

# Portable Monitoring and the Diagnosis of Obstructive Sleep Apnea

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## Abstract

Sleep disordered breathing (SDB) in children is a frequent disease with a prevalence varying from 1–5%. It is distinct from adults with respect to ideology, gender distribution, clinical manifestation, and treatment. Adenotonsillar enlargement is the most common cause of SDB in children. The diagnosis of SDB requires the use of special sensors such as nasal pressure transducer and esophageal pressure monitoring. The treatment of SDB in children includes amelioration of symptoms, normal cranio-facial growth and prevention of adult SDB. Adenotonsillectomy (AT) is the first line treatment of otherwise healthy children and also the initial treatment for children with multifactorial SDB. The success of AT as defined by reduction of AHI below 1 varies between 30 and 50% in various studies. A number of clinical factors such as nasal allergy, narrow and high hard palate, retro-position of mandible, enlargement of nasal inferior turbinates, high Mallampatti scale score, long face syndrome, age more than 8 years at the time of AT, and pretreatment apnea-hypopnea index (AHI) were associated with poor outcome. An impairment of nasal breathing due to adenotonsillar enlargement results in abnormal development of maxilla-mandibular skeleton resulting in narrowed upper airway. Surgery should be performed in young children as early as possible. Majority of patients have residual disease which requires additional treatment with orthodontic procedures such as rapid maxillary expansion (RME) and nasal CPAP. A multidisciplinary approach to evaluation and management of these children may lead to better treatment outcome.

**Keywords:** Pediatric sleep apnea, adenotonsillectomy, polysomnography, Rapid maxillary expansion

## Historical perspective

Obstructive sleep apnea (OSA) is a common condition, affecting at least 5% of the adult population in the Western countries<sup>1</sup>. The morbidity and mortality associated with OSA result in enhanced health care costs and significant impairment

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in the quality of life<sup>2-5</sup>. However, within the past two decades, the increased awareness of the consequences of untreated OSA has resulted in an increasing number of patients getting the diagnosis and appropriate treatment. Polysomnogram (PSG) is considered to be the “gold standard” to diagnose OSA. A typical sleep-lab PSG, however, requires sophisticated equipment with trained sleep technicians in attendance for the entire study, and trained professional to score or interpret the study. The lack of adequate number of sleep labs and trained professionals is considered to be the bottle-neck in the prompt diagnosis and treatment of patients with OSA<sup>6</sup>. In addition, the costs associated with a sleep-lab

PSG are considered to be prohibitively expensive in some instances.

Over the years, the advancement in medical technologies have resulted in sleep apnea diagnostic devices that are smarter, smaller, user friendly and hence do not necessarily require all the equipment, personnel, overhead costs, etc that are associated with a sleep-lab PSG i.e. these devices are more “portable”. Portable monitoring or home sleep testing (as it is often called) is used to conduct sleep studies to diagnose sleep apnea in a setting outside of the sleep centers or hospitals. However, skepticism regarding the utility of these devices in accurately diagnosing sleep apnea made it hard for the clinicians to effectively utilize these devices in day-to-day practice. But, the growing evidence regarding the validity and reliability of these devices leads the American Sleep Disorders Association (now, American Academy of Sleep Medicine) to publish scientific evaluation of these devices for the first time in 1994<sup>7</sup>. Although an attempt was made to classify the sleep testing devices into four types, it did not recommend the use of portable monitoring for the diagnosis of sleep apnea. In 1997, another review by the same organization came to the same conclusions<sup>8</sup>. The Agency for Health Care Research and Quality conducted a literature review and meta-analysis of all the studies with portable monitoring for obstructive sleep apnea. The agency concluded that there was insufficient evidence to make any firm recommendations for the use of portable monitoring in the diagnosis of OSA<sup>9</sup>. In 2004, a steering committee with representatives from American College of Chest Physicians (ACCP), the American Thoracic Society (ATS), and the American Academy of Sleep Medicine (AASM) issued practice parameters for portable monitoring in the investigation of adults with suspected sleep apnea<sup>10</sup>. The committee recommended that Type III devices may be acceptable for both to rule in and rule out OSA, with certain limitations. In 2004, the Centers for Medicare and Medicaid Services (CMS) re-viewed the National Coverage Determination (NCD) regarding the use of portable monitoring as a basis to prescribe CPAP therapy and in 2005 their final decision stated that there was not adequate evidence to use unattended portable monitoring in the diagnosis of OSA<sup>11</sup>. However, in 2007, the CMS initiated another review of NCD following a request from the American Academy of Otolaryngology–Head and Neck Surgery, and in 2008, the CMS eventually made a decision to reimburse portable monitoring to diagnose OSA and

prescribe therapy. In 2007, the AASM task force on portable monitoring also published a detailed report on the clinical guidance for use of unattended portable monitoring in the diagnosis of obstructive sleep apnea in the adult patients<sup>12</sup>.

Since 2008, following the comprehensive clinical guidelines from the AASM and NCD decision by the CMS, the use of portable monitoring to diagnose sleep apnea had seen a steady rise. Clinicians who have had reservations about the utility of these devices seem to have accepted portable monitoring as reliable and valid test to diagnose sleep apnea in a select group of patients. As the experience with portable monitoring increased, especially in the context of technologically advanced devices, portable monitoring for sleep apnea has become an integral part of many, if not all sleep centers.

## Sleep monitoring device types

In 1994, an attempt was made to classify sleep testing into various types and this is still used as a standard even today. Type I is an attended full polysomnography, performed at a sleep lab; Type II is an unattended full polysomnography outside the laboratory setting; Type III is an unattended limited channel polysomnography where at least four cardiopulmonary bioparameters are monitored; and Type IV is an unattended testing with only one or two cardiopulmonary bioparameters monitored (Table 1).

## Patient selection

One of the most important aspects of using portable monitoring devices to diagnose sleep apnea is the selection of appropriate subjects, realizing the fact that portable monitoring is not suitable for everyone. The AASM guidelines provide an evidence-based summary of the utility of portable monitoring, the recommended training for the personnel involved with testing or interpretation of data and the minimum standards for the monitoring devices.

- a. Portable monitoring for the diagnosis of OSA should be done only in conjunction with a comprehensive sleep evaluation. In addition, the clinical evaluation should be performed by a board certified sleep specialist or an individual who fulfills the eligibility criteria for the sleep medicine certification examination. The interpretation of the PM study,

Table 1 : Types of sleep apnea testing devices (based on Ferber et al <sup>7</sup>. portable recording in the assessment of obstructive sleep apnea)

	Type I	Type II	Type III	Type IV
Number of parameters monitored	≥ 7	≥ 7	≥ 4	1-2
Leads	EEG, EOG, EMG, ECG,	EMG, ECG, EMG, ECG, airflow, effort, oximetry	airflow, effort, Oximetry airflow, effort, oximetry,	oximetry and one ECG Other lead (usually airflow)
Setting of the study	Usually in a sleep center or hospital setting	Outside a sleep center or a hospital setting	Outside a sleep center or a hospital setting	Outside a sleep center or a hospital setting
Attended/Unattended	Attended	Unattended	Unattended	Unattended

supervision, and quality assurance should be the responsibility of a sleep specialist board certified in sleep medicine as is required for sleep center accreditation.

- b. Portable monitoring may be used as an alternative to polysomnography (PSG) for the diagnosis of OSA in patients with a high pretest probability of moderate to severe OSA. However, in the absence of valid predictive models that could reasonably identify subjects with “high pretest probability of moderate to severe sleep apnea”, the clinicians are guided by the presence of risk factors such as snoring, witnessed apnea, sleepiness, obesity, large neck circumference, history of hypertension, etc. Although each one of these is associated with increased risk for sleep apnea, there is no linear correlation between the cumulative effects of risk factors and the severity of sleep apnea. Since portable monitoring devices are sometimes associated with a false-negative result, an in-lab PSG should be performed in cases where portable monitoring shows a negative result or it is technically inadequate in patients with a high pretest probability for sleep apnea.
- c. PM may also be used in the diagnosis of OSA in patients for whom an in-lab PSG is not possible because of the nature or severity of co-morbid

conditions, immobility or for safety issues.

- d. PM may also be indicated to monitor the response to non-CPAP treatments for sleep apnea. These include upper airway surgery, oral appliance and (or) weight loss.

Portable monitoring are not indicated in

- a. Children.
- b. Significant co-morbid medical conditions that may degrade the accuracy of testing such as significant pulmonary problems, cardiac failure, etc (portable monitoring devices are not validated in these conditions).
- c. To diagnose other sleep disorders such as periodic limb movement disorders, REM sleep behavior disorders.

### Merits and demerits of portable monitoring

Portable monitoring can enhance access to the diagnosis of sleep apnea. This is particularly relevant in situations where access to sleep testing is not easy because of lack of sleep labs, lack of appropriately trained sleep physicians, sleep technicians, etc. Given that the number of sleep labs are inadequate compared to the prevalence

of sleep apnea, having the option of portable monitoring for patients with high pre-test probability of moderate to severe sleep apnea will help sleep labs to accommodate more patients who need in-lab testing for sleep apnea and other sleep disorders. Portable monitoring is also helpful in subjects who do not prefer to spend a night away from home or subjects who have to travel long distances to the sleep lab. In addition, many of the portable monitoring devices have capabilities to acquire data for more than few days. This may potentially minimize the “first-night” effect and the night-to-night variability in the apnea-hypopnea index (AHI) that is sometimes observed in patients with sleep apnea. Finally, the costs associated with sleep testing are significant. It is understood that portable monitoring, because of the lack of overhead costs associated with a sleep lab, are relatively inexpensive. However, no studies have been conducted to estimate or confirm the cost savings associated with portable monitoring.

Some of the limitations of portable monitoring include the fact that portable monitoring is not for everyone suspected to have sleep apnea. Portable monitoring should not be used as a screening tool to screen the general population for sleep apnea. Portable monitoring requires careful assessment of all the subjects to ensure they are appropriate for portable monitoring. Some of the devices (Type III and IV) used for portable monitoring do not capture EEG/EOG and EMG data and hence no sleep data is available. This can underestimate the AHI since the total recorded time, and not the total sleep time, is used as the denominator in the estimation of the AHI. In addition, respiratory events that are not associated with oxygen desaturations but have cortical arousals will not be accounted for in the estimation of the AHI.

### Portable monitoring in countries with restricted health care access

In many countries, both developed and developing or under-developed, where health care costs containment is a high priority, portable monitoring to diagnose patients with sleep apnea is a good option in majority of the situations. In some countries, such as India, where insurance coverage is limited and majority of the services are provided in the solo fee-for-service settings, portable monitoring offers a real choice for both the patients and the health care providers. The costs associated with setting up a sleep center with in-lab diagnostic sleep

testing are sometimes prohibitively expensive, and resources needed such as trained sleep technicians are just not available, except in tertiary academic centers.

### Future directions

The past decade has witnessed phenomenal advancements in the technologies developed and utilized in portable monitoring for sleep apnea. However, there are opportunities for improvements that will not just enhance the quality of data acquired, but also enhance the reliability and validity of these devices in different patient populations such as children, patients with certain co-morbidities such as cardiac and (or) pulmonary disorders.

### Conclusions

Portable monitoring is a significant advancement in sleep medicine, with a caveat that it is not suitable for all patients suspected of sleep apnea. The advantages of utilizing portable monitoring in day today practice are enormous and it appears that the cost-benefit analysis favors utilizing portable monitoring in the diagnosis of patients who have a high pre-test probability of moderate to severe sleep apnea. When used appropriately, portable monitoring will benefit both patients and health care professionals in the quick diagnosis and management of sleep apnea. With further refinements in the technology, portable monitoring can only get better.

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