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## Apnea hypopnea index supplied by CPAP devices: Time for standardization?

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### Abstract:

#### Background/Objective

For obstructive sleep apnea (OSA) patients on continuous positive airway pressure  
(CPAP) treatment, the apnea hypopnea index (AHI) is a key measure of treatment  
efficacy. However, the residual AHI is CPAP brand specific.

Here, we studied changes in residual AHI in patients who used two different brands over their treatment history,

### **Patients/Methods**

Using our CPAP telemonitoring database of 3102 patients, we compared the residual AHI of 69 patients before and after change in their CPAP device.

### **Results**

A paired Wilcoxon signed-rank test revealed a significant difference between brands in the reported AHI, which might be clinically misleading.

### **Conclusions**

These findings suggest that physicians should be alerted to the differences between brands and learned societies should push for standardization of AHI reporting.

### **Keywords:**

sleep apnea; continuous positive airway pressure; telemonitoring

To the Editor:

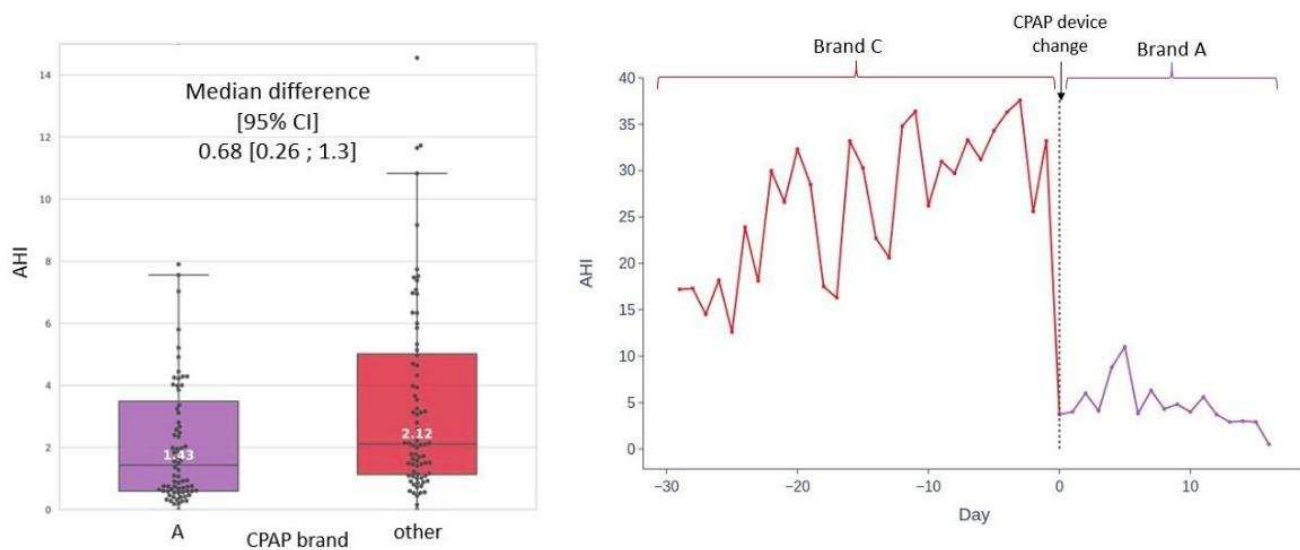
Sleep apnea syndrome (SAS), particularly obstructive sleep apnea (OSA) is one of the most frequent chronic diseases, affecting nearly one billion people worldwide.<sup>1</sup> Continuous positive airway pressure (CPAP), the first-line treatment for moderate to severe OSA, is currently used internationally by millions of patients for long-term home treatment. OSA is the only chronic disease for which objective daily measurements of adherence are available through telemonitoring of data from CPAP devices.<sup>2, 3</sup> Tele-monitoring also delivers the residual apnea-hypopnea index (AHI) at the end of every night of CPAP treatment, making it possible for clinicians to closely monitor treatment efficacy, to potentially adjust pressures<sup>5</sup> or even to switch to other positive airway therapy modalities.<sup>6</sup> The residual AHIs afforded by CPAP devices have been validated against polysomnography<sup>7</sup> or during bench test studies<sup>8,9</sup> demonstrating acceptable reliability. However, every CPAP device manufacturer uses a proprietary algorithm to detect, classify and aggregate events throughout the night to finally compute for physicians a brand specific residual AHI. The types of residual events included in the summary of nightly events vary between CPAP manufacturers essentially by including or not central hypopneas and respiratory effort-related arousals (RERAs).

An important unsolved question is the range of variation of reported residual AHIs among different CPAP brands for a given patient. To address this issue, we used a CPAP telemonitoring database [registered and ethically approved by the French C.C.T.I.R.S: N°15.925bis and ethics regulations MR003 N° 1996650v0] to measure any apparent changes in residual AHI in a group of patients switching from one CPAP brand to another during their follow-up. With such a study design, every patient was acting as her/his own comparator allowing us to assess in “controlled conditions” the impact of technology on residual AHI reporting.

## **Methods**

This study was conducted on data from 3102 patients prescribed with CPAP in a fixed or automatic mode by the Grenoble Alpes University Hospital sleep laboratory from 2015 to 2019. All were followed-up homogeneously by the same home-care provider. Patients used RESMED, PHILIPS, SEFAM and LÖWENSTEIN brands. CPAP device brands were anonymized. Data from manufacturer A's devices, which does not include central hypopneas and RERAs in residual AHI, was compared with devices from manufacturers B, C and D. For patients who had several changes in CPAP brands during their follow-up, every CPAP changeover was considered independently. Individuals with changes in CPAP mode, pressure settings or mask were excluded from the analysis. Three periods of 7, 14 and 31 days before and after the CPAP device changeover were investigated to evaluate stability of the evolution in residual AHI and the minimal period required to reliably identify modifications. Statistical analyses were performed using the non-parametric paired Wilcoxon signed-rank test due to the absence of normality of the residual AHI distribution (shown using the Shapiro-Wilk test). We compared residual AHIs from CPAP devices B, C and D with those of manufacturer A because we hypothesized that the later would give lower AHI values. We also compared brand A's residual AHI variance with other companies' residual AHI variances using a Pitman-Morgan test. All data analysis was performed using Python language and the SciPy package. The magnitude of the changeover effect was quantified with paired median and mean

differences, as well as Cohen's d, which were computed taking 5000 bootstrap samples.<sup>10</sup> Effect size is reported with its 95% confidence interval.



*Figure 1: (A) Median residual AHI of 69 patients and results of the paired Wilcoxon signed-rank test comparing the residual AHI of telemonitoring data acquired over the 14 days before and after CPAP brand changeover. (B) An elderly patient with co-existing sleep apnea at diagnosis (central and obstructive events) with clinically relevant differences in brand specific residual AHI.*

## Results

Sixty nine of the 3102 CPAP-treated patients ( $BMI\ 31.4 \pm 5.5\ kg/m^2$ , AHI at diagnosis  $41 \pm 16$  events/hour) exhibited at least one CPAP brand change during follow-up with reliable telemonitoring data before and after the changeover. Residual AHI reported by the CPAP brand “A” was significantly lower than the residual AHI reported by other CPAP brands (Figure 1A,  $P$ -value  $< 0.01$ ), when all three time windows were considered (7, 14 and 31 days with respective devices before and after shift). Considering data acquired over a 14 day window, the median difference in residual events/hour was 0.68 [95%CI 0.26, 1.3] and the effect size was considered as small (Cohen's  $d \approx 0.25$ ) for the overall population. Evaluating only the changes occurring under fixed pressure setting ( $n=50$ ), the median difference in residual AHI became non-significant between brands. Residual AHI changed by more than 5 events/hour in 6.6% of the population and was clinically relevant for several patients (Figure 1B). A telemonitoring window of 7 days was sufficient to identify a significant change in AHI after CPAP brand changeover, which then persisted over the 31-day follow-up period. The consistency of the results obtained over different time frames demonstrates the stability of the changes in residual AHI level.

## Discussion

Our study, using an original design with patients being their own control, confirmed that statistically significant differences exist between CPAP brands when reporting residual AHI, especially in automatic mode. In our unselected OSA population, the range of difference in residual AHI was limited, without clinical significance in 93.4%

of the patients. However, the impact may be clinically relevant in a small subgroup of individuals and probably in some specific phenotypes. We acknowledge that a limitation of our study is that we do not report data regarding the evolution of symptoms (i.e. ESS and quality-of-life) across CPAP device switches. The absence of reporting of residual central hypopnea events or the lack of RERA detection by some brands limits the opportunity of identifying emergent or persistent central sleep apnea and the need for increasing CPAP pressure in the case of persisting subtle obstructive events. As residual AHI is the primary information used to evaluate CPAP efficacy in routine clinical practice, clinicians should be aware of differences between CPAP brands.

We suggest that scientific societies<sup>4</sup> strongly recommend to CPAP manufacturers that they agree on a standardized way of reporting residual AHIs using consensual event definitions and algorithms to compute the sum of residual events.

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