New Approaches to Diagnosing Sleep-Disordered Breathing

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KEYWORDS

• Apnea • Screening • Phenotyping • Technology

KEY POINTS

- Home sleep testing is now widely used.
- Advanced analysis of respiratory sounds, electrocardiogram, and body movements will likely enable widespread screening for sleep-disordered breathing.
- Semi-automated scoring algorithms will reduce the resources required and improve consistency of diagnoses.
- Personalized sleep medicine will approach actuality as noninvasive methods reveal sleep apnea mechanisms, allowing clinicians to determine what options are best suited for individual patients.

DETECTING THE PRESENCE OF EVENTS: DIAGNOSTIC AND SCREENING TECHNOLOGY

In-laboratory diagnostic polysomnography has traditionally been the gold standard for obstructive sleep apnea (OSA) diagnosis, but the high prevalence of disease and the massive number of patients at risk of disease cannot reasonably be diagnosed at in-laboratory facilities. Peppard and colleagues[1] conservatively estimated that 10% of the US population has clinically important OSA, suggesting more than 30 million people afflicted with OSA in the United States alone. Clearly, many more are at risk of OSA or have more mild disease. Heinzer and colleagues[2] used gold-standard techniques in Switzerland and estimated up to 50% of men had some degree of clinically important apnea. Thus, the use of new technology to detect respiratory events (without the need for cumbersome and expensive in-laboratory testing) is an important step forward. Home sleep testing (HST) provides acceptable diagnostic sensitivity and specificity, although most technologies cannot distinguish wake from sleep, non-rapid eye movement (NREM) from rapid eye movement (REM) sleep, or supine from lateral posture. As a result, clinicians get only partial information when determining therapy.

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Home Sleep Testing

HST has been used widely around the world and has recently increased in popularity in the United States. The factors driving home testing are primarily financial given the realization of the massive numbers of patients who may need to undergo testing and the data suggesting a satisfactory clinical result can be obtained using a HST approach. Several randomized trials were completed that compared the results of HST plus in home auto-titration positive airway pressure (PAP) therapy versus usual care via in-laboratory polysomnography or split night testing.[3–9] Although still the topic of debate,[10,11] the data in aggregate support a home testing approach suggesting equal if not better outcomes using home testing as compared with the traditional approach. An important caveat, however, is that most studies have carefully screened for patients at risk for moderate to severe OSA and studied patients without comorbid medical disorders (eg, chronic obstructive pulmonary disease, heart failure, obesity-hypoventilation, opioids for chronic pain).

A variety of devices are available for HST, each with potential strengths and weaknesses. In general, simple equipment provides fewer channels and potentially less data to interpret, whereas more complex equipment can record multiple channels but can be more cumbersome to use and interpret. The authors think that the number of channels on a given device is less relevant than the sensitivity and specificity of the device and the clinical outcomes that a given device can achieve. Thus, the classification system based on number of channels, for example, level 2 versus level 3, is not particularly helpful.

Given the appropriate reliance on home testing, many subtleties are worth mentioning:

a. Given that home testing rarely monitors body position in a robust manner, positional therapy becomes hard to implement in the HST era. Positional therapy can be useful for patients who are intolerant of continuous positive airway pressure (CPAP) or as an adjunctive therapy in patients with partial response to therapies such as weight loss or oral appliance therapy. Thus, in-laboratory testing or other methods of position monitoring may have a role for select patients.
b. Respiratory events may have varying impact depending on whether they occur during REM sleep versus NREM sleep. Because REM sleep is characterized by physiologic variability, some have argued that respiratory fluctuations during REM sleep may not have major consequences. On the other hand, some recent data do support clinically important impact of respiratory events during REM sleep.[12,13] Moreover, some patients experience profound desaturations during REM sleep, presumably as a result of skeletal muscle atonia in accessory respiratory muscles. These profound desaturations are unlikely to be physiologic and thus likely require therapy. As a result, CPAP therapy is often prescribed for both REM and NREM events, making the distinction during diagnostic testing between these 2 states less important clinically.
c. Because most HST devices do not monitor sleep, the devices work on the assumption that the total recording time is actually the total sleep time, that is, that the patient sleeps 100% of the night. As a result, the apnea hypopnea index (AHI) as judged by HST can underestimate the actual AHI, particularly among patients with reduced sleep efficiency. For example, a patient with 50% sleep efficiency who has an AHI of 4/h may actually have an AHI = 8/h if the impact of poor sleep quality was addressed. Thus, the interpretation of HST must be made cautiously in patients with comorbid insomnia or in patients who report poor sleep quality during the recording.
d. When sleep is not monitored, the HST-reported AHI may underestimate hypopneas that terminate as arousals from sleep. In particular, younger and leaner patients who have normal cardiopulmonary function (ie, normal lung volume, alveolar-arterial gradient), and thus less prone to oxygen desaturation for any given reduction in airflow, may not exhibit frequent (eg, >3%) desaturation events but may still have sleep fragmentation. These events may not meet criteria because arousals cannot be scored on most home devices. Home devices that do assess sleep stages and arousals may thus have additional value over those that ignore sleep staging.

Novel Approaches to Screening and Monitoring Sleep Apnea

For the large-scale screening for sleep apnea, even the most accurate HST is limited because of the availability of equipment. For longer-term monitoring of sleep apnea, in the era of patient-directed health management, the requirement for sensors to be placed on the body is an additional limitation. Novel screening approaches typically do not measure directly the key features of sleep apnea (airflow, oxygen