life.

Quiet sleep may present trace alternant or slow waves continuous pattern up to 4-6 weeks.

The appearance of spindles (beyond 6-8 weeks), allows to score stage 2 at the beginning of Quiet Sleep. Beyond 3 months of life, spindles are long lasting, before decreasing after 6-7 months. K complexes have not been observed.

Stage 3-4 can be individualized since the appearance of Stage 2. Distinction between stages 3 and 4 is difficult. Slow waves are very slow and of high amplitude, as compared with adults, with important between-subject differences.

Stage one can be distinguished around 5 month of age. It may appear as high voltage theta EEG hypersynchrony when the infant is falling asleep or awakening. Some vertex sharp waves can be found during the second half of the year.

In conclusion, Rechtschaffen and Kales criteria for sleep stages scoring are not adapted before 3-4 months of age. Beyond this age, many differences in EEG amplitude and frequency persist. Moreover, there are important inter-and intra- (from one sleep cycle to another) individual differences, whatever the age.
Scoring of sleep and wakefulness in infancy and childhood in dependency on age

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In 1968, 'A Manual of Standardized Terminology, Techniques and Scoring System for Sleep Stages of Human Subjects', edited by A. Rechtschaffan and A. Kales in cooperation with an international committee introduced a standard scoring system for human sleep on the basis of a visual epoch-by-epoch analysis of EEG patterns, eye movements and muscle tone. This manual, however, was designed for adult humans. Sleep medicine in infants and children is confronted with the fact that there are marked developmental changes of the central nervous system, which are reflected in the maturation of the electroencephalogram as well as in cardiorespiratory and other autonomic functions. Maturational trends are apparent in spectral analysis of EEG, of sleep EEG too. The power spectral analysis of sleep EEG patterns illustrates structural changes of sleep in different age groups. The appearance of specific wave forms in the EEG corresponds to maturity. Therefore features of the normal pediatric patterns in different sleep stages are changing in dependency on age. This must be considered in sleep scoring. For example sleep spindles can be seen firstly in infants aged 4 weeks. These spindles develop rapidly through 8 weeks and clearly characterize NREM sleep by 3 months of age. There is a progressive increase of inter-spindle intervals with maturation. K-complexes appear first around 6 months of age and are fully developed in children aged 2 years. If there are sleep spindles and K-complexes in EEG it is possible to score the sleep referring to Rechtschaffen & Kales (mostly after the 5th month of life) and thus to provide for continuity between infant and adult studies.

But in the age group 6 months to 3 years the discrimination of the different sleep EEG patterns is more complicated than in older children because the patterns are not so characteristically shaped. So we prefer the scoring for light sleep, including NREM 1 and NREM 2, and deep sleep or slow-wave-sleep, including NREM 3 and 4, as well as REM sleep. In children older than 3 years the scoring of sleep as proposed by Rechtschaffen and Kales is no problem, if age dependent variations of specific EEG patterns are considered. In infants and children EEG amplitudes during quiet/deep NREM sleep can be markedly higher than in adults. Therefore the Rechtschaffen & Kales rules for staging of NREM 3 and 4 (delta waves higher than 75 μV) are not applicable to children. Amplitudes are influenced not only by age, but also by several variables, for example time constants, the position of electrodes, interelectrode distance and the quality of electrode fixation (electrical resistance). Therefore the detection of high delta waves, characteristic for stage 3 (20-50% of an epoch) and stage 4 (>50% of an epoch), should be done in comparison with mean amplitudes of stage 2. Furthermore it is necessary to consider that there is a wide variability between and within subjects studied in the pediatric sleep laboratory.

References

POSTER PRESENTATIONS
Cerebral hemodynamics during arousals in preterm infants: preliminary data

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Objective: The aim of the study was to evaluate changes in cerebral hemodynamics during arousals in preterm infants.

Methods: Arousals were scored according to the guidelines of the Pediatric wake-up Club (Bruxelles 2002). Changes in cerebral blood volume (ÄCBV) and in cerebral hemoglobin oxygenation (ÄcHbD) were measured by near infrared spectroscopy (NIRS). Values of interest were assessed during the arousal period and 30 seconds before and thereafter. These periods were subdivided into 10 second intervals and compared to the arousal period.

Results: Polygraphic recordings were performed in 9 stable preterm infants (4 female) with a gestational age of 31.3 ±1.4 weeks, a postconceptional age of 34.6 ±1.1 weeks, a birth weight of 1515 ±235 g and an actual weight of 1768 ±128 g [mean (±SD)]. Sixty-five arousals with a duration of 7 ±2 seconds were scored. Respiratory rate increased (34 ±15 bpm) during the arousal when compared to the period preceding (30 ±15 bpm; p < 0.05) and following (29 ±10 bpm; p < 0.001) the arousal. Heart rate decreased during the arousal (131 ±31 bpm) when compared to the 10 second period preceding (142 ±15 bpm; p < 0.05) and following (139 ±20 bpm; p < 0.05) the arousal. ÄCBV (-0.011 ±0.071 ml/100g brain) and ÄcHbD (-3.440 ±1.000 mmol/l) slightly decreased during the arousal when compared to the period preceding.

Conclusion: Arousals in preterm infants are associated with a slight decrease in cerebral blood volume and cerebral blood oxygenation. The mechanisms leading to reduced cerebral blood volume / oxygenation during arousals remain to be clarified.
Relationships between pediatric sleep problems: a statistical point of view

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Introduction. Sleep questionnaires are easily used in research. On the one hand, the scarce information on definitions, prevalence and differential diagnosis of children's sleep problems sustains the use of adult classification systems as basis. Logically, when reviewing relevant literature, heterogeneity of sleep problem -definitions for the pediatric population is divulged. On the other hand, when a sleep questionnaire is used only few studies focus on its psychometric characteristics or describe the relationships between sleep problems from a statistical point of view.

Our aim was to explore the relationships between clinically common sleep problems. The health-behaviour questionnaire (HBQ), designed for our larger study and screening night time and daytime behaviour plus health of the school aged child, included the 26 sleep items from the Sleep Disturbance Scale for Children (SDSC) (Bruni et al 1996) plus 23 other sleep items dispersed over the HBQ. Since the SDSC had good psychometric characteristics, resembles the ASDC (1979) classification and results in 6 disorder-subscases we used it as core for the modulation of relationships between sleep problems.

Subjects and Methods. Caregivers of 3045 six to twelve year olds filled out the HBQ. 21 SDSC-items and 15 other sleep items were selected for further modulation.

The following structural equation models were tested exploring
(1) relationships within and between disorder-subscases,
(2) relationships between the disorder-subscases with 3 indexes added; i.e. sleep efficiency index, sleep environment index and sleep enuresis -index and
(3) relationships of the disorder-subscases to their categorization, dyssomnia and parasomnia, without and with the indexes (i.e. the final model).

Results and Conclusion. The final model had a satisfying fit and approximates the ASDC (1979) classification.

First, between the 2 categories, dyssomnias and parasomnias, a strong correlation was found which underlines clinical intuition. An outsider position of disorder-subscale Disorders of Excessive Somnolence , as specified in our study, was revealed as was the relation with the other disorder-scales and the categories of the in the ICSD (1990) proposed disorder-subscale Sleep Hyperhydrosis .

Secondly, each disorder-subscale can be used individually. Yet, the statistical point of view discloses that some items, that are commonly used, are of low value. Consequently their use as the inferences based on them should be watched over.

The overall fit of the model was improved by adding the 3 indexes. Here the complexity of sleep enuresis was exposed. An international classification system, where the presentation, the underlying causes, the significance and other are written, would be useful to all disciplines involved in pediatric sleep research.
Tactile communication, sleep and emotional expression in the first hours of life

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Objective. Effects of tactile communication on Behavioral States in the first hours of life. We match four newborns groups. Three groups receiving 8 of only tactile communications by an Adult standing behind the cradle:

a) Continuous Communication [CC] (8);

b) Discontinuous Non Periodic Communication [DNPC] (3 communication; 1 pause; 1 communication; 1 pause; 2 communication: 8);

c) Discontinuous Periodic Communication [DPC] (120 communication; 2 pause; 120 communication; 2 pause; 120 communication: 8);

d) one group receiving No Communication Control Group [NC].

Hypothesis. Groups will differ about 1) Behavioral States length 2) Active Sleep AS Phasic Events patterns; 3) AS Emotional Facial Expressions patterns.

Method. Obtained parents permission, we videotaped, without any interferences on normal routine, 74 full term healthy newborns in Quiet Alert (mean age 23 hours), for 120 (including 2 baseline and 8 communication), in Newborn care division Policlinico Umberto I*, University La Sapienza, Rome We codified: 5 Behavioral States [Wake, Drowse, Active Sleep, Quiet Sleep, Cry] (1); 4 AS Phasic Events [Isolated and Grouped Rapid Eye Movements, Facial Expressions, Body Movements] (1); AS Smiles (2).

Results. 51/74 newborns complete one Sleep Cycle within 120: 10/17 CC; 11/20 DNPC; 10/17 DPC; 20/20 NC.

- CC group shows: longest Wake (30), shortest AS (14), less frequent Grouped REM (1 each 12), more frequent Smiles (1 each 47);

- DNPC group, instead, has: short Wake (7), longest AS (27), most frequent Grouped REM (1 each 6), less frequent Smiles (1 each 405)

- DPC and 20/20 NC show intermediate patterns of Behavioral States, AS Phasic Events and AS Smiles, between 10/17 CC and 11/20 DNPC.

23/74 newborns, 7/17 CC, 9/20 DNPC, 7/17 DPC, don’t complete the Sleep Cycle within the 120; they also show the intermediate pattern.

Preliminary hypothetical interpretation. CC is continuous, predictable and pleasant, so the newborns stay pleasantly awake for a long time elaborating the communication completely. During the short AS, characterised by few Grouped REM, the newborns rehearse the elaboration pleasantly, as shown by the highest number of Smiles. DNPC, on the other hand, is discontinuous, not predictable and unpleasant, so newborns stay unpleasantly awake for a short time and elaborate the communication only partially. During the long AS, characterised by many Grouped REM, they still elaborate the communication unpleasantly as shown by the nearly total absence of Smiles.

Research perspectives. We are studying on all 74/74 newborns:

a. Smiles during the Communication and the Wake after Communication;

b. negative Emotional Facial Expression along the 120 ;
c. effects on newborns behavior of Adult’s hands presentation, at the end of the Wake after communication and of Sleep Cycle, in order to better understand the meaning of the behavior of the 10/17 CC and of the 11/20 DNPC in relation to the behavior of the 23/74 newborns without Sleep Cycle.

References
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Treatment of sleep terrors in children with L-5-hydroxytryptophan

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Objectives: To test the hypothesis that the administration of L-5-hydroxytryptophan (L-5-HTP) might exert beneficial effects on sleep terrors we conducted an open pharmacological trial in a group of children with sleep terrors compared to a group of children with the same disorder but without L-5-HTP treatment.

Participants: 45 children (34 males and 11 females; age range 3.2-10.6 years), referred to the Sleep Center of the Department of Developmental Neurology and Psychiatry of the University of Rome "La Sapienza", affected by sleep terrors.

Intervention: A dosage of 2 mg/kg/day of L-5-HTP was administered at bedtime to 31/45 randomly selected patients, for a single period of 20 consecutive days.

Measurements and Results: a) complete medical and sleep history; b) complete neurological examination and EEG recording during wakefulness and sleep, c) structured sleep diary for two months, d) after one month, all subjects were examined again from the clinical and EEG points of view, e) after 6 months, structured interview in order to evaluate the clinical outcome. After 1 month of treatment, L-5-HTP determined a positive response in 29/31 cases (93.55%) of cases. The complete disappearance of sleep terrors was achieved in 16/31 (51.6%) cases while 13 children showed a reduction > 50% in frequency of episodes. In the comparison group without drug therapy, after one month, 10 children (71.43%) showed the persistence of episodes with the same frequency as before; in 2 children (14.29%) the episodes disappeared and in the remaining 2 there was a reduction > 50% in frequency of events. After 6 months, 24/31 (77.42%) of children treated with L-5HTP were sleep terror-free, and another 2 (6.45%) had a reduction in frequency of attacks > 50%; sleep terrors were still present in five children (16.12%). Among the children belonging to the comparison group, 9 (90%) continued to show sleep terrors at 6-month follow-up, the remaining patient showed a reduction > 50% of the attacks.

Conclusions: To our knowledge, this is the first study demonstrating the efficacy of a new drug treatment for sleep terrors; in fact, the difference in sleep terror episode recurrence between children treated with L-5-HTP and those without drug therapy is clear and significant. These results confirm our initial hypothesis and represent the evidence that the treatment with L-5-HTP is able to modulate the arousal level in children and to induce a long term improvement of sleep terrors.
Epileptic discharge during sleep

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Introduction. Sleep neurophysiology facilitate the spreading of abnormal electrical activity, mainly due to synchronization phenomenon. In 15% of epileptics subjects, seizures occurs mostly or exclusively during the night. Furthermore, abnormal movements (parasonias) and obstructive sleep apnea are frequently seen in children.

Objective. Evaluate the frequency of epileptic discharges in children with sleep disorders.

Methods. Electroencefalographic (EEG) abnormalities suggestive of epileptic discharges were selected in children and adolescents referred to polysomnography (PSG) in a university based general sleep laboratory.

Results. We evaluate 998 patients, aged 1 til 18 years, who were submitted to polysomnography between May and October 2003 in Instituto do Sono of Universidade Federal de Sao Paulo. Thirty five (3,5%) presented epileptiform EEG activity. Twelve were referred to the sleep laboratory to investigate parasomnias episodes, 13 for sleep-disordered breathing and 9 for possible nocturnal epilepsy.

Discussion. NREM related parasomnias are frequently encountered in a pediatric population, along with epileptic seizures such as Rolandic benign epilepsy. During PSG recordings, careful analysis of EEG channels, even in basal montages for respiratory sleep disorders, could help with diagnosis and advise on suitable epileptic treatment.

This work was supported by AFIP and FAPESP-CEPID 98/14303-3
Neuromuscular diseases, sleep and non-invasive ventilation

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Introduction. The physiologic decrement of minute ventilation during sleep is secondary to decreases in respiratory drive and muscle tone. Patients with neuromuscular and/or restrict lung diseases are prone to have respiratory irregularities during sleep. The first signs of alveolar hypoventilation occurs, as a general rule, during REM sleep.

Objective. Assess the characteristics of patients with neuromuscular disease referred for non-invasive ventilatory support.

Methods. Between June and October 2003, 99 patients with neuromuscular diseases, aged 8 til 41 years, three females, were clinically evaluated. Most of them had pulmonary function tests (Vemax®) and basal polysomnography (Alice Host®) performed. Twenty eight out 43 patients who were started on non-invasive mechanical ventilation, had polysomnographic BIPAP titration (Maestro®).

Results. Transcutaneous SaO2 and expired CO2 was normal during wakefulness in all patients. Forty three patients required non-invasive ventilation. Twenty six patients had sleep hypoxemia (1 also had hypercapnia) and reduced forced vital capacity (FVC), while 17 did not have nigh time hypoxia but had reduced FVC (< 40%) associated with clinical symptoms, repeated pulmonary infections and/or significant thoracic deformities.

Discussion. In this group of patients, sleep studies helped to indicate the need for non-invasive mechanical ventilation. Furthermore, a second night in the sleep lab was useful for adaptation and to establish adequate pressures and respiratory rate.

This work was supported by AFIP and FAPESP-CEPID 98/14303-3
POSTERS
The use of nasal cannulas in children screened for OSA: limits due to technical problems

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Introduction. Obstructive Sleep Apnea Syndrome in children can manifest as brief apneas (OA), hypopneas (OH) or flow limitations. Nasal cannulas (NC) or naso-buccal thermistors (NBT) have been proposed to measure airflow signal in polysomnographic studies, but several studies emphasized that NC are more effective than NBT [1,2]. The aim of our study was to assess the technical problems arising with the use of NC in polysomnographic studies of children screened for OSA.

Methods. We retrospectively evaluated all children’s recordings performed with the use of NC (Nasal Oxygen Cannula Allegiance, Children Size) in our lab in the last 8 months. 35 recordings were selected: 5 standard polysomnographic recordings in the laboratory (Embla; FLA GA); 21 afternoon abbreviated polysomnographic recordings in the laboratory (Embla; FLA GA) fitting the literature validity criteria (2 hours sleep with a REM period); 9 nocturnal cardiorespiratory sleep studies at home (Embletta FLA GA). Children (mean age 4.57±1.14, range 2-8) were referred to our centre by ENTs specialist because of clinical symptoms of OSA and adeno-tonsillar hypertrophy; they did not present active infections at time of sleep studies and were not on drug treatment.

We measured the quality of the airflow signal and considered an uninterpretable flow signal when flow respiratory fluctuation were unreliable for identification of respiratory events. We considered: 1) recording with uninterpretable flow signal (RU) when it was unreliable for >50% of the recorded sleep period; 2) recording with partially uninterpretable flow signal (RPU) when it was unreliable for <=50% and >10%; 3) recording with interpretable flow signal (RI) when it was unreliable for <=10%.

Results. Eighteen children (51.5%) showed RU; 10 children (28%) showed RPU and 7 (21%) showed RI. The main cause of NC malfunctioning was mouth breathing, then poor child compliance and less frequently sleep movements.

We compared the flow signal in the laboratory and home studies and found that 35% of laboratory recordings were RI vs 11% of home studies.

Discussion. NC are more accurate than NBT in identifying nocturnal obstructive events in OSAS children, in particular OH and flow limitation. However children with adeno-tonsillar hypertrophy are mouth breathers and literature data demonstrated that 29% of sleep studies were RU mainly for this reason [2]. Our study demonstrated an even higher percentage of NC unreliability (51%). Literature reports suggest using NBT addition to NC to improve the detection of respiratory events, but we emphasize the limits of NBT.

Our results also showed a better efficacy of laboratory recordings against home studies in terms of flow signal quality because of a presence of a technician to reposition NC. A new cannula needs to be designed to detect both nasal and mouth air-flow.

References
Association between Sleep Disordered Breathing (SBD) and Neurobehavioral Disorders in Children: a Case Report and Practical Implications

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The impact of SBD on daytime functioning in children is widely assessed (Blunden S et al., J Clin Exp Neuropsychol 2000). In particular, obstructive sleep apnea (OSA) has been associated with substantial morbidities affecting neurobehavioral systems which may not be completely reversed with appropriate treatment (Gozal D et al., Paed Respir Rev 2002).

Few patients with a common neurobehavioral disease in childhood, the attention deficit hyperactivity disorder (ADHD), referred to our Clinic in the last years and here we report a singular case.

Case report: L.G., 5 years old, came to our ward for out-patient scheduled examination. Since he was 3 years old, he suffered for intermittent asthma, recurrent upper airways infections, nocturnal oral breathing and snoring. During the visit, the parents reported that when their child went to the pre-school, he started experiencing attention deficit, hyperactivity, impulsivity and started having stammer.

The main observations to the physical examination of the child were alopecia and tonsillar hypertrophy, while the skin prick tests, which we also performed to the patient, showed a sensitization to inhalant allergens.

The severity of the sleep problems of this patient was assessed by nocturnal polysomnography and this study documented a primitive snoring (Apnea/Hypopnea Index <2). Our patient was referred to pediatric neuropsychiatrists who diagnosed the ADHD after psychiatric examination.

This patient underwent pharmacological treatment to prevent allergic asthma and to control snoring. Environmental measures were also recommended.

He was periodically followed by the psychiatric Clinic: the psychiatrists started a parents training to let them know how to deal with the condition of their child and adopted other specific psychiatric treatments.

We also set a follow-up to verify if an intervention on sleep and respiratory problems could affect the behavior and the neurocognitive performances of the patient.

After six months, during a second visit, we recorded a clinical improvement of SBD, of asthmatic episodes and we observed that the alopecia was completely disappeared in the child. Parents also referred improvements on daytime alertness although the patient kept having troubles with words articulation.

We conclude that a longer follow-up will probably help to better understand if interventions on sleep disorders might affect at least few aspects of ADHD. It is important that the interest in ADHD is increased as a result of the recognition that some neurobehavioral characteristics of children, like hyperactivity or impulsivity, underestimated in the past, may be signs of a complex disorder that requires a multidisciplinary approach.
Depression and trouble sleeping in childhood

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Introduction. Depressive disorders have a prevalence of about 2-3% in childhood; 0,3% in pre-school age, 2% in scholars and 5% in adolescents. Interesting links between sleep and mood regulation in children and adolescents have been reported, but the interactions are complex and not completely understood. Sleep onset disturbances occur in one out of three children with depressive disorders, although most studies have indicated that sleep structure is relatively unaffected. It is important to note that sleep disturbance is among the diagnostic criteria for affective disorders. As many as 90% of depressed children and adolescents report significant changes in sleep duration and poor sleep quality with 75% meeting diagnostic criteria for insomnia. The study of sleep disorders is very useful in understanding the whole clinical picture as well as the course of the disease. Therefore the examination of sleep problems in childhood may be helpful in recognizing subjects with an increased risk for affective disorder.

Aims. The purpose of this research is to assess the association between children’s trouble sleeping and depression in the age range from 3 to 13 years. This study analyses the clinical features of sleep disorders and their impact on the mood disorder organization.

Methods. The sample consists of 80 children who met DSM IV criteria for Depressive Disorders (50 males and 30 females – mean age 7,6 years; s.d.3; range 3-13.4 years) consecutively referred to our out-patient service for psychopathological developmental disorders during the last year. The subjects underwent psychodiagnostic and neuropsychological assessment, including children interview, play observation, spontaneous drawing and a specific battery tests (WISC-R, K-SADS PL, CDI, CDRS-R, Rorschach, CGI). The whole sample was divided in two subgroups: [A] presence of sleep disorder and [B] absence of sleep disorder. Age, gender, clinical history, parental psychopathology, comorbidity, course and severity of depression were evaluated.

Results. The prevalence of sleep disorder in the total sample was 68% (54/80). Of these 54 depressed children, 26 (48%) presented early sleep disorders, before the onset of the depressive disorder. In the remaining 28 (52%), the sleep disturbance appears within the depressive clinical picture. A positive correlation was found between sleep disturbance and course and severity of depressive disorder, parental psychopathology and the number of family components. The different types of sleep disturbances were homogeneously distributed in our sample and no specific sleep disorders were found to be associated with depressive disorders in children and adolescents. Although no statistically significant gender differences for the prevalence of sleep disorders was found, females presented a high prevalence of irregular sleep and parasomnias.

Conclusion. Sleep disturbance is frequent in depressed children and adolescents but it seems to be an aspecific symptom in its different clinical manifestations. The predictive value of sleep disorders is to be further investigated.
Sleep disturbances in depressed and traumatized children

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Introduction. Sleep difficulties in children are among the most common disturbances that families refer to the attention of pediatricians and child neuropsychiatrists. The vulnerability of the biological, physiological and psychosocial mechanisms that lead to consolidated sleep-wake patterns is demonstrated by the close relationships between sleep disturbances, psychopathology and trauma. In clinical populations of children and adolescents sleep problems have been associated with many disorders including depression as well as post-traumatic stress disorders. Recent studies have demonstrated that traumatized children show high rates (>50%) of sleep disturbances (mostly nightmares, night terrors and bedtime resistance). About ninety percent of depressed children and adolescents reports significant changes in sleep duration and poor sleep quality. Recent researches have assessed comorbidity between sleep, trauma and affective disorders and have identified sleep troubles as early predictors of affective/behavioral disorders in adults.

Aims. The purpose of this study is to assess associations between quantity and quality of sleep in depressed and traumatized children, in order to point out differences and analogies of the clinical sleep disturbances in the two samples.

Methods. Ninety-two children consecutively referred to our out-patient service for psychopathological developmental disorders during the last 2 years, were retrospectively analyzed. The sample was composed of: a) 46 traumatized children (mean age 7.6 years); b) 46 depressed children (mean age 7.5 years).

From the clinical charts, data regarding psychodiagnostic and neuropsychological assessment and sleep disorders were derived. In the clinical charts, a section was devoted to sleep behavior and disturbances from which we obtained data on the presence of early sleep disorders and of the clinical type of sleep disorders. The prevalence of different types of sleep disorders was analyzed between the two groups.

Results. No differences between depressed and traumatized children have been found regarding the prevalence of bedtime difficulties, parasomnias and cosleeping, while a higher presence of night awakenings and early morning awakenings was found in depressed children (62% vs. 10%; chi-square 13.76; p<.001). Intragroup analysis showed that cosleeping in traumatized children (51%) and night awakenings and early morning awakenings in depressed children were the most prevalent sleep abnormalities.

Conclusion. Night awakenings was the sleep disorders that differentiated the two groups most represented in depressed children. Cosleeping in traumatized children could be related to the characteristic relationships of families with traumatized children.
European Pediatric Sleep Club