

## HOME SLEEP TESTING REVISITED

By Richard Bonato, PhD, MA, RST, RPSGT

Historic events occurring around us will forever change the landscape of sleep technology and the delivery of sleep medicine. This nexus at the core of the paradigm change is brought about by the convergence of evolutionary technology, aging baby boomer demographics, increasing incidence and prevalence of obesity, worldwide financial strain on health care insurance systems both private and public, and the approval in March 2008 of home sleep apnea testing (HST) by the Centers for Medicare and Medicaid Services (CMS). This last event was the barometer by which most of the world practices sleep medicine and by which private payers in the U.S. gauge their reimbursement structure. Indeed, many private payers began reimbursing HST following the watershed 2008 CMS decision. Sleep technologists and sleep laboratories must be prepared for this paradigm change, which means understanding the future delivery of sleep medicine.

Frequently, I meet sleep technologists who feel threatened by home sleep apnea testing, with the most typical comment being about losing employment. This misperception is entirely the opposite of what will occur. Because the vast majority of people with sleep apnea remain undiagnosed, perhaps upwards of 75 percent, there exists an enormous opportunity to expand the market size for both diagnostics and therapeutics. Furthermore, many patients simply refuse to go to a sleep laboratory. Ask 10 people on the street if they would rather sleep at home or at a sleep laboratory, and all will respond “home.”

However, to take advantage of this opportunity, sleep laboratories need to extend the diagnostic arm of the traditional sleep lab into the bedrooms of the nation. Doing so means tapping into a larger market size. Larger markets mean more opportunity. More opportunity for screening, diagnosis, treatment (both unattended and attended), and increased overall business for the sleep laboratory.

A sleep technologist will still be needed for equipment preparation, patient setup and education, and data analysis according to published criteria.<sup>1,2,3</sup> But rather than working with two or three patients, the home sleep apnea testing paradigm will permit the sleep technologist to record several patients while the sleep technologist sleeps at night and works during the daytime. As a first line of screening, more PSG channels with few patients will be exchanged for less HST channels and many patients. Certainly, many sleep technologists will

welcome this change. Combine this with new state and federal initiatives by various transportation departments concerning sleepiness and sleep apnea, and there is another growth market forthcoming. For sleep technologists this means new skills and a burgeoning opportunity.

One such skill involves looking at home sleep apnea testing for what it is. It is simply another tool used in the diagnosis and management of sleep apnea. It is *not* a total replacement for polysomnography (PSG). This understanding is key. Home sleep apnea testing is *complementary* to PSG, not competitive. Throw any notion of mutual exclusivity out the window.

A diagnosis of sleep apnea is not made in a vacuum. A thorough medical history is needed, patient questionnaires are completed, the board-certified sleep physician performs a clinical interview and recommends a PSG or HST based on this collection of data. If there is a high probability of sleep apnea with no significant comorbidities, then an HST may be indicated; otherwise a PSG is used. For difficult-to-diagnose cases and certain pediatric and geriatric populations, a PSG may be indicated. And for all the other sleep disorders out there, a PSG may be needed. But for the run-of-the-mill, otherwise healthy, middle-aged individual with a high probability for sleep apnea, an HST program can be efficiently used for both diagnostics and therapeutics.

### THE HST PROTOCOL

*Recommendation: Develop a clinical home sleep apnea testing protocol within your sleep laboratory using published guidelines to deliver cost-effective and successful clinical outcomes in an increasingly strained and competitive health care environment.<sup>1,2,3</sup>*

One very pragmatic HST protocol involves the combination of clinical interview, subjective questionnaires, HST, PSG, and CPAP titration either at home by the patient or in the laboratory by the technologist.<sup>4,5</sup> In this clinical protocol, the sleep physician performs a clinical interview with the patient and bed partner (if possible) followed by the administration of validated sleep questionnaires, such as the Sleep Apnea Clinical Score, the Stop-Bang, and the Berlin. If there is a high probability of sleep apnea in the absence of comorbid conditions contraindicating an HST, then an unattended home test is scheduled. The presence of comorbidities usually requires a PSG, but sometimes an HST is useful when sleep apnea may be an underlying cause of the medical condition (see Figures 1 and 2). If the objective home apnea test confirms the apnea, then CPAP may be prescribed using a published home CPAP titration protocol.<sup>4</sup>

This protocol has already shown home self-titration of CPAP to be as effective as in-laboratory manual titration for patients diagnosed with OSA. More recent research has confirmed the clinical importance of objective measurement used in combination with subjective questionnaires.<sup>5</sup> An important aspect of this protocol is that it enables the sleep laboratory medical director to effectively triage patients using a



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**Baseline Study: Respiratory Results by Body Position**

Body Position	Supine	Prone	Left Side	Right Side	Total Non Supine
% Time in Position	49.2%	0.0%	34.6%	16.1%	50.7%
Snoring events	673	0	676	253	929
Apnea + Hypopnea events	151	0	4	1	5
Apnea + Hypopnea Index	45.5	0.0	1.7	0.9	1.5

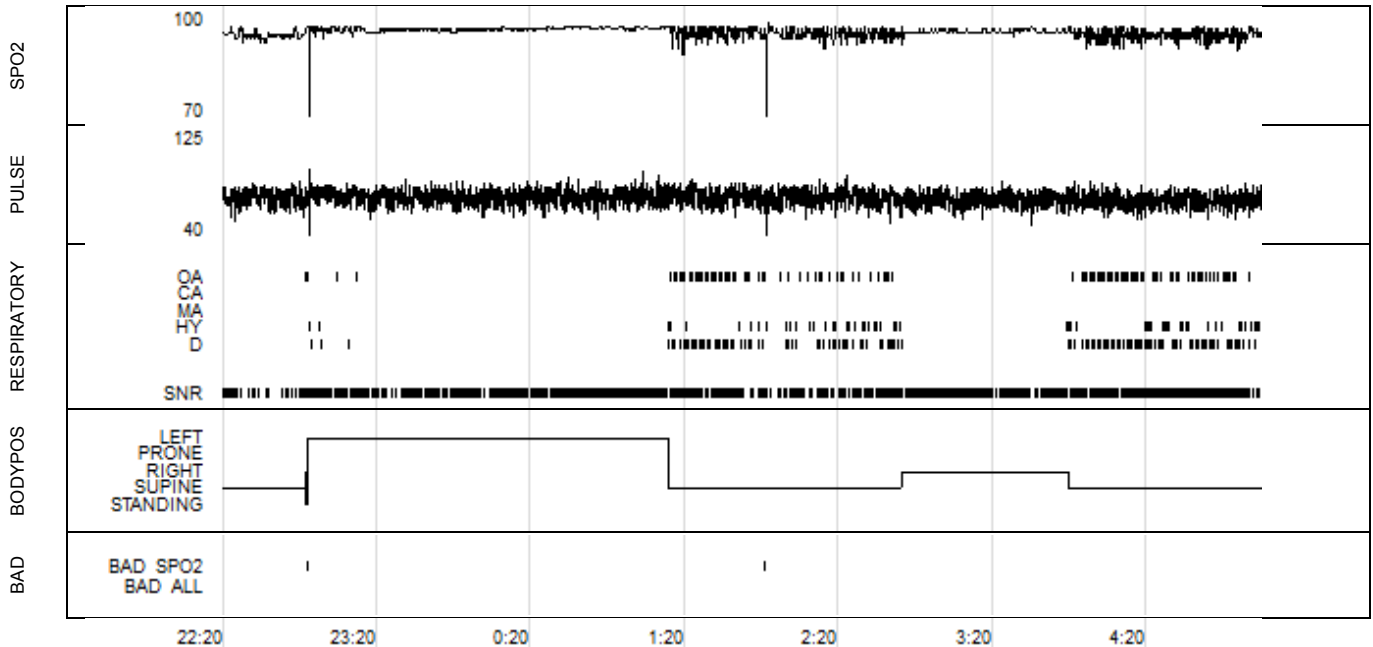


Figure 1. Severe positional OSA in a 73-year old male patient diagnosed with atrial fibrillation after failed electrical cardioversion. Neither the cardiologist nor family doctor had considered screening for OSA. Patient had severe OSA with AHI of 45.5 while sleeping in the supine position. Total nonsupine AHI was 1.5. Test was performed May 23.

**Follow-up Study: Respiratory Results by Body Position using Positional Treatment**

Body Position	Supine	Prone	Left Side	Right Side	Total Non Supine
% Time in Pos	0.0%	0.1%	97.1%	2.4%	99.6%
Snoring events	0	2	1860	66	1928
Apnea + Hypopnea Events	0	0	24	1	25
Apnea + Hypopnea Index	0.0	0.0	3.9	6.5	4.0

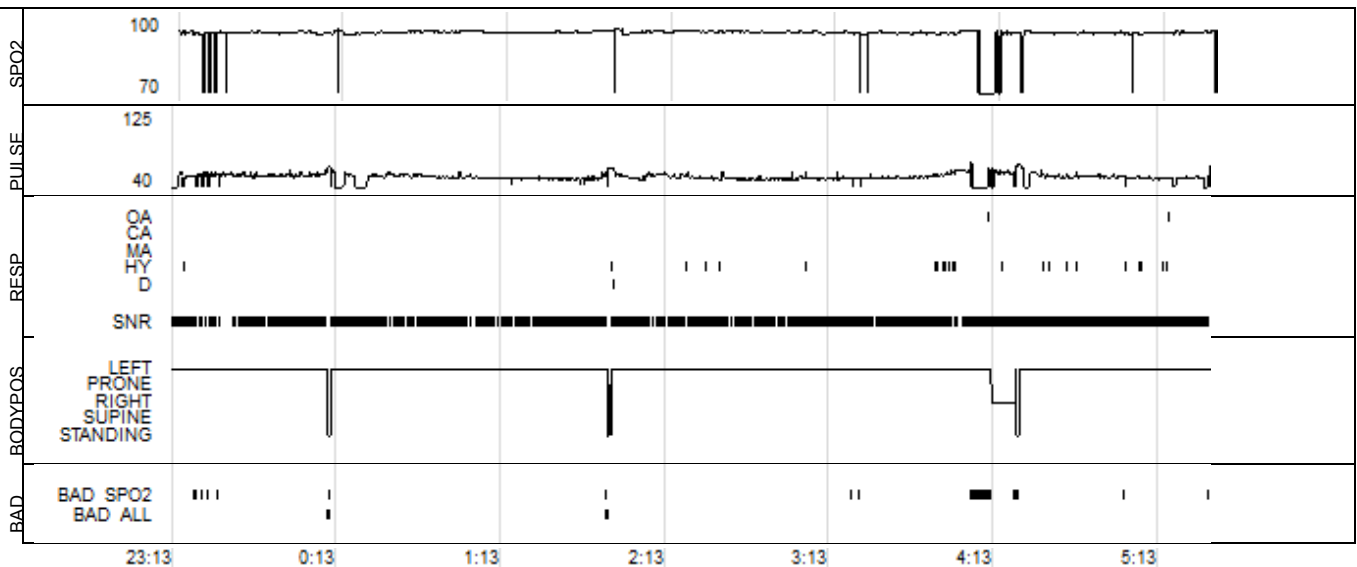


Figure 2. Treatment of OSA using positional therapy. No supine sleep observed. Note total nonsupine AHI index of 4.0. Follow-up home apnea test was performed June 17, approximately 3 weeks after baseline test.

clinical pathway that most efficiently uses health care resources. For straightforward cases without comorbidities, the home environment may be used for both diagnostics and treatment. For cases that are difficult to diagnose, pediatric or geriatric populations, or for those cases with more serious medical conditions, the laboratory remains the primary delivery locale for both diagnosis and treatment. Regardless of the locale, the technologist plays a crucial role in health care delivery and must have a solid grasp on the technology employed.

## THE HST TECHNOLOGY

*Recommendation: Use the same technology in the home environment as you do in the laboratory.*

Perhaps home sleep apnea technology evaluations have become too complicated. Sophisticated scales are used to classify technology with various levels and sublevels, and such scales are useful to parse through commercial product offerings.<sup>6</sup> However, the choice of product to use is not complicated, nor should it be. Rather, I prefer the principle of parsimony. Quite simply, if technology is good enough for the sleep laboratory, then you should demand the exact same technology for the home environment. The same minimum sampling rates, the same sleep sensors. Demand the exact same technology. Apply the aforementioned published guidelines to your HST technology and be prepared to reap the rewards.<sup>1</sup>

For example, there should be no surprise to find Pearson product-moment correlations of 0.92 and high sensitivity and specificity if you use the same technology in the home and laboratory.<sup>7</sup> There is no need to relearn the underlying technology. The problem is not the availability of technology, but rather the magnitude of poor technology on the market. This one simple requirement to use the exact same technology in the home as in the sleep laboratory permits the sleep technologist to analyze the data in the same manner: full disclosure of data using the same sensors and with analysis according to AASM rules. The only real difference should be the recording environment of laboratory versus home.

We breathe through our mouth and nose; therefore use an oronasal pressure cannula and oronasal thermistor. Ventilatory effort is shown by muscular contractions in the thorax and abdomen; therefore use respiratory inductive plethysmography (RIP) technology. Numerous products on the market purport to record apnea and effort using proprietary technology, but when you peel back the layers you find they are indirect measurements that only offer correlation. Any first year statistics textbook will explain all about the challenges of indirect correlational measurement.

Sophisticated HST analysis scales also miss the boat on one crucial difference between the sleep laboratory and unattended home sleep apnea testing. The fundamental difference between HST and PSG is that the hardware used in the home is used by a layperson, whereas the hardware in the laboratory is used by a trained professional. You could have the most sophisticated technology in the world, but if it is too difficult to use it will fail. Do you really expect a layperson to perform at the same level as a sleep technologist?

Therefore, ease of use and overall friendliness of design with data protection redundancies are essential. This is called “ergonomics” and is fundamental to both hardware and software

industrial design. Consequently, the hardware must be super simple to use. In fact, it should be so simple that a 10-year-old can connect everything with zero supervision. Color-coded connectors are a start, but that alone is insufficient. Unique locking connectors are an absolute necessity. More than 10 years ago, I repeatedly lost data because SpO<sub>2</sub> connectors fell off during the night. This is totally unacceptable in the 21<sup>st</sup> century. Therefore, technology is only part of the overall equation. Ease of use for the layperson is key, and simplicity of design is the starting point.

However, size also matters. The hardware must be relatively small, and at a minimum it must be thin. If it is so large that it needs to be placed under the pillow, it will be a problem. If it is more than one inch thick and worn on the chest, it will make patients feel like they have impaled themselves when they roll over and will disrupt sleep more than necessary. Any evaluation scale of HST technology falls short if the analysis fails to include simplicity of design.

## SUMMARY AND CONCLUSION

The choice of HST or PSG is a choice of which tool is appropriate for the job. Sometimes PSG is best indicated, and sometimes it will be HST. For a variety of reasons health care delivery is changing around the world, and sleep technology needs to keep up with the evolution. Successful sleep laboratories of the future will seize the changing paradigm and successfully employ technology that falls under the umbrella of recognized published standards. Sleep laboratories will always be here, but the sleep laboratory of the future will use HST to cost-effectively diagnose and treat sleep apnea, will oversee CPAP titration both in the home and in the laboratory, and will increasingly deal with patients in the lab who are difficult to diagnose or have comorbidities (i.e., increasingly sick).

The role of sleep technologists shall adapt to these changes. A couple decades ago, change involved migration from ink and paper PSG to digital paperless technology. Those of us who are old enough remember the changes well. Today, change means adding the new HST tool to the repertoire of a sleep technologist. Using the properly designed HST tool for the right job will bring success. Changing technology is part of life, and sleep technologists must embrace this change.

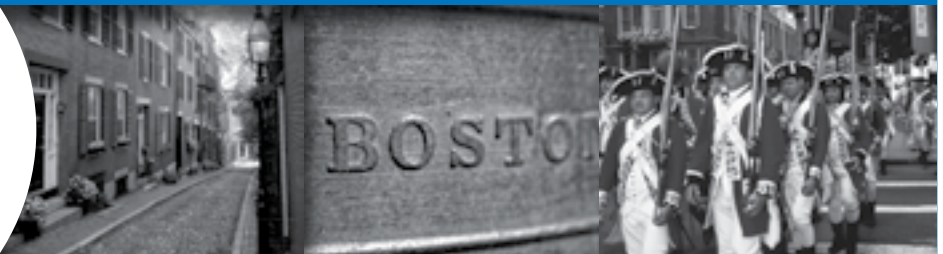
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