JCSM
Journal of Clinical Sleep Medicine

COMMENTARY

Man Versus Machine

Gagnadoux et al. Validation of the System One RemStar Auto A-Flex for obstructive sleep apnea treatment and detection of residual apnea-hypopnea index: a European randomized trial. *J Clin Sleep Med.* 2017;13(2):283–290.

Christine H. Won, MD, MS

Section of Pulmonary, Critical Care and Sleep Medicine, Yale University School of Medicine, New Haven, CT

Obstructive sleep apnea (OSA) is a highly prevalent disorder that is associated with significant health consequences.[1] The gold standard for diagnosing or treating OSA relies on a single-night attended polysomnography during which the severity of sleep apnea or optimal continuous positive airway pressure (CPAP) setting is determined. By virtue of being a single-night study, this algorithm allows only a snapshot into the patient's disease. The apnea-hypopnea index (AHI) can vary substantially from night to night because of variations in sleep stages, body position, medications, or alcohol, and other influences on the upper airway.[2] Moreover, effective CPAP can change over time with age, weight, medications, or other health conditions.[3] For these reasons, reliable technology for detecting and treating sleep apnea as it occurs in the patient's night-to-night sleep conditions has its advantages.

Technology for automated detection of abnormal breathing patterns and autoadjusting pressures has become standard in clinical practice. This technology addresses the issue of night-to-night variability, provides longitudinal data for analysis, and accounts for progression or regression of disease over time.[4] Autoadjusting continuous positive airway pressure (APAP) has been heralded as the future of sleep apnea therapy, and as this technology continues to develop, one can appreciate its potential to improve compliance, efficacy, and cost-effective care.

Numerous ambulatory devices for diagnosing and treating sleep-disordered breathing are in clinical use.[5] These devices are often complex, a "black box", if you will, with proprietary algorithms for detecting and reacting to respiratory events. For these reasons, Gagnadoux et al.'s study on the validation of the System One RemStar Auto A-Flex for OSA treatment is a much-needed assessment of current technology.[6] The study investigates several fundamental questions: Is APAP as effective as fixed CPAP in reducing AHI? Is sleep architecture preserved despite fluctuating pressures on APAP? Finally, is the machine's calculated "AHI" accurate? The authors' results reassure us that for the System One RemStar Auto A-Flex APAP machine, when it comes to treatment, sleep quality, and calculating AHI, the machine performs as well as humans.

As Gagnadoux et al. note, algorithms for events detection and automatic pressure adjustments are device specific, and therefore their findings are not generalizable to all machines. For example, one manufacturer's APAP determines apneas and hypopneas based on a calculation of the square root of the variance of the digitized flow signal. Another manufacturer's APAP detects apneas and hypopneas based on weighted peak flow comparisons over a moving window of time. In either case, it should be noted that machine-derived "hypopneas" and therefore machine-derived "AHI" do not by definition measure the same thing as polysomnography-based hypopneas or AHI, and should be renamed to reflect this.[7,8]

The response algorithms also vary from machine to machine. One manufacturer's machine increases pressures up to 3 cm H_2O per 10 sec for apneas, and up to 0.5–6 cm H_2O per breath for flow limitation. A different manufacturer's machine increases pressures at 1 cm H_2O per 1 min for more than 2 apneas, hypopneas, or snores with a limit of 3 cm H_2O. Given the range of response algorithms, Gagnadoux et al.'s findings should implore us to explore comparisons between other APAP machines.

Another concern with APAP technology that needs further investigation is how reliably they detect and respond to treatment-associated central apneas.[9] Again, these algorithms differ significantly between machines, with some machines relying on forced oscillation technique, whereas others measure pressure pulse. The accuracy and reliability of these APAP machines to detect and appropriately treat central apnea need to be subjected to similar scrutiny.

OSA, like many other diseases, is heterogeneous. We are challenged to identify subgroups of OSA patients who benefit from APAP therapy. It is assumed, for example, that rapid eye movement-related and supine-related OSA would benefit from APAP because pressure requirements fluctuate over the course of the night. We may consider, however, there is often an abrupt transition into a period of cyclical upper airway obstruction, necessitating a quick uptitration by the APAP device. Gagnadoux et al.'s study did not find excessive sleep disturbances with APAP therapy; however, it did not target these specific groups. Another group of patients who deserve consideration are those whose OSA is mostly driven by hypopneas rather than frank apneas. The agreement between machine and polysomnography AHI may vary by machine, as well as by changing oxygen desaturation definitions for polysomnography AHI.[10]

It has also been shown that the accuracy of APAP may be degraded at higher settings. At higher pressures there tends to be greater leak and more inaccuracies in AHI determination, central apnea detection, and pressure responses. In this study, the median and mean values for 90th percentile pressure remained on the lower side at 8 to 9 cm H_2O. It is unknown then whether APAP would have performed as well as at higher pressures. Finally, there remains the question of how best to apply APAP technology. In clinical practice, APAP is often prescribed at 4 to 20 cm H_2O. A wide range of pressures allows for flexibility; however, it may result in more time at subtherapeutic settings and increased residual AHI. Whether using narrower settings or converting to fixed CPAP after a period of titration is a better strategy with APAP needs to be clarified.

In conclusion, based on the study by Gagnadoux et al., a flow-based respiratory event detection and automated response technology can be considered reliable and effective for treating moderate and severe OSA. Questions remain about generalizability, applicability, and an optimal strategy for APAP use in clinical practice.[11] Perhaps most importantly, there is still the need to explore the effect of this technology on treatment adherence, symptom management, cardiovascular and metabolic outcomes, and health care costs.

CITATION

Won CH. Man versus machine. *J Clin Sleep Med*. 2017;13(2):167–168.

REFERENCES

1. Nieto FJ, Young TB, Lind BK, et al. Association of sleep-disordered breathing, sleep apnea, and hypertension in a large community-based study. Sleep Heart Health Study. *JAMA*. 2000;283(14):1829–1836.
2. White LH, Lyons OD, Yadollahi A, Ryan CM, Bradley TD. Night-to-night variability in obstructive sleep apnea severity: relationship to overnight rostral fluid shift. *J Clin Sleep Med*. 2015;11(2):149–156.
3. Schiza SE, Mermigkis C, Bouloukaki I. The effect of weight loss on obstructive sleep apnea (OSA) severity and position dependence in the bariatric population. *Sleep Breath*. 2014;18(4):679–681.
4. Ip S, D'Ambrosio C, Patel K, et al. Auto-titrating versus fixed continuous positive airway pressure for the treatment of obstructive sleep apnea: a systematic review with meta-analyses. *Syst Rev*. 2012;1:20.
5. Berry RB, Parish JM, Hartse KM. The use of auto-titrating continuous positive airway pressure for treatment of adult obstructive sleep apnea. An American Academy of Sleep Medicine review. *Sleep*. 2002;25(2):148–173.
6. Gagnadoux F, Pevernagie D, Jennum P, et al. Validation of the System One RemStar Auto A-Flex for obstructive sleep apnea treatment and detection of residual apnea-hypopnea index: a European randomized trial. *J Clin Sleep Med*. 2017;13(2):283–290.
7. Reiter J, Zleik B, Bazalakova M, Mehta P, Thomas RJ. Residual events during use of cpap: prevalence, predictors, and detection accuracy. *J Clin Sleep Med*. 2016;12(8):1153–1158.
8. Cilli A, Uzun R, Bilge U. The accuracy of autotitrating CPAP-determined residual apnea-hypopnea index. *Sleep Breath*. 2013;17(1):189–193.
9. Huang HC, Hillman DR, McArdle N. Control of OSA during automatic positive airway pressure titration in a clinical case series: predictors and accuracy of device download data. *Sleep*. 2012;35(9):1277–1283.
10. Prasad B, Carley DW, Herdegen JJ. Continuous positive airway pressure device-based automated detection of obstructive sleep apnea compared to standard laboratory polysomnography. *Sleep Breath*. 2010;14(2):101–107.
11. Morgenthaler TI, Aurora RN, Brown T, et al. Practice parameters for the use of autotitrating continuous positive airway pressure devices for titrating pressures and treating adult patients with obstructive sleep apnea syndrome: an update for 2007. An American Academy of Sleep Medicine report. *Sleep*. 2008;31(1):141–147.

SUBMISSION & CORRESPONDENCE INFORMATION

Submitted for publication December, 2016
Submitted in final revised form December, 2016
Accepted for publication December, 2016
Address correspondence to: Christine Won, MD, MS, Section of Pulmonary, Critical Care and Sleep Medicine, Yale University School of Medicine, PO Box 208057, 333 Cedar Street, New Haven, CT 06520-8057; Tel: (203) 785-4163; Fax: (203) 785-3634; Email: christine.won@yale.edu

DISCLOSURE STATEMENT

Dr. Won has indicated no financial conflicts of interest.