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How Many More Nights? Diagnosing and Classifying Obstructive Sleep Apnea Using Multinight Home Studies

Sleep duration, the proportion of REM and non-REM sleep, body position, and perceived sleep quality alter from night to night. It is not surprising that sleep disordered breathing varies too (1). Respiratory events may change across the night with the greatest changes in Sa_{O_2} seen during REM sleep (2). Obstructive apneas are more pronounced in the supine position, and other anatomical features such as nasal patency and upper airway collapse (3) can fluctuate night to night.

For clinical decision-making, any uncertainty in the apnea–hypopnea index (AHI) matters as the diagnosis obstructive sleep apnea (OSA) and its degree of severity are currently classified by simple cutoff values: mild OSA if AHI is 5–15, moderate OSA if AHI is >15–30, and severe OSA if AHI is >30.

Night-to-night variation in AHI is well established. Punjabi and colleagues (4) in a three-night study using a type III sleep apnea test showed 93% of those with a normal study on first night and 87% with severe OSA on first night were correctly identified compared with pooled values obtained over three nights. However, ~20% of patients with mild or moderate OSA on the first night were misdiagnosed or misclassified. A study (5) based on three nights of home testing using peripheral arterial tonometry showed that 24% of patients were misclassified using one night compared with three nights of data. Variability was partially explained by the duration of time spent supine. Notably, these studies, and those included in a meta-analysis and systematic review (1), observed night-to-night variation in AHI over a handful of nights with relatively small numbers of subjects.

In this issue of the *Journal*, Lechat and colleagues (pp. 563–569) set out to assess the prevalence of OSA (using a cutoff for diagnosis of AHI ⩾15), and night-to-night variation in AHI over a far longer period than in previous studies, and with a large sample size to understand the impact on diagnostic certainty (6). This was made feasible by using a contactless noninvasive diagnostic device (Withings Sleep Analyzer) placed under the user's mattress at home. Signals of body movement, respiratory rate, heart rate, snoring, and breathing pauses were used to calculate AHI, total sleep time, bedtime and waketime, and AHI using automated algorithms. Study data were obtained from 67,278 participants who used the device for more than 28 days; average use was very significantly longer than previous studies at 170 nights.

The authors examined the global prevalence of OSA in 20 countries in which at least 300 users had registered. They estimated overall prevalence of OSA in Japan to be 15%, the United States 21.6%, Germany 29%, France 23.1%, and the United Kingdom 22.9%. These findings are in line with the prevalence estimates of Benjafield and colleagues (7), although these present results should not be generalized, as the study group comprised self-selected individuals who purchased the under-mattress device so were likely to have had sleep-related symptoms and were therefore not a random sample.

Of key interest is whether extending the number of nights studied beyond a few nights minimizes potential misdiagnosis and misclassification. Clearly this seems most important when differentiating between no sleep apnea and mild OSA, and mild and moderate OSA. Here Lechat and colleagues add important clarity (6). They showed that an average of 21% of diagnoses (no OSA vs. OSA) would be false negative on a single night study. Severe OSA was correctly classified in 85% of cases, whereas mild and moderate OSA were correctly classified in only 54% and 52% of nights on a single night. Although data were obtained from the study group for 28 days to 8 months, the authors found that performance improved from 1 night of data to 14 nights of data, but beyond 14 nights there was no increase in area under the receiver operating characteristics curve and no further decrease in false negative and false positive rates.

What should the clinician take from this? First, that misdiagnosis and misclassification are relatively common after a

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single night study. However, there are caveats—clinicians aim to diagnose OSA/hypopnea syndrome (OSAHS)—that is, we balance symptoms and indices of OSA and use guidelines and common sense to further investigate those individuals with symptoms suggestive of OSAHS, but with a negative one-night study.

Second, how accurate and reproducible is the under-mattress monitor? Can we extrapolate the findings from this device to other portable sleep monitoring systems? A one-night comparison with polysomnography showed a sensitivity of 88% and a specificity of 88% for moderate to severe OSA (8). However, the validation studies are small, women are underrepresented, and the studies were not performed over longer periods. Clearly polysomnography comparison with the under-mattress device over many nights in the sleep laboratory or at home is not practical, but further data would be helpful.

One could argue what the "*correct*" value for AHI is. Ultimately, up to 28 nights of study gives us a more accurately representative *mean* AHI. A misclassification between mild and moderate OSA can be important in affecting treatment choices too, as many guidelines suggest continuous positive airway pressure is first-line therapy in those with moderate and severe OSA. This dilemma is reduced in countries where recent guidelines (9) have supported continuous positive airway pressure as first-line therapy in symptomatic patients with mild OSAHS.

What is most useful about this study is that it reinforces the point that single night studies are imperfect and give an estimate, which in some cases may be adequate and in others wrong to an important degree. We are not able to do 14-night studies for all our patients, nor do we probably need too. However, the importance of a missed diagnosis in those with mild OSA should be borne in mind. These simple home studies give us far more flexibility at a lower cost than polysomnography, though we lose other data, sensitivity, and specificity. The findings make the case for us to consider multinight studies in those patients who present diagnostic dilemmas and have a discrepancy between symptoms and AHI. Multinight studies perhaps will prove an even more helpful way to understand natural variations in OSA over time and responses to therapy.

The results also reinforce what we have known all along from personal experience: sleep is dynamic and variable, and this understanding should feed into our clinical decision-making on OSA too. ■

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