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ORIGINALARBEIT

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An algorithm for the differential diagnosis of daytime sleepiness in childhood

Algorithmus zur Differenzialdiagnostik der Tagesmüdigkeit im Kindesalter

▶ **Zusammenfassung** Vermehrte Müdigkeit am Tage ist das Leitsymptom eines nicht-erholsamen Schlafs. Klagen über Unruhe und Reizbarkeit des Kindes können im Vordergrund stehen und die Müdigkeitsproblematik maskieren. Unter Berücksichtigung der großen Spannweite vom 1 Tag alten Neugeborenen bis zum 18-jährigen jungen Erwachsenen kann die Abgrenzung von physiologischer entwicklungsbedingter Veränderung des individuellen Wachheitsgrades von einer pathologischen Müdigkeit bei Patienten mit hypersomnischen bzw. insomnischen klinischen Erscheinungsbildern mit besonderen Schwierigkeiten verbunden sein. Deshalb wurde in der Arbeitsgruppe Pädiatrie der Deutschen Gesellschaft für Schlafforschung und Schlafmedizin ein diagnostischer Algorithmus erarbeitet, der ein rationales Vorgehen unter Berücksichtigung der Internationalen Klassifikation der Schlafstörungen (International Classification of Sleep Disorders, ICSD) sowie einen rationellen Einsatz von Ressourcen gewährleisten soll.

▶ **Schlüsselwörter** Schlafstörungen bei Kindern – Tagesmüdigkeit – Differenzialdiagnose – Algorithmus

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▶ **Summary** Hypersomnolence is the leading symptom of non-restorative sleep. Complaints of the child's restless, irritative or aggressive behaviour may be prominent, masking the problem of sleepiness. Assessing the significance of daytime sleepiness in pediatric patients may be difficult with respect to the child's age, ranging from the 1-day-old newborn infant to the 18-years-old adolescent. Physiological developmental changes of the individual degree of wakefulness have to be distinguished from pathological sleepiness in patients with hypersomnic and insomnic states. Thus, the Pediatric Group of the German Sleep Society (DGSM) has elaborated an algorithm providing a rational pathway with respect to the International Classification of Sleep Disorders (ICSD) as well as an economic use of resources.

▶ **Key words** sleep disturbances in children – daytime sleepiness – differential diagnosis – algorithm

Introduction

The physiologic and psychologic basis of sleep ontogeny during childhood [12] and the clinical and pathophysiological variety of sleep disturbances in children [13] lead to a broad spectrum of disorders summarized in the International Classification of Sleep Disorders (2nd edition 2005, ICSD-2 [3]). Thus, in the practice of pediatric sleep medicine the question arises, how to perform a comprehensive and economically adequate diagnostic work-up of sleep-related problems in infants, children and adolescents with respect to limited resources concerning sleep ambulances and sleep laboratories for children.

Starting from excessive daytime sleepiness as the leading symptom of a non-restorative sleep [7], the Pediatric Group of the German Sleep Society (DGSM) elaborated an algorithm [14] including five time points, at which a differential diagnostic work-up should be carried out in children with persistent daytime sleepiness: T_0 (onset of excessive daytime sleepiness), T_1 (duration: 1 week), T_2 (duration: 4 weeks), T_3 (duration: >3 months), T_4 (duration: >6 months). General pediatric diseases should be covered by the algorithm. The diagnosis of a pediatric sleep disorder should be clarified within 3 to 6 months after onset of excessive daytime sleepiness. Depending on individual symptoms and complaints, a somnological diagnostic including polysomnography should immediately be taken.

Definitions

The terms "sleepiness", "tiredness" and "tendency to fall asleep" have different meanings. "Sleepiness" refers to an individual's degree of wakefulness. An individual's capacity to fall asleep is called "tendency to fall asleep" [16]. An individual's psychic state of exhaustion accompanied by irritability, concentration deficit and the personal feeling of exhaustion is called "tiredness" [16]. "Tiredness" can be regarded as the result of intrapsychic processes, whereas "sleepiness" is directly related to the degree of central nervous activity [16]. "Tiredness" can be gathered from a person's complaints.

Especially in young children, the medical history concerning tiredness is much less clear as compared with adults. Anamnestic data can even be misleading when restlessness and fuzziness (young infants) or irritability and aggressive behaviour (pre-school and school age) are the main complaints [10]. The child's sleepiness and its tendency to fall asleep can be observed by parents or caregivers; they can be measured by distinct tests (e. g. Multiple sleep latency test, MSLT) [16]. In children, it should always be taken into account, that physiologic sleep periods during the day as well as physiologic arousals from sleep during the night occur within the normal range of developmental phenomena. The development of the circadian sleep cycle is closely related to the child's chronological and developmental age, respectively [12].

Physiologic phenomena may be misinterpreted by parents and caregivers and can be complained of as "sleeping or waking at an inadequate or unwelcome time of the day". This has to be distinguished from pathologic tiredness in hypersomnic and insomnic patients, respectively. Hypersomnia and insomnia are clinical phenomena which can be caused by a multitude of underlying sleep disorders [7]. Insomnia is connected with "tiredness" and "sleeping and waking at an inadequate or unwelcome time of the day", whereas "excessive daytime sleepiness" and an increased "tendency to fall asleep" are characteristic features of hypersomnia [16].

Epidemiology

In epidemiologic studies of infancy, childhood and adolescence, frequencies of daytime sleepiness reflect the physiologic development of the circadian cycle of sleep and wakefulness (Table 1). Frequencies of daytime sleepiness declined from early infancy to school age [1, 2, 9, 11]; in comparison with school children adolescents showed an increased prevalence of daytime sleepiness [4].

Especially in young infants, frequencies of the items "sometimes tired" and "every day tired" differ widely [11]. This shows, that epidemiologic studies failed to distinguish physiologic developmental phenomena from pathologic daytime sleepiness. In older children, self-reported symptoms should be distinguished from symptoms reported by parents or care givers [9].

Pediatric semiology and nosology

In pediatric semiology and nosology "tiredness" is looked at as a general complaint, which often accompanies in a large number of acute and chronic diseases. In distinct

Table 1 Epidemiology of daytime sleepiness in distinct age groups

Population	Age (Years)	Prevalence (%)	References
Germany, 1999	1–6	45.6 (sometimes) 3.7 (every day)	Paditz et al. 1999 [11]
UK, 1989–90	4–5	20.7	Ali et al. 1993 [1]
UK, 1992	6–7	10.2	Ali et al. 1994 [2]
Germany, 2002	First year at school Fourth year at school	4 (parents) 18 (p: sometimes) 1 (p: often)	Kraenz et al. 2003 [9]
Iceland, 1995	15–16	16 (very often) 6.5 (always)	Benediktsdottir et al. 1997 [4]

p parental questionnaire

chapters of their book, Tunnessen and Spranger [15] dealt with "exhaustion", "disturbed sleep" and "coma". In his book, Lampert [10] used the terms "weakness", "irritability and restlessness" and "tiredness" in order to characterize the clinical symptomatology of different disease entities. The attempt to list up only the most important causes of these symptoms produces an extremely broad differential diagnostic spectrum, providing an overview over the entire range of clinical pediatrics (Table 2). At this point, it becomes evident, that the practice of sleep medicine in infants, children and adolescents cannot be detached from professional competence in general pediatrics.

Table 2 Pediatric diseases with sleepiness as the possibly leading symptome/complaint (Lampert 1981 [10]; Tunnessen and Spranger 1987 [15]: exhaustion, concentration deficit, weakness, irritability, tiredness)

Addison's disease
Adrenogenital syndrome
Alcohol intoxication
Allergy
Anemia
Asthma bronchiale
Attention deficithyperactivity syndrome
Bacterial infections
Bronchitis
Carditis
Celiac disease
Collagenosis
Cystic fibrosis
Depression
Diabetes mellitus
Drug reactions
Encephalitis
Epilepsy
Gastroenteritis
Heart failure
Hepatitis
Hypoglycemia
Hypothyroidism
Intracranial pressure
Malignant diseases (e. g. Leukemia)
Meningitis
Migraine
Nephritis
Nephrotic syndrome
Obesity
Pheochromocytoma
Pneumonia
Psychic factors
Renal failure
Sinusitis
Tachycardia
Upper airways obstruction (adenotonsillar hyperplasia)
Vegetative-orthostatic dysregulation
Viral infections (e. g. Epstein-Barr Virus)

Algorithm for the differential diagnostic work-up of daytime sleepiness in childhood

The algorithm was expected to have a low threshold concerning intensity and duration of symptoms and complaints, respectively. The entire spectrum of causes should be covered by the algorithm, reaching from a concomitant symptomatology in a general pediatric problem (e. g. tiredness due to viral infections) to the diagnosis of a distinct sleep disorder (e. g. narcolepsy, sleep-related breathing disorders, restless legs and periodic leg movement disorder during sleep) [7, 13]. The diagnosis of a sleep disorder in a child should be clarified within 3 to 6 months after onset of symptoms. Depending on individual symptoms and complaints, a somnological diagnostic including polysomnography should immediately be taken. For clearness the algorithm is presented in 5 parts (Figs. 1–5).

Justification of time intervals

In a way, it is arbitrary to designate time intervals, when a child with excessive daytime sleepiness should be reexamined. In general, time intervals should not be too long, in order to recognize the rapid progression of diseases with uncharacteristic initial symptoms (e. g. diabetes mellitus, brain tumors). On the other hand, time intervals should not be too short, in order to avoid multiple diagnostic trials, which might overcharge the patient and might lead to wasting of scarce resources.

In the literature, authors distinguished self-limited sleep problems (duration less than 1 week) [6], transient sleep disturbances (duration less than 3 weeks) [6, 8] and protracted sleep disturbances (duration more than 3 weeks) [6]. Other authors used the term "transient sleep disturbances" in connection with acute febrile diseases, acute pain and acute changes of daily routines, respectively. "Chronic" sleep disturbances in children were sharply outlined against these "transient" sleep problems [17].

An algorithm for the complete diagnostic work-up of "leg pain" in children was elaborated by Birnbaum and co-workers [5]. They recommended time intervals of 4 weeks and 3 months for reexamination of children with persistent leg pain.

In epidemiologic studies on the prevalence of sleep problems in childhood, reexamination of the nature and the intensity of symptoms were performed 6 months after the first questionnaire [18].

Algorithm: time point T_0 (onset of excessive daytime sleepiness; Fig. 1)

The situation at time point T_0 describes a child with newly manifest daytime sleepiness (duration less than 1

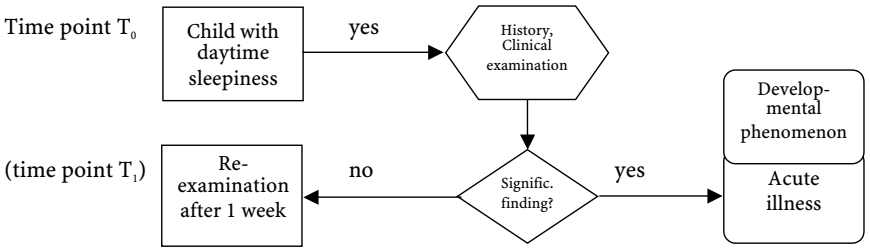

Fig. 1 Algorithm for the differential diagnosis of daytime sleepiness in childhood, part 1. *Signific. finding?* Significant findings derived from history and/or clinical examination?

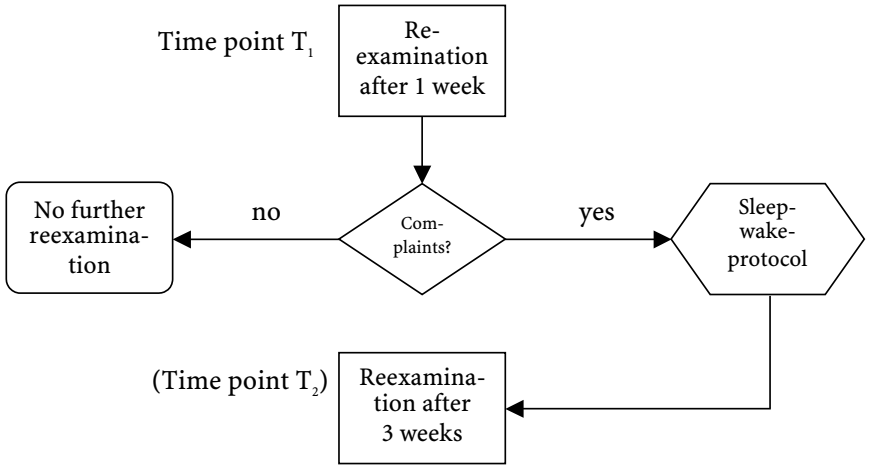

Fig. 2 Algorithm for the differential diagnosis of daytime sleepiness in childhood, part 2

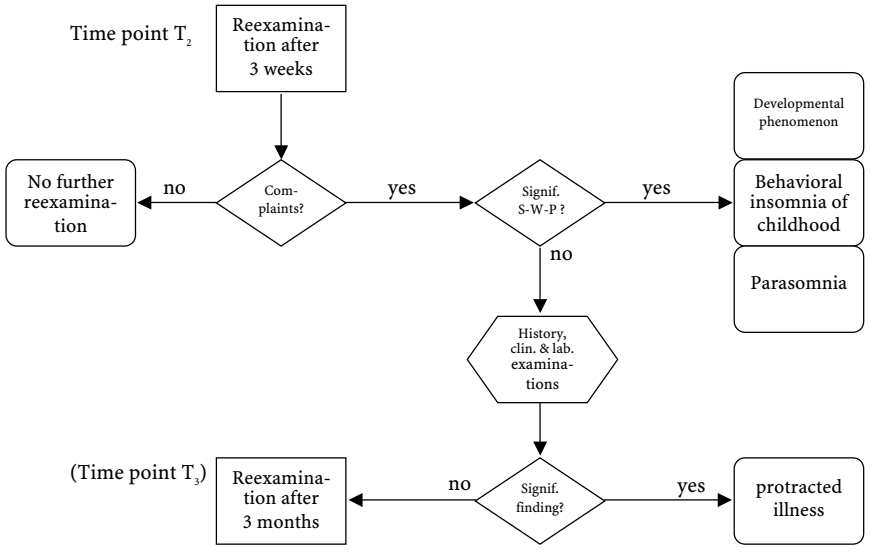

Fig. 3 Algorithm for the differential diagnosis of daytime sleepiness in childhood, part 3. *Signif. S-W-P?* Significant findings derived from a sleep-wakefulness protocol?; *Clin. & lab. examinations* Clinical and laboratory examinations

week), which is referred to a general practitioner, a family pediatrician or an emergency ambulance, respectively. The assumption of a self-limited problem can be used as a preliminary working hypothesis. In any case, a structured anamnestic interview and a clinical examination should be carried out. An attempt should be made, to classify the child's actual symptomatology as hypersomnia (excessive daytime sleepiness and increased tendency to fall asleep are observed by parents or care givers) or insomnia (the child itself complains of feeling exhausted). Acute illness as the cause of daytime sleepiness will be revealed by clinical examination (e. g. upper airways infection, otitis media, abdominal pain). If there are no findings hinting at an acute illness, a transient sleep problem due to physiologic developmental phenomena cannot be excluded at this early time point. A reexamination after 1 week is recommended.

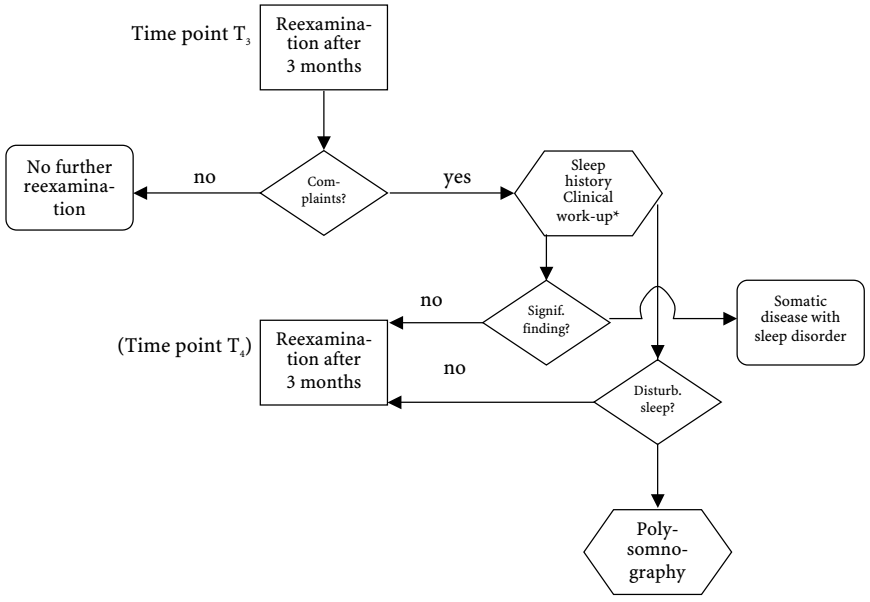

Fig. 4 Algorithm for the differential diagnosis of daytime sleepiness in childhood, part 4. *Clinical work-up including neurologic examination, laboratory examinations, and ultrasonography, X-ray and MRT examinations, if indicated

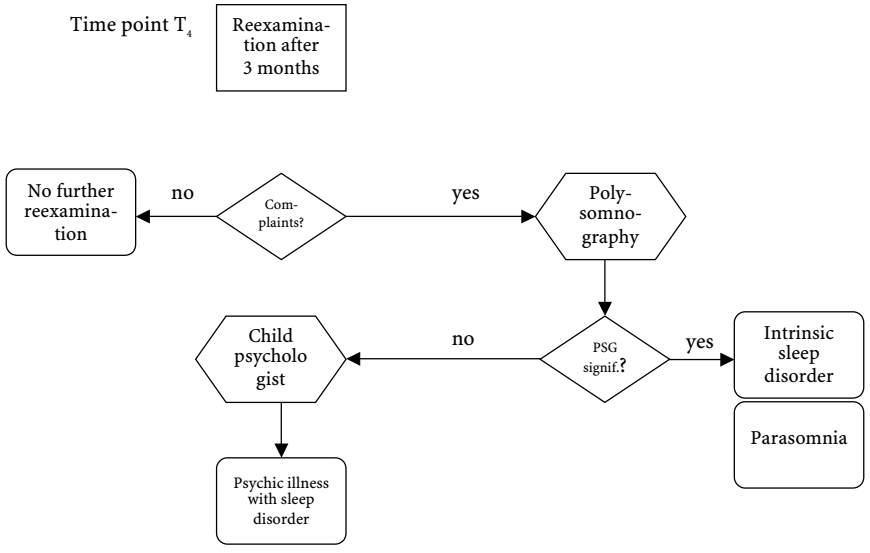

Fig. 5 Algorithm for the differential diagnosis of daytime sleepiness in childhood, part 5. *PSG signif.?* Significant findings derived from a polysomnography?

Algorithm: time point T_1 (duration: 1 week; Fig. 2)

If the child is well after 1 week (time point T_1), the assumption of a self-limited developmental phenomenon can be taken as confirmed; no further reexamination is necessary in these cases. If there is a persistent complaint of excessive daytime sleepiness, history and clinical examination should be repeated. If there is no relevant finding, the parents should be instructed to take down a sleep-wake-protocol over a time period of 2 to 3 weeks. A reexamination should be recommended after 3 weeks.

Algorithm: time point T_2 (duration: 4 weeks; Fig. 3)

If the child is well after 3 weeks (time point T_2), the assumption of a self-limited developmental phenomenon can be taken as confirmed; no further reexamination is necessary in these cases. If there is a persistent complaint of excessive daytime sleepiness, a duration of 4 weeks is documented at this time point. Again the attempt should be made to classify the child's symptomatology as hypersomnia or insomnia, based on history and clinical examination. The sleep-wake-protocol might hint at a physiologic developmental phenomenon, a sleep disorder (e. g. inadequate sleep hygiene, behavioural insomnia of childhood, non-organic insom-

nia), a disturbance of the circadian sleep cycle or a parasomnia, respectively. Otherwise, history and clinical examination should be repeated and a blood sample should be taken (laboratory exclusion of protracted diseases, e. g. anemia, diabetes mellitus, hypothyroidism, mononucleosis). If there are no relevant findings, a reexamination should be recommended after 3 months.

Algorithm: time point T_3 (duration: > 3 months; Fig. 4)

If the child is well after 3 months (time point T_3), the assumption of a self-limited developmental phenomenon can be taken as confirmed; no further reexamination is necessary in these cases. Otherwise, a duration of more than 4 months is documented at this time point. With increasing duration the probability of a transient, developmental problem decreases, and the probability of a sleep disorder (narcolepsy, sleep-related breathing disorders, restless legs and periodic leg movement disorder during sleep) increases. Again the attempt should be made to classify the child's symptomatology as hypersomnia or insomnia, based on history and clinical examination. At this time point (T_3), an intensive diagnostic work-up is recommended, including history, clinical and laboratory examinations, distinct neurologic examination, EEG, and neuroradiologic examination. The diagnosis of a sleep disorder due to a somatic (internal or neurologic) disease should be clarified at this time point. Furthermore, it should be possible to recognize parasomnias and a disturbance of the circadian sleep cycle, respectively. If the distinct sleep history reveals features of a sleep disorder, a polygraphic sleep recording (pediatric sleep laboratory) should be recommended at this time point (T_3). If there is no relevant finding, a reexamination should be recommended after further 3 months.

Algorithm: time point T_4 (duration: > 6 months; Fig. 5)

If the child is well after further 3 weeks (time point T_4), the assumption of a self-limited developmental phenomenon can be taken as confirmed; no further reexamination is necessary in these cases. Otherwise, a duration of more than 6 months is documented at this time point (T_4). The assumption of a self-limited developmental problem should be refused. The possibility of a sleep disorder (narcolepsy, sleep-related breathing disorders, restless legs and periodic leg movement disorder during sleep) should be stressed, and the child should be referred to a pediatric sleep laboratory (whole-night polysomnography, MSLT). If there is no relevant polysomnographic finding, referral of the child with protracted daytime sleepiness to a child psychologist is recommended.

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