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To sleep, or not to sleep – that is the question, for polysomnography

Landmark papers in respiratory medicine

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As the English dramatist Thomas Dekker wrote, "Sleep is that golden chain that ties health and our bodies together". One of the most frequently sleep-related disorders (SRD) is obstructive sleep apnoea syndrome (OSAS). OSAS is a relatively "young" disease and at the same time, one of the most important respiratory conditions discovered in the last 50 years due to its incidence, prevalence, health-related impact on the patient's life and economic burden [1].

Nevertheless, 50 years is still a large amount of time and our understanding of OSAS has grown significantly over these years. The first reports discussed how to diagnose this rare condition [2]. Later, it was demonstrated that the disease itself is not that rare and is extremely underdiagnosed [3]. This was only the tip of the iceberg, since it was furthermore discovered that OSAS is linked to multiple comorbidities and is a major healthcare problem [4, 5]. Now, we are moving further forward, and discussing more efficient ways to diagnose and manage this condition.

The Wisconsin Sleep Cohort Study demonstrated that the current prevalence of moderate-to-severe sleep-disordered breathing (SDB) ranges from 3% to 17% depending on the age and sex of the patients. When the data for the periods 1988–1994 and 2007–2010 were compared, the results were even more disturbing. There was a relative increase in prevalence of between 14% and 55% depending on the subgroup, which represents a substantial increases over the last two decades [6].

There is no doubt that the incidence and prevalence of the disease is increasing. With all this in mind, the economic burden of OSAS becomes even more substantial [7]. Especially since this condition is often found to overlap with other obstructive lung disease and patients usually have multiple comorbidities [8]. The list of health-related conditions implicated with OSAS is striking, and includes diminished neurocognitive function, increased risk of motor vehicle accidents, reduced quality of life, and cardiovascular, neurovascular and metabolic disease [9, 10].

For years, the gold standard for diagnosis of OSAS was an overnight polysomnography (PSG). This study measures several physiological parameters, such as electroencephalography (EEG), electro-oculography (EOG), ECG, chin and leg electromyography (EMG), body position, finger pulse oximetry, measurements of airflow, and measurements of thoracic and abdominal respiratory effort. It is performed under laboratory conditions with a sleep technician who carefully monitors the parameters [11].

Based on the 2007 recommendations of the Portable Monitoring Task Force of the American

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Have we reached the point where respiratory polygraphy can replace polysomnography in the assessment of OSAS? http://ow.ly/UxCU30bNopq

Academy of Sleep Medicine [11], portable monitors may be used as an alternative to PSG for the diagnosis of OSAS:

- in patients with a high pre-test probability of moderate-to-severe OSAS
- in patients for whom in-laboratory PSG is not possible by virtue of immobility, safety or critical illness
- to monitor the response to treatments for sleep apnoea other than continuous positive airway pressure

It was also recommended that at a minimum, portable monitors must record airflow, respiratory effort and blood oxygenation. However, portable monitors cannot be used for the diagnosis of OSAS in patients with significant comorbid medical conditions that may degrade the accuracy of portable monitoring, for the diagnostic evaluation of patients suspected of having comorbid sleep disorders or for general screening of asymptomatic populations [11]. Portable monitoring devices, according to the Standards of Practice Committee of the American Sleep Disorders Association, are classified into several types [12].

- Comprehensive portable PSG: minimum of seven channels monitored, including EEG, EOG, chin EMG, ECG or heart rate, airflow, respiratory effort and oxygen saturation
- Modified portable sleep apnoea testing: minimum of four channels, including ventilation or airflow with at least two channels of respiratory movement, or respiratory movement and airflow; heart rate or ECG; and oxygen saturation
- Continuous single or dual bioparameters: one or two channels, typically including oxygen saturation or airflow

The current data indicate that portable monitoring is an adequate method for clinical therapeutic decision making, with an agreement with PSG of ~90% [13].

It is evident that for many countries, whether to use PSG or respiratory polygraphy is an open question. A recent study demonstrated that in Europe, uniform standards for the recording and scoring of respiratory events during sleep are lacking. Many centres follow the recommendations of the American Academy of Sleep Medicine. In a recent European study, 29 countries completed a special questionnaire that was sent to representatives of the 31 national sleep societies in the Assembly of National Sleep Societies of the European Sleep Research Society. PSG was considered the primary diagnostic method for sleep apnoea diagnosis in 10 (34.5%), respiratory polygraphy was used primarily in six (20.7%) and the remaining 13 (44.8%) countries had no preferred method. It is also important to underline that only 15 (51.7%) countries had developed some type of national uniform standards, and these standards varied significantly in terms of scoring criteria, device specifications and quality assurance procedures between countries [14].

In recent years, respiratory polygraphy recordings have emerged as a useful and reliable method for the diagnosis of OSAS. This leads to a reasonable question of whether it is the time to make a shift from PSG to portable monitoring and if we are ready to make this step.

Since an important cohort of patients with SRD have heart failure, it would be logical to look at whether respiratory polygraphy can be used efficiently in this case. It was demonstrated that in patients with heart failure, respiratory polygraphy registers more respiratory events than analysis of portable PSG, apnoea–hypopnea index (AHI) estimated by respiratory polygraphy showed a negligible negative bias relative to portable PSG, limits of agreement between the two systems were much smaller than those previously observed between two nights using the same scoring modality, and the κ coefficient using categorised AHI was 0.89 (95% CI 0.82–0.96) [15]. Another study reported a diagnostic accuracy of respiratory polygraphy compared with PSG ranging 78.6–84%, with sensitivity of 68.4–82.5% and specificity of 88.6–97.8% for the different AHI thresholds in patients with heart failure [16]. All of this combined suggests that respiratory polygraphy may be used as an alternative to portable PSG in the assessment of SRD in patients with heart failure, with good sensitivity and specificity.

The report of the Swiss respiratory polygraphy registry datasets was based on 11485 respiratory polygraphies, of which 8179 were performed to evaluate suspected OSAS. In patients with clinical symptoms of OSAS (snoring, witnessed apnoea and hypersomnia) (4180 patients), 80.2% of respiratory polygraphies confirmed OSAS, and only 3.5% were inconclusive and thus required PSG. According to the practice in Switzerland, PSG are rarely required, suggesting relevant cost savings from respiratory polygraphy [17].

In a randomised clinical trial by Masa *et al.* [18] that involved 366 patients, the therapeutic decisions using respiratory polygraphy had a sensitivity of 73%, a specificity of 77% and an agreement level of 76%. Patients with higher respiratory-polygraphic AHI scores had a sensitivity of 94% and a specificity of 44%, and the agreement level was 91%. In other words, respiratory polygraphy-based therapeutic decisions were adequate when AHI was high but deficient in cases of mild-to-moderate AHI. Interestingly, the "impossible decision" case was not observed with either PSG or respiratory polygraphy. Randomised clinical trials are always a key element in collecting valuable data that eventually change the way we do our day-to-day practice but are these results sufficient to make a final decision to shift to respiratory polygraphy, or are we not yet ready?

The rational conclusion, which is supported by several authors, is that in adults, respiratory polygraphy is a reliable technique for the diagnosis of OSAS. It is cost-effective to use respiratory polygraphy and in uncertain cases, the results can always be verified by PSG [19].

Another key point that should be discussed is whether the absence of EEG can lead so serious consequences. EEG is a valuable, adjunct tool for the diagnosis of SDB particularly in patients with epilepsy or other neurological conditions [20]. Besides that, there are data that are obtained during EEG that may be crucial in day-to-day practice. EEG may also be used to detect pathological cortical changes and microarousals as well as to monitor of the brain activity during sleep cycles more precisely [21, 22]. For instance, children with OSAS frequently have paroxysmal activity and seizures, which may have implications in the neurocognitive outcome of OSAS [23, 24].

This progress and paradigm shift in adult sleep medicine has also influenced paediatric somnology, and now the same question is also actively discussed by leading specialists in paediatric sleep medicine. On one hand, there are studies that demonstrate the AHI is underestimated by respiratory polygraphy compared to PSG, which can significantly affect clinical management decisions, particularly in children with mild and moderate obstructive sleep apnoea (AHI ≥1 to <10 per h of total sleep time) [25]. On other hand, in another study that involved 50 children with a mean age of 5.3±2.5 years, the optimal AHI from home respiratory polygraphy corresponding to the PSG-defined OSAS criterion was established as a cut-off point of ≥5.6 per h. This exhibited an excellent sensitivity of 90.9% (95% CI 79.6–100%) and a specificity of 94.1% (95% CI 80–100%) [26].

As accurately stated by Gozal *et al.* [27], this shift has further emphasised the urgent need for the development and validation of less inconvenient and laborious approaches than PSG for evaluation of children. This conclusion is based on overall improvements in technology and in our understanding of paediatric SRD, which will reduce of the overall burden to the family while achieving high levels of diagnostic accuracy.

As an overall conclusion, to date, PSG is the most accurate method for diagnosing SRD and particularly OSAS. It is the gold standard, with accurate and reproducible results, and is widely used in clinical sleep medicine. The downside of this method is its cost and the time that is required to perform PSG. Compared to PSG, respiratory polygraphy represents a simpler device that can be used effectively at home. Still, the recording does not have all the measurements that PSG has. In particular, it lacks data from EEG, EOG, ECG, and chin and leg EMG. However, the sensitivity and specificity of this method make it fairly accurate. Besides that, it is more cost effective than a PSG.

Any healthcare system depends, first and foremost, on rational distribution of funds. It is always important to bear in mind that adequate distribution of finances results in better outcomes and eventually causes development in the field. The cost-effectiveness of respiratory polygraphy and PSG should be assessed in the near future to give a final answer whether it is the time for PSG "to sleep".

Conflict of interest

None declared.

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