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## Market Trend

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### Keeping a Pulse on Oximetry

by Tor Valenza

**Whether inside a PSG system or a new home testing device, having a system with a modern pulse oximeter remains vital for proper OSA diagnosis.**



Not all pulse oximeters are alike. Pulse oximetry has always been important for the proper diagnosis of sleep-disordered breathing, but the pulse oximetry channel is receiving even more scrutiny now that the sleep industry is heading toward portable monitors (PMs) for home testing. The latest pulse oximeter technology boasts faster signal recording times and sophisticated algorithms that account for motion artifact, yet older PSG systems and PMs with built-in oximeters may still be using oximeters with slower signal averaging times—which may affect a proper diagnosis.

### FASTER SIGNAL AVERAGING TIMES

Faster signal averaging time is perhaps the most important new trend that manufacturers are incorporating into their new pulse oximeters.

Previous generations of oximeters had 4-second or longer averaging times, but now oximetry companies are producing high-resolution pulse oximeters (HRPOs) with 1- or 2-second signal averaging times.

Lawrence A. Lynn, DO, FCCP, executive director of the Sleep and Breathing Research Institute, Columbus, Ohio, and a member of the Food and Drug Administration's standards committee for pulse oximeters, identifies optimal HRPOs as having "a high horizontal resolution of the  $SpO_2$  (averaging 1-2 seconds) and a high vertical resolution of the  $SpO_2$  (0.1%  $SpO_2$ ) and a high horizontal resolution of the heart rate (1-2 seconds)."

Lynn points to several studies that show how an oximeter's signal averaging time can influence the correct diagnosis for prescribing CPAP. For example, he cites a 2005 study in *Chest*, which concluded that the choice of oximeter can affect the apnea-hypopnea index (AHI).<sup>1</sup> In the study's abstract, the authors report that "Although the use of three oximeters resulted in a similar AHI (bias, < 1 event per hour), the fourth oximeter showed an overall increase in AHI of 3.7 events per hour. This caused 7 of 113 patients to have an AHI of  $\geq$  15 events per hour (meeting the Medicare criteria for treatment) by one oximeter, but not when a different oximeter was used."<sup>1</sup>



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In addition, an earlier 2003 study in *Sleep* showed that the number of events associated with a 3% desaturation can be variable—even when using a single brand of oximeter.<sup>2</sup>

The AASM recently addressed signal averaging times in its update of PSG scoring standards as well as in its new guidelines issued for PMs.

Nancy Collop, MD, the lead author of the AASM's PM guidelines, says, "The maximum acceptable signal averaging time [for an oximeter] is 3 seconds (at a heart rate of > 80 bpm). This was the same standard we

adopted for the PM guideline paper."

Lynn also notes that modern pulse oximeters should have a high-resolution recording of the pulse as well. He explains, "Often when you're looking for a physiological arousal, you want to identify a pulse rise that occurs in association with an airflow attenuation and/or a desaturation. So if you're not using a high-resolution pulse oximeter, you may miss the pulse rise that may occur. That may be detected on ECG, but it's nice to have it on the pulse oximeter, too."

## **REDUCING MOTION ARTIFACT**

Manufacturers also have been developing ways to reduce motion artifact through new algorithms that compensate for patient movement during sleep.

Andrew Jones, director of Alternate Care for Masimo, Irvine, Calif, says, "The 2-second averaging doesn't help unless you have the ability to read through motion. If you go to a faster averaging time and you can't read through motion, you just lose more data faster."

Masimo's oximeter read-through motion technology comes from a combination of what the company calls "adaptive filters." Jones says that these filters and proprietary algorithms differentiate between the pulsing arterial blood and the sloshing venous blood.

Lynn suggests that sleep laboratories contact their PSG or PM manufacturer and learn about the device's motion tolerance specifications and whether it achieves motion tolerance through algorithms or the less accurate method of averaging the signals.

He explains, "The older oximeters achieve motion tolerance by averaging the signal, and in essence, averaging away these little desaturations that came from motion. When you do that, you run into the high-resolution problem and you're not high resolution anymore. So they have to have a motion-tolerant algorithm product."

## **EXTERNALLY UPDATING YOUR PULSE OXIMETER IN PSGS**

If, after consulting with their PSG system provider, a sleep laboratory discovers that their existing PSG system is not up to modern 3-second or better standards, there may be a simple way to upgrade the obsolete oximeter.

SatShare is a cabled system that allows an external Masimo SET oximeter to connect into most PSG systems through its oximeter input connector.

Consequently, SatShare may be an inexpensive alternative to replacing the entire PSG that is otherwise meeting the AASM's new scoring guidelines. (Of course, one would also have to consider the cost of purchasing a compatible Masimo oximeter.)

"There really haven't been that many changes since the 1970s with PSG," says Lynn. "But as far as formatting and averaging times, oximetry has been one of the areas where there has been a dramatic change. So if you have an older unit with long averaging, you should strongly consider replacing or getting an updated oximeter."

## **OXIMETRY IN PM DEVICES**

The AASM prefers Type III portable devices, which have a minimum of four channels, including ventilation or airflow (at least two channels of respiratory movement, or respiratory movement and airflow), heart rate or electrocardiogram, and oxygen saturation. Consequently, a portable monitor's oximetry channel will be significant for accurate home testing for OSA.

The good news for PM is that much of the same oximetry technology that can be included in a modern PSG

system can also be applied to smaller home testing devices.

The 1- or 2-second signal averaging times and algorithms to reduce motion artifact are both possible features in the latest PMs—but those features are not necessarily standard. As with PSG systems, owners should check with the PM manufacturer about specifications for the oximetry channel.

"You definitely want high resolution," says Lynn. "All of these old oximeters that people have should never be used for home screening of sleep apnea. They will give you improper results and should not be used for home screening unless it's a high-resolution oximeter."

In addition, Lynn says it is important that the PM is able to record at high resolution for 2 or 3 consecutive nights. Being able to record 2 or 3 consecutive nights allows for weekend studies, which can reveal a patient's night-to-night variability. Some units may record for longer periods, but may compromise their resolution to do so.

Other things that Lynn recommends in a PM with oximetry:

- Ideally, the unit should be wearable, on the hand or chest, or be very small.
- The data should be easily downloadable to a computer through a USB port.
- Also, the unit should have a simple AA or AAA battery that can be replaced easily by the patient or the person providing the unit. Rechargeable units can work well, but buyers should keep in mind that the unit will be out of commission while charging, and thus patient turnover will be slower.
- The unit should have a simple on-off switch.

Although pulse oximetry technology is becoming more accurate and small enough to fit into a PM device, manufacturers continue to provide new advanced features.

One trend is separately measuring carboxyhemoglobin, which may help to more accurately diagnose OSA in smokers, though that is still being studied. Another trend is providing a plethysmographic waveform (Pleth) output, which can help clinicians detect arousals.

Some of these features are already available on stand-alone pulse oximeter devices, but Lynn expects that they will eventually be incorporated into PSG and PM systems as well.

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