E.A. Abashidze

Scientific Centre of Children's Health, RAMS, Moscow

Sleep quality assessment in children with somatic pathologies and nervous system diseases

Contact information:

Abashidze, Eka Amiranovna, is a post-graduate student of the laboratory and instrumental diagnostics office of the Consultation&diagnostics Department at Preventive Pediatrics& Rehabilitation Care Center at the Scientific Centre of Children's Health, RAMS

Address: 119991, Moscow, Lomonosovsky ave, 2/2 **phone:** (495) 967-14-20

Received: 22.11.2011, accepted for publication: 01.03.2012

This research work was intended to assess the nature of sleep changes in children with various pathologies. The study involved 103 children who were later divided into three main groups: children with diseases of the nervous system, ENT disorders and allergic diseases. Polysomnography was carried out for all children - the synchronous recording of various physiological parameters during sleep. The vast majority of patients in groups under survey had a changed sleep microstructure in comparison with healthy children (control group). Breathing disorders during sleep could be observed in the form of apnea / hypopnea episodes. These changes were associated with the severity of somatic pathology.

Key words*: children, sleep assessment, sleep disorders, allergic diseases, ENT pathology, diseases of the nervous system, polysomnography.*

Sleep is a vital periodical functional state of the body, that takes a person about a third of every day and can be characterized by the absence of any physical activity, by an almost complete shutdown of external world sensory effects, by dreams, and also by specific electrophysiological, autonomic and humoral presentations [1]. Currently, there is a high prevalence of sleep disorders in the pediatric population. According to the recent survey by U.S. physicians, about 25% of children aged under 5 years old already have sleep problems. The study by P. Lam (2003) noted that sleep disorders diagnosed in children under 1 year tend to become chronic in 32% of cases.

Here is a list of long sleep disorders' consequences: attention deficit, hyperactivity disorder syndrome [2], aggressive and deviant behavior [3], and reduced learning ability [4]. Some negative effects of sleep disorders on child growth and development were discovered [5, 6], as the growth hormone is produced during sleep. Life quality for parents, whose child experiences sleep disorders, decreases inevitably [7-9].

Thus, proper sleep is one of the most important components for the health of a child of any age.

In the 1950s, American scientists N. Kleitman and J. Azerinsky were the first to describe sleep phases. N. Kleitman, who organized the first "sleeping" school, read it from the Soviet press that children observed during sleep were making some specific movements with their eyeballs. He decided to verify the information and record these movements. The experiment was a success and showed that sleep is obviously an inhomogeneous state.

Thus, sleep was divided into two main phases: quick sleep, which is usually called a rapid eye movement phase, and a slow wave sleep.

In recent years, the studying of disordered breathing during sleep became one of the prioritized medical streamlines. This is due to the fact that this pathology is quite common among children and affects their life quality.

Among the most noteworthy risk factors associated with sleep, there is breathing disorder which undermines episodes of temporary breathing cessation (apnea), which is the most common dissomny presentation.

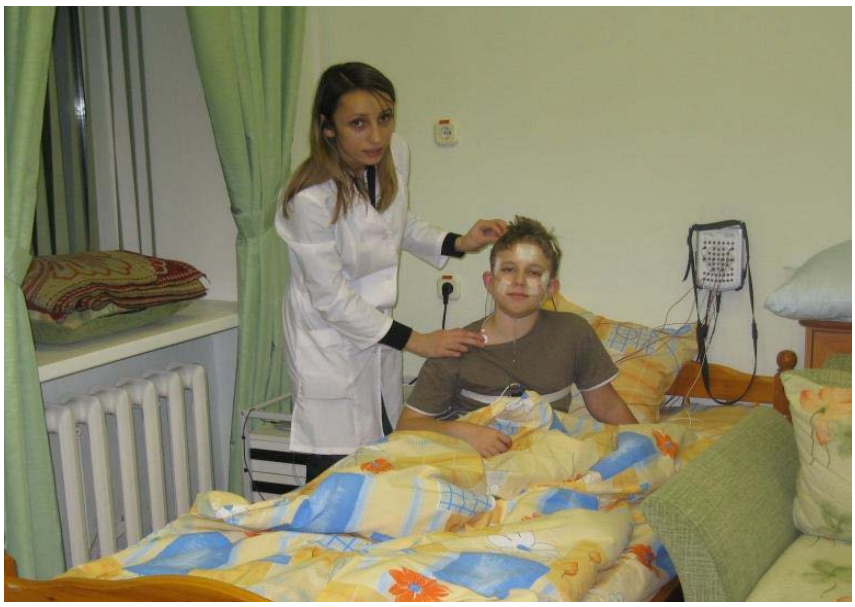
Nowadays there are no more arguments concerning that about 90% of all apnea episodes during sleep are associated with upper respiratory tract obstruction (the so-called obstructive sleep apnea (OSA) [10].

OCA in children has been first described in the literature by Guilleminault in 1975 [11]. Obstructive sleep apnea is a breathing disorder characterized by prolonged partial and/or transient complete upper respiratory tract obstruction [12]

The main method of instrumental diagnosis of sleep disorders is a night polysomnography (PSG) which is an objective method of sleep structure research (Fig. 1). This method involves a parallel registration of the following parameters: electroencephalogram, electrooculogram, electromyogram, electrocardiogram, blood pressure, locomotor activity (overall and in the extremities), respiratory movements of chest and abdominal wall, oronasal air flow, level of oxygen saturation in blood, video monitoring.

Polysomnogram is used to diagnose a wide range of sleep disorders and serves as a valuable diagnostic method that allows perform an objective evaluation of sleep disorders and accurately determine the cause of illness in each particular case [13].

Fig. 1. Preparing for polysomnography



Patients and methods

This survey was based on the care effected in the laboratory and instrumental diagnostics office of a Consultation&diagnostics Department at Preventive Pediatrics& Rehabilitation Care Center in Child Health Research Center of RAMS.

The study included 103 children aged 3 to 17 years having diseases of the nervous system, ENT disorders and allergic diseases (AD).

Healthy group to compare with was comprised of 13 healthy children (7 girls and 6 boys) with a median age of 10 years with interquartile span of 8.0, 14.0.

Group I included 35 children (24 boys and 11 girls) having various pathologies of the nervous system: 15 children (45%) with parasomnias, 8 (24%) - with epysyndrome, 6 (11%) - with cefalgia, 3 (10%) - with the syndrome of hyperactivity and attention deficit, and 3 (10%) - with neurogenic urinary bladder dysfunction. The median age of patients of this group was 9.0 years (with interquartile scale of 5.0, 12.0). Depending on the presence of the concomitant ENT-pathology, patients of this group were divided into 2 groups: 1st - children having this pathology (adenoids, tonsillar hypertrophy), 2nd - children with no signs of ENT diseases.

Group II included 25 children (17 boys and 8 girls) having ENT disorders (adenoids of II-III degree, tonsillar hypertrophy of II-III degree) with a median age of 8.7 years (4.4, 23.1).
Group III included 30 children (20 boys and 10 girls) having AD: bronchial asthma, moderate and severe (atopic) allergic rhinitis in remission. Median age is 13.5 (8.0, 14.0). All the children in this group underwent the basic anti-inflammatory therapy, which was presented with inhaled corticosteroids, and these children were supervised by the specialist (allergist / pulmonologist).

To assess the quality of sleep in children there was used a "Questionnaire for the assessment of sleep", which is a Russified analogue of the Child Sleep Questionnaire.

This questionnaire is designed to assess the sleep quality as of a healthy child as of the patient with disease, irrespective of nosology. Basing on the objective and subjective assessments of

respondents, this questionnaire forms of physical performance indicators of both physical (physical activity, the role of physical problems in limiting life activity, general health) and psychosocial status of the child (general behavior, school performance). This questionnaire helped to carry out a survey with the following data provided: sleep history of the child; symptoms observed during sleep and daytime; pre-history: the presence of somatic diseases, diseases of the nervous system, the real history of the disease: bad habits of the child, current school performance, information on the family and the presence of sleep disorders in family members. Questionnaires were filled with patients' parents during the interview.

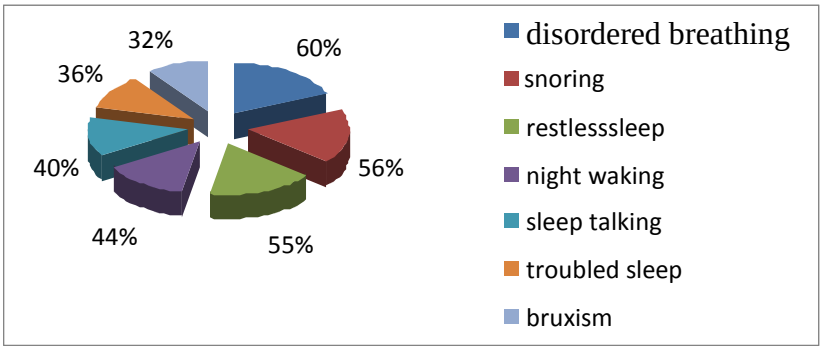
Statistical processing was performed using the software package SPSS 16.0. Since distribution of the majority of the investigated substances was not normal, and the group variances were not equal, the differences between groups were determined using the nonparametric Kruskal-Wallis test, and upon the detection of statistically significant differences there were performed pairwise comparisons using Mann-Whitney test. Differences were considered statistically significant at $p < 0,05$ [14].

Survey results and discussion

75% of patients complained on sleep disturbances (Fig. 2). A rather low subjective assessment covered all the main characteristics of sleep, among which the most significant were respiratory disorders, snoring, restless sleep and night waking.

Among the complaints were in the lead disordered breathing during sleep and snoring, restless sleep are also featured, night waking, difficulty falling asleep, increasing the time needed to fall asleep, troubled sleep, sleep talking, bruxism, daytime sleepiness, anxiety in the morning (see Fig. 2).

Fig. 2. The structure of the complaints of sleep disturbance complaints



The most common sleep disorders in children with ENT-pathologies included breathing disorders during sleep in the form of apnea / hypopnea episodes along with changes in sleep architecture, and these changes were associated with severity of somathic disease course.

Conducting of PSG among children showed that the percentage of time that falls on the first sleep stage (S1) is the highest in groups III and I, and it was also significantly different in group II

compared with the control group (pls refer to Table). Duration of second stage (S2) was increased in all groups compared with the control group, while most of second stage's length was observed in children of group II.

In contrast, the duration of slow wave sleep stages (S3 + S4) decreased in all groups, and its lowest recorded duration was registered in group III. REM sleep (rapid eye movement phase) was also decreased in all groups compared with that of a control group. Thus, the identified changes prove the violation of microstructure of sleep architecture and microstructure (description of the phases and stages).

An increased wakefulness during sleep was registered in children of group III in comparison with other groups and the control group.

In addition, apnea / hypopnea index (NCI) was the highest in patients of group II and was significantly different from that of the children in I, III and comparison groups. These differences can be explained by the fact that group II consisted of children having ENT disorders. In addition, the value of NCI was also significantly higher in group I compared with group III and control group, which is probably linked with prevalence of neurological symptoms in children in group I; there were also identified patients with concomitant ENT-pathology that led to an overestimation of NCI indicator.

There were registered no significant changes in sleep duration, in latency of sleep stage I, the average figure of minimum oxygen saturation and in heart rate during the study period of night sleep of the children surveyed.

Thus, the survey results show that the vast majority of patients under study underwent various changes in sleep architecture compared with that of the control group.

In particular, among these changes there is an increase in representation of the early stages of slow wave sleep, of wakefulness within the sleep time along with the reduction of REM sleep and deep stages of slow wave sleep. Various complaints on sleep quality decrease had place for the majority of children having diseases of the nervous system, and ENT-organs pathologies.

Thus, PSG is a highly informative method, which makes it possible to measure the degree and nature of sleep disorders in children having various pathologies, to form an accurate diagnosis; to timely develop optimal treatment and to assess its effectiveness.

This all allows to successfully carry out research on children of all ages and to repeatedly apply it to dynamics assessment, along with the therapy.

References list

1. A. Wayne A., Hecht K. Sleep of a man. Physiology and pathologies. M,: Medicine.1989.272 p.
2. Melendrez D., Sisley B. et al. Nasal dilator strip therapy for chronic sleep maintenance insomnia: a case series. *Sleep breathing*. 2004. P. 133−140.
3. Owens J.A. et al. Pediatric restless legs syndrome: Qualitative analysis of symptom descriptions and drawings. *Sleep*. 2008; 33.
4. Gozal D. Sleep disordered breathing and school performance in children. *Pediatrics*. 1998; 102.
5. Jan J., Reiter R., Bax C. et al. Long-term sleep disturbances in children: A cause of neuronal loss. *European journal of pediatrics*. 2010; 14: 380−390.
6. Tikotzky L. Sleep-wake patterns in children with intrauterine growth retardation. *Journal of child neurology*. 2010; 17 (12): 872−876.
7. Hiscock H., Wake M. Infant sleep problems and postnatal depression: a community-based study. *Pediatrics*. 2001; 107 (6): 1317−1322.
8. Mindell J.A., Owens J.A. A clinical guide to pediatric sleep: Diagnosis and management of sleep problems. Pediatric Clinics of North America. 2003.
9. Tarasenko E.S., Blokhin B.M., Poluektov M.G. and others. Life quality of parents of children having sleep disorders. Proceedings of the XIV Congress of pediatricians of Russia "Actual pediatrics problems". Moscow, February 15-18. 2010. p. 779.
10. Kalinkin A.L. Polysomnogram research. Functional diagnostics. 2004, 2: 61-65.
11. Guilleminault C., Dement W.C., Monod N. Sudden (infant) death syndrome: apnea during sleep. New hypothesis. *Nouv Presse Med*. 1973; 2 (20): 1355−1386.
12. Loughlin G.M., Brouillette R.T., Brooke L.J. et al. American Thoracic Society Standards and indications for cardiopulmonary sleep studies in children. *Am J Respir Crit Care Med*. 1996; 153: 866−878.
13. Butkov N. High standards in sleep medicine and polysomnography. School of Clinical Polysomnography: Medford, USA. 2005. p. 74-75.
14. Petrie A, Sabin C. Medical Statistics Visuals. M. GEOTAR Media. , 2009. 168 p.

Table. Objective measures of sleep structure

Polysomnography measurements	**The median [interquartile range]**			
	I group	**II group**	**III group**	**Control group**
Age	9,0 [5,0; 12,0]	7 [6; 9]	13,5 [8,0; 16,0]	10 [8,0; 14,0]
I sleep stage (S1),%	13,9 [5,5; 23,3]	8,7 [4,4; 23,1]	18,7 [7; 24,2]	6,9 [2,8; 9,0]
II sleep stage (S2), %	37,4 [29,4; 45,8]	41,3 [34; 45,6]	40,5 [34; 43,9]	30,6 [29,0; 41,4]
Slow wave sleep stage (S3+S4), %	22,9 [18,8; 32,0]	23,05 [18,1; 29,1]	22,4[18,9; 28,0]	36,5 [28,9; 38,0]
REM phase	14,8 [10,1; 19,0]	14,5 [5; 19,7]	14,9[10,3; 18,0]	24,0 [20,8; 27]
Wakefulness during sleep (minutes)	3,1 [0,8; 7,5]	4,4 [0,6; 7,8]	5,4 [2,9; 9,1]	1,5 [0,6; 3,0]
BMI (Body mass index)	17,5 [15,0; 22,2]	18,6 [16,5; 22,3]	9,3 [17,6; 21,3]	8,0 [16,7; 19,5]
Sleep duration (minutes)	462 [445,6; 517,0]	471,5 [405; 514,4]	495,1[429; 551,7]	484 [477; 504]
NCI	1,5 [0,5; 2,3]	4,8 [3,3; 7,2]	0,3 [0,0; 1,2]	0,3 [0,2; 0,4]
SpO_2	98,2 [98,0; 98,5]	97,6 [95; 98,4]	98,05[97,5; 98,7]	98 [97,8; 98,7]
HR (beats per minute)	72 [68,9; 81]	78 [70; 88,3]	66,5 [61; 78,7]	73 [68; 74,6]
Sleep effectiveness, %	95,9 [90,5; 98,3]	94,3 [90; 99,4]	93,7[90,9; 95,7]	98,5 [94; 99,9]
The latent period of stage I (minutes)	14 [5,3; 29,0]	23,1 [5,1; 29,6]	8,4 [5,6; 18,7]	14 [13,2; 15,0]

Note. BMI - body mass index, NCI - apnea / hypopnea index, SpO2 - oxygen saturation, HRS - heart rate.