EDITORIAL

A Step Forward for Better Interpreting the Apnea-Hypopnea Index

Commentary on Ho et al. Calibration model for apnea-hypopnea indices: impact of alternative criteria for hypopneas. SLEEP 2015;38:1887–1892.

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Sir William Thomson, 1st Baron Kelvin, and one of the pillars in the history of physics and engineering wrote a few sentences that became a traditional citation:

> "I often say that when you can measure what you are speaking about, and express it in numbers, you know something about it; but when you cannot measure it, when you cannot express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely, in your thoughts, advanced to the stage of science, whatever the matter may be."[1]

This conceptual statement may come to our mind and raise a reflection when reading the work published by Ho and colleagues[2] in the present issue of *SLEEP*. Indeed, these authors focus on an important problem of metrology in the field of sleep disordered breathing (SDB). Specifically, they analyze how three different widespread criteria for defining hypopneas impact on the resulting apnea-hypopnea index (AHI). Whereas the clinical and scientific SDB community is already aware that application of different definition criteria may result in a variance of AHI figures,[3–6] the important value of the study by Ho et al. is that it provides numbers allowing us to quantify the effect of hypopnea metrics on AHI when applied to the very same raw data. The authors should be congratulated because their analysis also delivers tools for estimating the translation of results from the use of one or another AHI metric—what they refer to as calibration—thereby facilitating comparison of results from reports using different criteria to define hypopneas.[2]

The shocking results obtained by Ho et al. appear clearly summarized in their Figure 1, showing how the classification of obstructive sleep apnea (OSA) severity in a population of more than 6,400 individuals is affected by the metrics employed for estimating hypopneas. Indeed, among the individuals classified as suffering OSA (AHI $\geq$ 5 per hour) the distribution among severity categories (mild, moderate, or severe) varied considerably. Most strikingly, however, is that the percentage of individuals classified as normal were 48%, 30%, or 17% of the population under study, depending on the hypopnea metrics employed. In other words, almost one-third (31%) of the investigated subjects could be moved from normal to OSA labels or vice versa. Moreover, the proportion of moderate (15 $\leq$ AHI < 30 per hour) and severe (AHI $\geq$ 30 per hour) OSA changed as much as 13.5% and 10%, respectively, depending on the hypopnea definition used.[2]

Although the validity of AHI as a unique index for diagnosing OSA and for prescribing the corresponding therapy—typically continuous positive airway pressure (CPAP) —is certainly questionable[7,8] since more comprehensive clinical data should be taken into consideration, it is also a fact that AHI is commonly used as a sort of omnibus number. Specifically, AHI is used to quantify risk assessment in OSA (e.g. metabolic, cardiovascular, and cancer consequences[9–15]) and also for diagnostic and therapeutic decisions that have impact on the daily life of patients and on the financial costs associated to labor, insurance, and provision of health care.[16,17] Therefore, the potential variation in AHI quantification revealed by Ho et al.[2] point out the need for further studies to clarify how the diverse modes of quantifying hypopneas translate into different therapeutic decisions or influence clinical outcomes.

From a clinical perspective it is also interesting to note that the study by Ho et al.[2] clearly shows that discrepancies among hypopnea metrics are more relevant for patients with low AHI values, the differences being quantitatively less important in patients with more severe OSA. However, it must be taken into account that the calibration approach used by these authors has been constructed using a population-based sample in which moderate-severe OSA categories are usually under-represented. Accordingly, whether the derived calibration parameters can be directly applied to clinical-based samples needs to be confirmed. Another question that remains open is whether using one or another hypopnea definition would have a similar impact on different populations (e.g., women or elderly) with specific SDB phenotypes.

For the sake of discussion we could now speculate what Lord Kelvin would think on the metrics of AHI in view of his famous statement.[1] At first glance, he could think that if the SDB community is not able to assign a number (i.e., a clear measure) to a concept such as hypopnea it is because the knowledge on it is "of a meagre and unsatisfactory kind." In fact, this is rather true, since the event identified as hypopnea is a certain complex entity involving simultaneous changes in several physiological variables (e.g., those quantifying ventilation, breathing effort, sleep, or oxygenation). Moreover, it is unclear what are the exact clinical implications of hypopneas. Therefore, nobody

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could be blamed for a lack of scientific knowledge, which is not unusual in medicine. In addition to being somehow worried by the absence of a clear definition for hypopnea, Lord Kelvin probably would also be concerned about some technical issues in AHI measurement. First, concern might center on the fact that semi-quantitative sensors (thermistors, nasal prongs, or thoraco-abdominal bands) are used to obtain uncalibrated surrogate signals for key variables such as ventilation or effort.[18,19] Second, concern would occur because reductions in these signals for identifying hypopneas are in most cases detected semi-quantitatively by visual inspection of an expert, leading to potential inter-observer inaccuracies.[20]

Hence, while recognizing the true metrical difficulties in real life sleep studies, Lord Kelvin would probably ask the SDB community to proceed with more ambitious efforts for AHI metrics improvement, beyond the actual attempts carried out to date.[21–24] He probably would suggest working towards a better standardization, which always requires taking difficult decisions—to "advance to the stage of science,"[1] with the final aim of using common metrics for improving SDB research and clinical decisions. To finish with our speculative exercise involving Lord Kelvin, who in his time also faced serious metrology problems,[25] we could imagine that he would be in favor of following the successful examples in other metrical problems in respirology[26,27] or cardiology[28]: issuing clear expert statements firmly endorsed by as many world-span medical societies as possible. However, coming back to the current real world, the tools provided now by Ho et al.[2] can help the SDB community to better interpret the AHI computed by using different definitions.

CITATION

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DISCLOSURE STATEMENT

The authors have indicated no financial conflicts of interest.

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