

# Articles of the Month – August 2021

## Snoring

Sleep Breath. 2021 Apr 2. doi: 10.1007/s11325-021-02348-6. Online ahead of print.

Link: [Perceptual snoring as a basis for a psychoacoustical modeling and clinical patient profiling | SpringerLink](#)

### Perceptual snoring as a basis for a psychoacoustical modeling and clinical patient profiling

[Micheline M D De Meyer](#)<sup>1,2,3</sup>, [Seyed Abdolali Zareian Jahromi](#)<sup>4</sup>, [Dillon A Hambrook](#)<sup>4</sup>, [John E Remmers](#)<sup>4</sup>, [Luc A M Marks](#)<sup>5,6</sup>, [Wolfgang Jacquet](#)<sup>7,8</sup>

**Purpose:** The perceptual burden and social nuisance for mainly the co-sleeper can affect the relationship between snorer and bedpartner. Mandibular advancement devices (MAD) are commonly recommended to treat sleep-related breathing such as snoring or sleep apnea. There is no consensus about the definition of snoring particularly with MAD, which is essential for assessing the effectiveness of treatment. We aimed to establish a notion of perceptual snoring with MAD in place.

**Methods:** Sound samples, each 30 min long, were recorded during in-home, overnight, automatic mandibular repositioning titration studies in a population of 29 patients with obstructive sleep apnea syndrome (OSAS) from a clinical trial carried out to validate the MATRx plus. Three unspecialized and calibrated raters identified sound events and classified them as noise, snore, or breathing as well as providing scores for classification certainty and annoyance. Data were analyzed with respect to expiration-inspiration, duration, annoyance, and classification certainty.

**Results:** A Fleiss' kappa ( $>0.80$ ) and correlation duration of events ( $>0.90$ ) between raters were observed. Prevalence of all breath sounds: snore 55.6% (N = 6398), breathing sounds 31.7% (N = 3652), and noise 9.3% (N = 1072). Inspiration occurs in 88.3% of events, 96.8% contained at least on expiration phase. Snore and breath events had similar duration, respectively 2.58s (sd 1.43) and 2.41s (sd 1.22). Annoyance is lowest for breathing events (8.00 sd 0.98) and highest for snore events (4.90 sd 1.92) on a VAS from zero to ten.

**Conclusion:** Perceptual sound events can be a basis for analysis in a psychosocial context. Perceived snoring occurs during both expiration as well as inspiration. Substantial amount of snoring remains despite repositioning of the mandible aimed at the reduction of AHI-ODI.

**EADSM comment:** Snoring, the reason why patients seek medical treatment, has been scarcely evaluated in the literature. This is probably explained by the difficulties to measure and define snoring. These problems were high-lightened in a previous article by one of these authors, Miche De Meyer et al.: [Systematic review of the different aspects of primary snoring | Elsevier Enhanced Reader](#)

In the present study, the term “perceptual snoring” is launched. Unbiased listeners identified snoring, breathing sounds and noise during sleep. The study shows that snoring may occur both during inspiration and expiration and indicates that snoring may persist in many severe patients treated with MADs.

Sleep Breath. 2021 May 6.doi: 10.1007/s11325-021-02392-2. Online ahead of print.

Link: [The acoustical and perceptual features of snore-related sounds in patients with obstructive sleep apnea sleeping with the dynamic mandibular advancement system MATRx plus® | SpringerLink](#)

## **The acoustical and perceptual features of snore-related sounds in patients with obstructive sleep apnea sleeping with the dynamic mandibular advancement system MATRx plus®**

[Wolfgang Jacquet](#)<sup>#1,2</sup>, [Micheline M D De Meyer](#)<sup>#3,4,5</sup>, [John E Remmers](#)<sup>6</sup>, [Seyed Abdolali Zareian Jahromi](#)<sup>6</sup>, [Dillon A Hambrook](#)<sup>6</sup>, [Luc A M Marks](#)<sup>7</sup>

**Purpose:** The effect of snoring on the bed partner can be studied through the evaluation of in situ sound records by the bed partner or unspecialized raters as a proxy of real-life snoring perception. The aim was to characterize perceptual snore events through acoustical features in patients with obstructive sleep apnea (OSA) with an advanced mandibular position.

**Methods:** Thirty-minute sound samples of 29 patients with OSA were retrieved from overnight, in-home recordings of a study to validate the MATRx plus® dynamic mandibular advancement system. Three unspecialized raters identified sound events and classified them as noise, snore, or breathing. The raters provided ratings for classification certainty and annoyance. Data were analyzed with respect to respiratory phases, and annoyance.

**Results:** When subdividing perceptual events based on respiratory phase, the logarithm-transformed Mean Power, Spectral Centroid, and Snore Factor differed significantly between event types, although not substantially for the spectral centroid. The variability within event type was high and distributions suggested the presence of subpopulations. The general linear model (GLM) showed a significant patient effect. Inspiration segments occurred in 65% of snore events, expiration segments in 54%. The annoyance correlated with the logarithm of mean power ( $r = 0.48$ ) and the Snore Factor (0.46).

**Conclusion:** Perceptual sound events identified by non-experts contain a non-negligible mixture of expiration and inspiration phases making the characterization through acoustical features complex. The present study reveals that subpopulations may exist, and patient-specific features need to be introduced.

**EADSM comment:** This study further explores the characteristics of perceptual snoring.

Micheline De Meyer is just now finalizing her thesis in this interesting much needed topic.

## Impact of mandibular advancement device therapy on cerebrovascular reactivity in patients with carotid atherosclerosis combined with OSAHS

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*Sleep and Breathing* volume 25, pages1543–1552 (2021)

Link: <https://link.springer.com/content/pdf/10.1007/s11325-020-02230-x.pdf>

### Purpose

Obstructive sleep apnea-hypopnea syndrome (OSAHS) may affect cerebrovascular reactivity (CVR), representing cerebrovascular endothelial function, through complex cerebral functional changes. This study aimed to evaluate the change of CVR after 1-month and 6-month mandibular advancement device (MAD) treatment of patients with carotid atherosclerosis (CAS) combined with OSAHS.

### Methods

Patients with carotid atherosclerosis combined with OSAHS who voluntarily accepted Silensor-IL MAD therapy were prospectively enrolled. All patients underwent polysomnographic (PSG) examinations and CVR evaluation by breath-holding test using transcranial Doppler ultrasound at baseline (T0), 1 month (T1), and 6 months (T2) of MAD treatment.

### Results

Of 46 patients (mean age  $54.4 \pm 12.4$  years, mean body mass index [BMI]  $27.5 \pm 4.5$  kg/m<sup>2</sup>), 41 patients (responsive group) responded to the 1-month and 6-month treatment of MAD, an effective treatment rate of 89%. The remaining 5 patients (non-responsive group) were younger ( $47.4 \pm 13.5$  years) and had a higher BMI ( $35.8 \pm 1.8$  kg/m<sup>2</sup>). The responsive group had an improvement of apnea-hypopnea index (AHI) (events/h) from  $33.0 \pm 25.0$  (T0) to  $12.4 \pm 10.4$  (T1) and  $8.7 \pm 8.8$  (T2),  $P < 0.001$ ; minimum arterial oxygen saturation (minSpO<sub>2</sub>) (%) increased from  $79.8 \pm 9.1$  (T0) to  $81.8 \pm 9.4$  (T1) and  $85.2 \pm 5.4$  (T2),  $P < 0.01$ ; longest apnea (LA) (s) decreased from  $46.5 \pm 23.1$  (T0) to  $33.3 \pm 22.7$  (T1) and  $29.4 \pm 18.5$  (T2),  $P < 0.001$ ; T90 (%) decreased from  $10.3 \pm 14.9$  (T0) to  $6.1 \pm 11.8$  (T1) and  $3.3 \pm 7.5$  (T2),  $P < 0.05$ . Sleep architecture of these patients also improved significantly. The responsive group had a significant increase in left, right, and mean breath-holding index (BHI): left BHI(/s) from  $0.52 \pm 0.42$  (T0) to  $0.94 \pm 0.56$  (T1) and  $1.04 \pm 0.64$  (T2),  $P < 0.01$ ; right BHI(/s) from  $0.60 \pm 0.38$  (T0) to  $1.01 \pm 0.58$  (T1) and  $1.11 \pm 0.60$  (T2),  $P < 0.01$ ; mean BHI(/s) from  $0.56 \pm 0.38$  (T0) to  $0.97 \pm 0.55$  (T1) and  $1.07 \pm 0.59$  (T2),  $P < 0.01$ ), suggesting improved CVR.

### Conclusion

Effective MAD therapy is beneficial for restoring cerebrovascular endothelial function in patients with CAS and OSAHS in a short period (1 month and 6 months).

**EADSM comment:** Interesting results of beneficial effects on endothelial function from MADs in a small descriptive study of selected patients.

Mil Med. 2021 Aug 19;usab316.  
doi: 10.1093/milmed/usab316. Online ahead of print.

Link: <https://academic.oup.com/milmed/advance-article/doi/10.1093/milmed/usab316/6355142>

## Oral Appliances for OSA Treatment: Meeting the Quadruple Aim

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**Introduction:** In order to better treat obstructive sleep apnea (OSA) in a more efficient and cost-effective way, a joint program between dental clinics and the sleep medicine clinic was piloted at Fort Hood, Texas. Obstructive sleep apnea negatively affects soldier readiness and deployability, leading to the need to establish a successful and proven workflow to treat these patients with oral appliance therapy (OAT).

**Materials and methods:** We performed a retrospective review of a de-identified data set which included 288 patients from July 2016 to July 2020. Projected cost data were obtained from routinely collected sleep clinic positive airway pressure (PAP) data. Data were analyzed to determine treatment success and potential cost savings using OAT versus continuous positive airway pressure (CPAP). Patient workflow including successes and challenges with the program is summarized.

**Results:** About 85.5% of patients met criteria for successful control of their OSA using OAT as treatment. Five patients did not tolerate OAT and switched back to CPAP. A higher (less severe) O<sub>2</sub> nadir on diagnostic polysomnography is moderately correlated with OAT success. Diagnostic Apnea-Hypopnea Index was inversely and weakly correlated with success. Two of the major challenges noted in the program were (1) loss of follow-up and (2) the length of time from oral appliance referral to fitting the oral appliance. If this program was successfully implemented at other Defense Health Agency (DHA) medical treatment facility (MTF) markets nationwide, a potential cost savings of over \$500,000/year/MTF could be achieved.

**Conclusions:** Oral appliance therapy has the potential to increase both readiness and deployability for active duty soldiers. Using baseline O<sub>2</sub> nadir can help predict success with OAT patients, determining which patients will benefit from this joint program between the dental and medical sleep clinics. Future studies can aim to establish an evidence-based pathway for clinic testing and follow-up. If this patient workflow is implemented properly, there can be significant cost savings army-wide. This all helps The United States Medical Command (MEDCOM) align with the DHA's Quadruple Aim of increased readiness, better health, better care, and lower cost.

**EADSM comment:** Active soldiers might be a particular target group of patients for MAD therapy.

## EDS

Sleep Breathing Physiology and Disorders • Original Article

Link: <https://link.springer.com/article/10.1007/s11325-020-02223-w>

### **The rate of decrease in oxygen desaturation during severe obstructive sleep apnea syndrome is correlated with subjective excessive daytime sleepiness**

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*Sleep and Breathing* volume 25, pages1285–1291 (2021)

#### **Purpose**

To explore factors that influence subjective excessive daytime sleepiness (EDS) in patients with severe obstructive sleep apnea syndrome (OSAS).

#### **Methods**

Patients with snoring seen at the Sleep Medicine Center of The Affiliated Huaian No.1 People's Hospital of Nanjing Medical University between October 2018 and November 2019 were included in this study. All patients underwent polysomnography (PSG). Noninvasive frequency-domain analysis was used to assess the autonomic nervous system regulation of the heart, with the low frequency (LF)/high frequency (HF) power ratio used to represent the sympathetic-parasympathetic balance. Daytime sleepiness was evaluated by the Epworth sleepiness scale (ESS). Overnight apnea episodes were included for analyses. The rate of pulse oxyhemoglobin saturation (SpO<sub>2</sub>) decrease was measured as the change in the percentage of SpO<sub>2</sub> per second after obstructive apnea and was expressed as the oxygen desaturation rate (ODR).

#### **Results**

A total of 101 patients with severe OSAS were enrolled in this study and were further divided into two groups: the EDS group (ESS > 10,  $n = 52$ ) and the non-EDS group (ESS ≤ 10,  $n = 49$ ). The apnea-hypopnea index (AHI), respiratory effort-related arousals (RERAs), and LF/HF power ratio were significantly higher in the EDS group than in the non-EDS group (AHI:  $69.9 \pm 14.5$  vs.  $57.9 \pm 16.1$  events/h; RERAs:  $42.2 \pm 16.7$  vs.  $30.4 \pm 13.7$  events/h; LF/HF power ratio:  $2.9 \pm 0.8\%$  vs.  $2.4 \pm 0.9\%$ , all  $p < 0.001$ ). Multiple linear regression analyses revealed that after adjusting for covariates expected to affect this relationship, ESS scores were correlated with ODR ( $\beta = 0.520$ ,  $p < 0.001$ ) and LF/HF power ratio ( $\beta = 0.155$ ,  $p = 0.028$ ), rather than with the traditional sleep-disordered breathing parameters.

#### **Conclusions**

Compared with the traditional PSG parameters, both ODR and an increased LF/HF power ratio were more closely related to daytime sleepiness, especially ODR.

**EADSM comment:** Interesting result supporting a previous article discussing “The rise and fall of AHI”, here in the context of sleepiness that were better correlated with oxygenation than with respiratory events.

This result may be compared with the result in the above cited article about MAD treatment in soldiers, where treatment success with a MAD was best predicted by baseline O<sub>2</sub> Nadir and not by AHI.

## Blood pressure

ERJ Open Res. 2021 Aug 16;7(3):00338-2021.

doi: 10.1183/23120541.00338-2021. eCollection 2021 Jul.

Link: <https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8365144/pdf/00338-2021.pdf>

### Non-dipping nocturnal blood pressure correlates with obstructive sleep apnoea severity in normotensive subjects and may reverse with therapy

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**Background:** Obstructive sleep apnoea (OSA) is strongly associated with systemic hypertension, but there are limited data on the relationship with blood pressure (BP) in normotensive subjects. Here, we examined the relationship of OSA with nocturnal BP in a documented diurnal normotensive cohort, explored potential intermediate pathways and assessed the effects on BP of continuous positive airways pressure (CPAP) therapy.

**Methods:** 65 males referred for assessment of possible OSA and normotensive on 24-hour BP monitoring underwent overnight inpatient polysomnography (age 41±7 years, body mass index (BMI) 34±6 kg·m<sup>-2</sup>, apnoea-hypopnoea index (AHI) 14 (interquartile range 5-26)). Urine and serum were assessed for markers of sympathetic activation, renin-angiotensin-aldosterone system activity, oxidative stress, endothelial function and systemic inflammation. In a subset of patients, 24-hour BP monitoring was repeated after CPAP therapy.

**Results:** Within this normotensive cohort, night-time systolic and diastolic BP and nocturnal BP dip were highest in the fourth OSA severity quartile (p<0.05). Nocturnal BP dip correlated with AHI (r=-0.327, p<0.05) and oxygen desaturation index (ODI) (r=-0.371, p<0.05), but only ODI was an independent predictor of BP dip (B=-0.351, p<0.01) and non-dipping status (B=0.046, p<0.05). Overnight urinary norepinephrine correlated with nocturnal systolic BP (r=0.387, p<0.01) with a trend towards correlation with systolic dipping (p=0.087). In 20 CPAP-treated patients, night-time systolic BP decreased (p<0.05) and mean nocturnal BP dip increased (p≤0.05).

**Conclusion:** In this normotensive cohort, OSA severity was associated with higher nocturnal BP, which improved following CPAP therapy, and intermittent hypoxia was the most important OSA-related variable in this relationship.

**EADSM comment:** Beneficial effects on nocturnal BP and dipping from CPAP, also in normotensive non-dipping patients. Would be of interest to study effects of MADs on these variables in mild normotensive patients; a group of patients who often are regarded to have indications for MADs.