Investigation of obstructive respiratory disturbance during sleep

Obstructive sleep apnoea is the most widespread sleep-related respiratory disturbance. The patients are a heterogenous group. Rating of the condition may be inconsistent as a result of differences in the choice of diagnostic equipment and scoring rules. To ensure good workup and treatment of obstructive sleep apnoea, greater awareness is required when choosing scoring rules and types of equipment for investigating respiration during sleep.

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Obstructive sleep apnoea is primarily associated with the male sex, age and being overweight. The condition increases the risk of accidents, diabetes mellitus and cardiac and cerebrovascular events (1). A Norwegian study estimated the prevalence of moderate to pronounced sleep apnoea at 8 % in the age group 30–65 years (2).

The condition is usually diagnosed with polysomnography (PSG) or respiratory polygraphy (RPG). The degree of respiratory disturbance is usually determined by counting respiratory events in the form of apnoeas or hypopnoeas and dividing by the number of hours of sleep, which yields an apnoea-hypopnoea index (AHI). An index value of 0–4 is regarded as normal, values in the range 5–14 indicate mild sleep apnoea, values of 15–29 are moderate and values of ≥ 30 are signs of severe sleep apnoea (3). This classification is so entrenched that it remains a reference irrespective of how respiration is assessed. Different definitions are used within the professional circles concerned with obstructive sleep apnoea in Norway and elsewhere.

In this article we will discuss how the choice of scoring rules (Table 1) and type of equipment can influence the diagnosis of obstructive sleep apnoea. This analysis is intended to form a basis for selecting the best possible standard for studying the condition in Norway.

Workup

Workup of upper airway obstruction is conducted by demonstrating periodic reduction of airflow, degree of respiratory effort and subsequent central nervous arousal or reduced blood oxygen saturation. Airflow almost stops when apnoea events occur and is reduced with hypopnoea. In the most recently recommended definition, hypopnoea must be associated with either significant oxygen desaturation or a brief cortical EEG arousal (4, 5). Arousal is defined by the American Academy of Sleep Medicine (AASM) as a sudden increase in EEG frequency with a duration of more than three seconds. It occurs both spontaneously during sleep and in connection with respiratory and other sleep-disrupting events (4).

American guidelines for the diagnosis of obstructive sleep apnoea require that readings be taken from a least three sensor groups during sleep (6). The devices most commonly used in respiratory polygraphy measure airflow with a thermistor and nasal pressure transducer, respiratory effort (movements of the thorax and abdomen) and desaturation by means of oxymetry (6). The method is appropriate for examining persons with a likelihood of moderate to severe obstructive sleep apnoea. Polysomnography, which also includes EEG monitoring, electromyography (EMG) and electrooculography (EOG) (7), is recommended for use with persons with a likelihood of mild obstructive sleep apnoea (6), unresolved sleep disorder or comorbidity.

Observation of arousals associated with increased respiratory effort that do not fulfil the criteria for hypopnoea, called respiratory effort related arousals (RERA) have given rise to the diagnosis upper airway resistance syndrome (UARS) (8, 9).

Scoring of sleep respiratory events

There has been little discussion on scoring of apnoea events. It is recommended that they be scored with a thermistor (airflow sensor based on temperature changes), not

Table 1 Definitions of hypopnoea in the literature

	Airflow amplitude in relation to baseline sleep level		Oxygen saturation in relation to baseline sleep level
Chicago criteria 1999	< 50 % OR		
	< 70 %[1]	AND	(–3 % OR arousal)
AASM criteria 2007, recommended	< 70 %	AND	–4 %
AASM criteria 2007, acceptable	< 50 %	AND	(–3 % OR arousal)
AASM criteria 2012, acceptable	< 70 %	AND	–4 %
AASM criteria 2012 recommended	< 70 %	AND	(–3 % OR arousal)

[1] Discernible reduction

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with a nasal pressure transducer, which will overestimate the number of apnoea events (10).

There has been more discussion and change associated with scoring of hypopnoea, partly based on professional viewpoints, partly in connection with reimbursement schemes in the USA (11). The preliminary consequence of this is that the AASM still has two definitions of hypopnoea – one «recommended», in which hypopnoeas can now be scored if a 30 % amplitude reduction measured with a nasal pressure transducer is associated with desaturation of 3 % or EEG arousal, and one «acceptable», which does not include arousal, and the desaturation requirement is 4 %. In the earlier «Chicago criteria» of 1999 (Table 1) hypopnoeas could also be scored without a desaturation requirement (12).

The requirement of associated desaturations for scoring hypopnoeas has a strong effect on the apnoea-hypopnoea index. However, different oxymeters have different averaging times, which can vary from two to 21 seconds. A long averaging time results in fewer desaturation events, and a short averaging time results in more, but less reliable desaturations (13).

Experimental studies have proved the AASM's arousal definition to be valid and reliable, but arousals are demanding to score. Reliability varies with scoring experience, and is probably somewhat poorer between different groups of raters (14). Arousal is also a dynamic variable, with a triggering threshold that is influenced to a large degree by preceding sleep shortage/sleep disruption (15).

Upper airway resistance syndrome, like obstructive sleep apnoea, is characterised by daytime sleepiness, which is assumed to be due to disrupted sleep at night. However, nasal flow measurement has proved to be more sensitive than oesophageal pressure manometry (16), and when coupled with liberal hypopnoea criteria, events that were previously perceived as respiration-related arousals could be scored as hypopnoeas with ordinary polysomnography.

In a study in which 423 patients were referred to sleep centres owing to clinical suspicion of obstructive sleep apnoea, all tests were scored according to the Chicago criteria of 1999. The readings were then rescored according to the two hypopnoea criteria of the AASM of 2007. Median values for the apnoea-hypopnoea index then varied from 8.3 to 25.1, and the proportion of hyponoea events from 25 % to 60 % (10, 12, 17).

In another survey, 37 relatively young patients with little tendency to desaturations received the diagnosis obstructive sleep apnoea on the basis of symptoms and sleep records interpreted according to the Chicago criteria (18). After therapy, the patients reported subjective improvement and a clear fall in the apnoea-hypopnoea index. After rescoring using the two hypopnoea definitions of the AASM of 2007, the improvement tendency was the same.

As a result of the requirement of 4 % desaturation in order to score a hypopnoea, 14 of the 37 received an initial apnoea-hypopnoea index of less than 5. These 14 would not have received the diagnosis obstructive sleep apnoea or therapy if the 4 % criterion had been used. The article concluded that the «4 % criterion» should not be used in studies of young people with healthy lungs and good baseline O_2 saturation. It also gives pause for thought that in a population-based study where there was a requirement of associated 4 % desaturation (conservative), it was found that in the group with an apnoea-hypopnoea index of between 0.1 and 4.9 (i.e. some are in the «normal» range), there was a slightly larger proportion with high blood pressure than in the supernormal group (with apnoea-hypopnoea index = 0) four years later (19).

Discussion

The choice of sleep recording equipment and scoring method influences the apnoea-hypopnoea index. If the patient sleeps through the night and hypopnoea definitions that include EEG arousal are excluded, the results of polysomnography and respiratory polygraphy can be scored in virtually the same way. The apnoea-hypopnoea index obtained by means of respiratory polygraphy will usually be underestimated nonetheless compared with when polysmonography is used, because the number of respiratory events are divided by recording time and not sleeping time, which will usually be somewhat shorter. When the requirement of associated 3 % desaturation or arousal is added to score a hypopnoea, the number of respiratory events measured by respiratory polygraphy will be further underestimated compared with polysomnography measurement because EEG arousal cannot be scored.

The advantage of respiratory polygraphy rather than polysomnography is the relatively simple and inexpensive equipment, and less resource-intensive scoring. Automatic event detection by the therapeutic devices (positive airway pressure to keep the upper airways open) also provides an apnoea-hypopnoea index, but does not take account of desaturations or arousals (20), and may therefore yield different results from respiratory polygraphy and polysomnography.

If common scoring criteria are used for everyone, including young people with healthy lungs, it is difficult to reach consensus on a single hypopnoea definition that entails stringent desaturation requirements. The definition of hypopnoea with a requirement of associated 4 % desaturation is widely used in practice and in scientific studies, however. With this method, only the most pronounced respiratory events are counted, or events that are apparent because the person does not have optimal baseline O_2 saturation. Such criteria may also present a challenge if the apnoea-hypopnoea index is to communicate how respiration during sleep actually is.

Possible solutions

Equal and appropriate therapy for patients with obstructive sleep apnoea is contingent on reliable and valid diagnostic data. It is challenging for a therapist to receive referrals with results from a sleep study when the data are incomplete and come from an unknown investigator who has used unknown equipment. The recording quite often has to be repeated. A regular relationship and continuous dialogue between those interpreting the sleep records and those treating patients with obstructive sleep apnoea should increase the possibilities of achieving optimal therapeutic results and lead to better employment of resources.

If liberal hypopnoea criteria are used, and a nasal pressure transducer, it will largely be possible to include events previously called respiratory arousals in the definition of hypopnoea, so that obstructive sleep apnoea and upper airway resistance syndrome can be combined along a single scale. Instead of a definition of hypopnoea that combines respiration, desaturation and/or arousal, criteria that primarily evaluate respiratory variation, and where secondary variables such as arousals and desaturations are reported separately, may be an option. This would be similar to the Chicago criteria of 1999 (12).

The advantage would be better evaluation of respiration, the phenotype of obstructive sleep apnoea and therapeutic options (21). The drawback of such a liberalisation may be more time-consuming sleep analysis and a need to adjust the well known apnoea-hypopnoea index treatment limits in line with the results of current research. Efforts must also be made to achieve European or international consensus on such liberal criteria, which should also be able to yield comparable estimates of the apnoea-hypopnoea index, whether full polysomnography is used or simplified respiratory polygraphy.

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Received 23 March 2015, first revision submitted 14 July 2015, accepted 14 October 2015. Editor: Sigurd Høye