

In-Home Testing for Obstructive Sleep Apnea

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ABSTRACT

The landscape of sleep medicine practice is actively evolving out of the laboratory, driven primarily by the improvement of home testing technology and the implementation of utilization management by insurance companies. This article will review a case of a patient with possible obstructive sleep apnea and discuss the history of home sleep testing and the reasons that home sleep testing will have an increasingly large role in the practices of physicians who evaluate patients with sleep disorders. Neurologists with an interest in sleep medicine should educate themselves on the use of home testing in clinical practice.

Continuum (Minneapolis Minn) 2013;19(1):223–228.

Case

A 56-year-old man with a history of atrial fibrillation came to a sleep clinic for evaluation of snoring and gasping episodes noted by his bed partner. The symptoms had been occurring for several years. He had become more tired during the daytime over the past year and would doze while watching television in the evening. He had a body mass index of 34 kg/m², a neck circumference of 48.2 cm (17 in), and a Mallampati class IV airway. What type of sleep testing should be considered?

DISCUSSION

Polysomnography performed in a sleep laboratory has been the gold standard test for the evaluation of patients with suspected obstructive sleep apnea (OSA) since the designation of sleep medicine as a specialty area. Over the past few years, in-home evaluation for sleep-disordered breathing has become more common. This type of testing is known by many names, including portable monitoring, home sleep testing, limited channel monitoring, and out-of-center testing. This article summarizes the history of home sleep testing, the reason for its rapid growth, and issues related to test selection.

History of In-Home Sleep Testing

Although in-home assessment for OSA has been available since the early 1990s, it has only recently been accepted as a viable alternative to in-laboratory polysomnography. A 1994 review by the American Sleep Disorders Association listed three indications for in-home OSA assessment: (1) for patients with severe symptoms that require urgent treatment, but polysomnography is not readily available; (2) for patients who are unable to be studied in the laboratory; and (3) for evaluation of the response to therapy after the diagnosis is established by in-laboratory

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Relationship Disclosure:

Dr Kirsch reports no disclosure.

Unlabeled Use of

Products/Investigational

Use Disclosure:

Dr Kirsch reports no disclosure.

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polysomnography.¹ A joint review nearly 10 years later by the American Academy of Sleep Medicine (AASM), the American Thoracic Society, and the American College of Chest Physicians suggested that type III monitors (limited channel home sleep tests) were acceptable only in an attended setting. **Practice Table 1** shows the categorization of sleep studies.^{2,3}

AASM guidelines were updated in 2007 and indicate that unattended in-home sleep testing can be performed in the setting of moderate- to high-likelihood OSA if there is an absence of comorbid conditions (eg, significant intrinsic lung disease or neuromuscular conditions that may cause hypoventilation) or an absence of suspected or known comorbid sleep disorders (eg, central sleep apnea, insomnia, or periodic limb movements).³ In 2007 and 2008, unattended in-home sleep testing was also approved by the Center for Medicare & Medicaid Services (CMS).⁴ These decisions were based in part on studies demonstrating that an ambulatory approach (with portable monitoring and autotitrating positive pressure therapy) was at least equivalent to in-laboratory testing in terms of adherence to positive pressure therapy and resolution of sleep apnea symptoms in patients with a high pretest probability of OSA (identified at least in part by overnight oximetry).⁵ Some of the focus on in-home testing by CMS was to slow the growth of sleep testing costs, which had increased from \$62 million to \$235 million between 2001 and 2009.⁶

In 2010 and 2011, some Massachusetts-based insurance companies began to employ utilization management companies for sleep medicine. The utilization management companies constructed prior authorization protocols for sleep studies that generally reflect the 2007 AASM guidelines for in-home sleep testing but may be more lenient about their use for patients with certain comorbidities. This new system favors evaluating a high proportion of patients at risk for OSA in the home rather than in a laboratory setting. Beginning in late 2011, some national private insurance providers started similar programs.

Issues With In-Home Sleep Testing

The benefit of in-home sleep testing is that patients are evaluated in their usual sleeping environment with fewer discomfort-causing measurement leads. In-home testing also costs considerably less than in-laboratory testing. In-home tests, however, have a higher failure rate (3% to 18% depending on the study and device), are only approved for the diagnosis of a single disorder (OSA), and

PRACTICE TABLE 1 **Categorization of Sleep Testing^a**

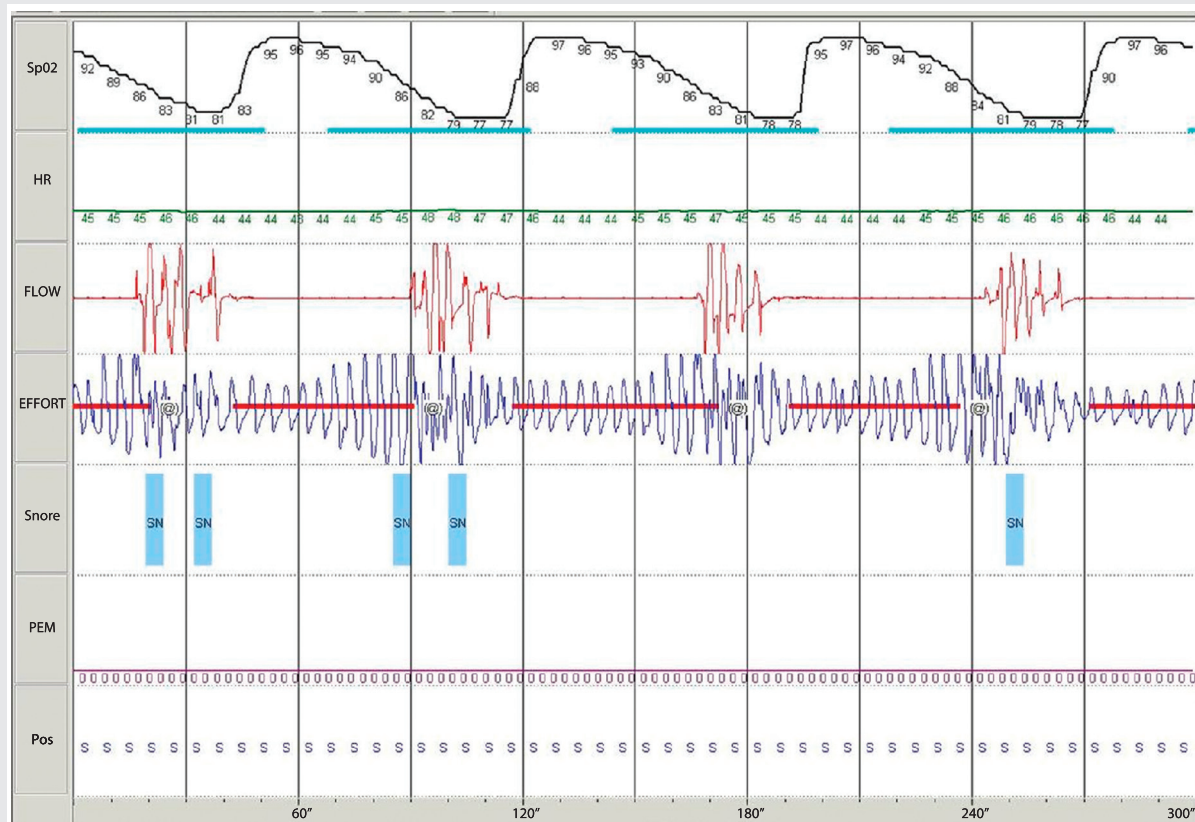
| Type | Testing |
|------|---|
| I | Full attended polysomnography (≥7 channels) in a laboratory setting |
| II | Full unattended polysomnography (≥7 channels) |
| III | Limited-channel devices (usually using 4–7 channels) |
| IV | One or 2 channels, usually using oximetry as one of the parameters |

^a Adapted from Collop NA, et al. J Clin Sleep Med.³ Used with permission of the American Academy of Sleep Medicine, Darien, IL, 2012. www.aasmnet.org/jlscm/ViewAbstract.aspx?pid=27032.

have not been well studied in some populations, including in persons under the age of 18 and those over the age of 65 years.³

Most type III portable monitors, which test for at least four physiologic variables, assess a subset of the measures of a typical polysomnogram (eg, airflow, respiratory effort, heart rate, and oximetry).⁷ One version of an algorithm for portable sleep testing is provided in **Appendix B**. The AASM strongly suggests that a comprehensive sleep evaluation by a sleep specialist be part of in-home testing to ensure adequate assessment and treatment. Most in-home sleep monitors lack EEG leads; the absence of brain wave measurement limits accurate sleep staging and identification of cortical arousals.³ Many portable tests underestimate OSA severity; the numerator of the apnea-hypopnea index (respiratory events) is lower than that for an in-laboratory test as subtle sleep-disordered breathing is not as readily identified and the number of events per hour is higher because recording time rather than sleep time is measured. In few instances, overnight oximetry (considered a type IV device) may also be used to screen for severe sleep apnea or to assess the efficacy of treatment of OSA; however, oximetry alone will likely fail to detect mild OSA.

Not all portable testing devices measure the same parameters. Most in-home devices measure airflow, respiratory effort, and oximetry via standard signals



PRACTICE FIGURE 1

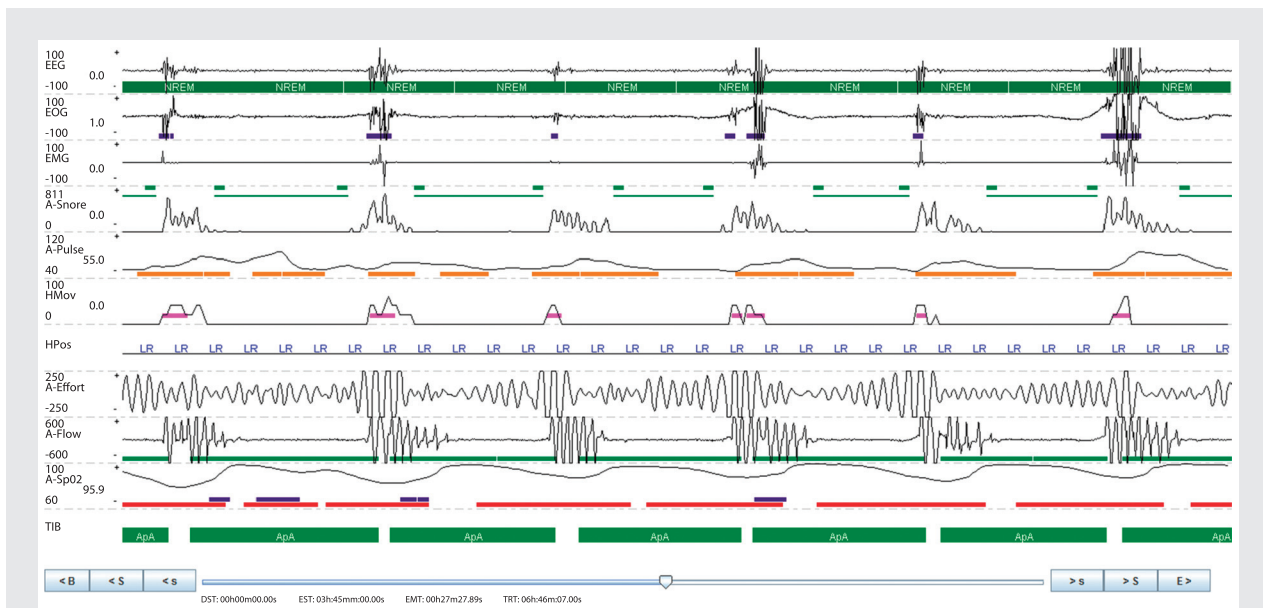
Five-minute epoch of in-home sleep testing device 1 shows readings from a 64-year-old woman with obstructive sleep apnea. Channels from the top down are arterial oxyhemoglobin saturation (SpO2); followed by heart rate (HR); nasal pressure (FLOW); respiratory effort (EFFORT); snoring (Snore); patient event marker (PEM); and position (Pos), in this case, supine. The study shows repetitive apneas with absent nasal pressure and continuous respiratory effort.

(oral-nasal thermistor/nasal pressure, oximetry/pulse rate, respiratory effort belt) (**Practice Figure 1**). Some devices use alternative signals, such as peripheral artery tonometry as a substitute for airflow and respiratory effort, or venous pulsation as a surrogate for respiratory effort. Certain in-home testing devices are expandable, allowing the addition of ECG, EMG, or EEG signals for improved diagnostic accuracy. Others include estimators of sleep time, such as actigraphy or algorithms using a combination of EEG, electrooculography, actigraphy, or peripheral artery tonometry signal analysis. **Practice Figure 2** gives an example of a recording from a different in-home testing device, including some of these extra signals. When selecting an in-home testing device, it is important to understand its features and associated software. **Practice Table 2** reviews some aspects of in-home devices.

Standard in-home sleep testing is designed to evaluate OSA in a specific set of patients. An in-laboratory test is more appropriate when assessment of parasomnias, nocturnal seizures, periodic limb movements, or daytime sleepiness (in the absence of OSA) is required. Furthermore, for patients at risk for OSA who have had strokes or have neuromuscular disease such as ALS, in-home testing is likely not appropriate for assessment of sleep-disordered breathing, given the likelihood of central sleep apnea and hypoventilation, respectively. Lastly, an in-laboratory test is recommended if in-home sleep testing is negative in a patient with high pretest probability of OSA.

The Changing Testing Paradigm

In-home sleep testing is a quickly developing segment of sleep medicine, spurred by the large and growing number of patients in whom possible OSA is considered, the limited number of sleep laboratories, and the cost savings to



PRACTICE FIGURE 2 Five-minute epoch of in-home sleep testing device 2 shows readings from a 45-year-old man with obstructive sleep apnea. Channels from the top down are EEG, estimated sleep stage (NREM), electrooculography (EOG), EMG, snore (A-Snore), pulse rate (A-Pulse), head actigraphy (HMOv), head position (HPos), effort (A-Effort), nasal pressure (A-Flow), and arterial oxyhemoglobin saturation (A-SpO₂). The study image shows repetitive apneas with absent nasal pressure and continuous effort signal.

PRACTICE TABLE 2 Considerations in the Choice of Home Testing Devices

- ▶ Cost of device
- ▶ Cost per study (disposable equipment, data management)
- ▶ Number and type of sensors available (Is the device expandable?)
- ▶ Location of test scoring
- ▶ Software integration with current computer system
- ▶ Ease of patient use
- ▶ Failure rate, quality of study
- ▶ Quality of auto-scoring (reduction in technologist scoring time)
- ▶ Option for chain of custody tracking (if necessary for patients at risk for placing the device on another person to fraudulently obtain or avoid a diagnosis of OSA)
- ▶ Report design flexibility

insurance programs with in-home compared to in-laboratory testing. This form of testing may allow sleep specialists to assess and treat many patients who were previously unwilling or unable to be evaluated in a sleep laboratory. The use of these devices may also allow OSA screening programs for patients scheduled for general or orthopedic surgery to develop, potentially increasing patient volume and improving surgical outcomes.

The increased use of in-home sleep testing also presents challenges for the current sleep laboratory paradigm. One utilization management company representative indicated, “It should be 70% at home and 30% in the lab.”⁸ A change of this magnitude would lead to a dramatic reduction in laboratory-based studies and would require significant changes in the structure of sleep laboratories. Some options to increase efficiency may include altering the number of available laboratory beds, increasing patient to technologist ratios, and cautious use of auto-scoring software in the laboratory. The shift to in-home testing is likely to require reductions in manpower and adjustment in roles for sleep technologists. A home testing program might repurpose sleep technologists as patient educators, teaching the patient about OSA and training the patient on testing device use. Sleep centers will need to focus on building an in-home sleep testing program designed to maintain high study quality, a low failure rate, and the most efficient distribution of testing devices.

Although Massachusetts was an epicenter of utilization management programs in sleep medicine from 2010 to 2011, several national insurance companies have initiated similar programs in attempts to slow the rapid growth of money spent on sleep medicine. Developing a well-organized in-home sleep testing program and improving laboratory efficiency will be essential to the success of many sleep centers in this changing health care environment. Physicians with sleep specialization should use in-home sleep testing as appropriate but should also continue to use in-laboratory polysomnography for patients with medical or sleep comorbidities.

Case Comment

Proceeding with in-home testing would be a reasonable first step for this patient given his high pretest probability for OSA. If in-home testing is negative, an in-laboratory polysomnogram should be obtained.

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