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Performance of the NOSE Questionnaire in Mask Selection for Home CPAP Titration

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Abstract

Introduction Many patients abandon CPAP treatment because they find the mask uncomfortable. Therefore, specialists may benefit from the predictive value of airway assessment tools.

Objective To identify nasal ventilation failure through the Nasal Obstruction Symptom Evaluation (NOSE) scale in patients with obstructive sleep apnea (OSA) who undergo home-based auto-adjusting CPAP titration and to determine whether there is a correlation between NOSE score and the type of mask selected.

Materials and Methods In this prospective correlational study, the NOSE scale was used in terms of mask selection and titration indicators. Patients were classified based on their NOSE score: $>$ or $<$ 50.

Results We included 303 patients; 226 men (74.5%), BMI: $33.2 \pm 6.1\,kg/m^2$, neck circumference (cm): 42.8 ± 3.6 and Epworth (ESS) score: 9.2 ± 5.6, mild OSA: 12 (3.9%), moderate OSA: 127 (41.9%), and severe OSA: 164 (54.1%). The mean NOSE score was 24.3 ± 22.8 and 42 patients (13.8%) had NOSE scores $>$ 50. Indicators for both groups were: compliance (5.9 ± 1.3 vs. 5.8 ± 1.4 hours) p: 0.41, therapeutic pressure (9.1 ± 2.0 vs. 8.8 ± 1.6 cm of H_2O) p: 0.23, residual AHI (2.3 ± 1.8 vs. 2.8 ± 2.6 events/hour) p: 0.25, and leaks (20.5 ± 10.6 vs. 21.3 ± 10.7 liters/minute) p: 0.64. According to adjusted multiple regression, a NOSE of $>$ 50 was not a predictor of mask selection.

Conclusions A $>$ 50 NOSE score was not a predictor of mask selection, and it was not correlated to titration performance.

Keywords
- Sleep Apnea syndrome
- masks
- continuous positive airway pressure
- nasal obstruction

Introduction

Continuous positive airway pressure (CPAP) is considered the treatment of choice for moderate-severe obstructive sleep apnea (OSA). Even though CPAP is effective, long-term compliance ranges between 40% and 80% as 10-20% of patients abandon treatment after the first night.[1,2] Discomfort -one of the determining factors of intolerance- is frequently the reason for abandonment.[3–6] Though the first choice is an anatomical mask with a minimal contact design (i.e., a nasal mask or nasal pillow), patients report difficulty breathing normally through the nose during sleep. Others suffer from nasal obstruction during the day—defined as resistance or discomfort due to insufficient airflow through

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the nose secondary to anatomical anomalies (deviated septum, congenital bone deformity, trauma), inflammatory processes (chronic rhinitis or hypertrophic mucosa, nasal polyps), and tumors.[5,7,8]

Before examination of the airways, it is necessary to use practical predictive tools to identify the adequate type of interface or determine the need for specific treatment (medical, endoscopic, or surgical).[9] Specialists can assess nasal ventilatory failure through physical examination, validated questionnaires, objective studies like rhinodebitomanometry and acoustic rhinometry. These tests have proven useful to measure the extent of nasal obstruction; however, they are not routinely performed at sleep care units.[10,11]

With the objective to identify nasal ventilatory failure symptoms, we test the NOSE scale (Nasal Obstruction Symptom Evaluation), in OSA patients undergoing home-based auto-adjusting CPAP titration and its correlation with the type of mask selected.

Materials and Methods

Study Design

This single-center, prospective and correlational study analyzed systematically collected data from auto-adjusting CPAP titration tests performed in OSA patients who had a consultation with a sleep specialist in a community hospital between May 2019 and January 2021.

The protocol was approved by the Institutional Review Board of Buenos Aires Hospital Británico in according with Helsinki declaration (protocol n°. #932, approved on April 24, 2019).

Population

We included patients diagnosed with obstructive sleep apnea referred for home-based CPAP titration. We excluded patients with a history of nasal surgery, obesity-hypoventilation syndrome, periodic breathing, or baseline central apnea and patients who needed other treatment modalities (i.e., two levels of continuous pressure, servo-controlled ventilation, concomitant oxygen).

The baseline apnea-hypopnea index (AHI) was obtained from polysomnography (PSG) and respiratory polygraphy (RP) recordings. Body mass index (BMI) and neck circumference were obtained before CPAP devices were delivered.

Auto-adjusting CPAP therapy - Compliance and efficacy

Devices were calibrated between 4 and 15 cm of H_2O without humidifier. Data were obtained by downloading the memory card (SD cards) of CPAP devices using Encore pro® II Philips-Respironics® and ResScan®- ResMed® software or ResMed® Air View® online platform for remote monitoring (a routine procedure to monitor treatment).

Mask Selection

Mask type, size, and model were selected using our Sleep and Ventilation Unit's standard procedure, after a demonstration of interface use[12,13]; a minimum of 3 different interfaces were tested. Then, the "mask fit" function was used to evaluate unintentional leaks. Final selection was based on patient's preference/tolerance and leak testing results. Full face masks were only used by patients who could not tolerate nasal masks. All patients received basic training on CPAP use and mask fitting.

The NOSE Scale

Patients completed a Spanish[14] validated version of NOSE scale (see attached NOSE questionnaire), which includes 5 items on nasal symptoms perceived by the patient during the last month. Each question was answered using a 5-point Likert scale. The responses to all 5 questions were added and then multiplied by 5 to obtain a total score ranging between 0-100, where the highest value corresponds to the most severe symptoms of nasal obstruction. Patients were divided into 2 groups based on their NOSE score: $>$ or $<$ 50 points. The clinical specialists in charge of mask selection were blinded to the patients' NOSE score.

Correlation Indicators

Data from auto-adjusting CPAP readings were compared to the type of interface selected (compliance in hours/nights, working pressure, mean airway pressure, mean leak and residual AHI) and NOSE scores. Effective pressure data were obtained after a visual analysis of each night's pressure/time curve and leak periods >30 liters/minute[7] were excluded (equipment compensation limit). The effective therapeutic pressure was selected based on nights with more intensive use, fewer leaks, and residual AHI $<$ 5 events/hour.[7]

Statistical Analysis

Results are expressed as percentages for categorical variables and as mean or standard deviation ($\pm$) for numerical variables. Differences were compared using Fisher's exact test, Mann Whitney, or $\chi 2$. Finally, a logistic multiple regression analysis was performed considering NOSE score $>$ 50 = 1 as an independent variable (this threshold was selected based on pilot study data),[8] baseline AHI (events/hour), obesity = 1 (BMI $>$ 30 kg/m^2), age (years) for the 3 categories of masks used (nasal, full face, and nasal pillow).

Statistical analysis was conducted using Graph Pad Prism-5™ software.

Results

We included 303 patients who visited the Sleep Unit at our hospital over the course of 20 months, 226 men (74.5%), BMI: 33.2 ± 6.1 kg/m^2, neck circumference (cm): 42.8 ± 3.6, Epworth's (ESS) score: 9.2 ± 5.6. 9.2 ± 5.6).

OSA diagnosis was based on respiratory polygraphy in 230 cases (75.9%). Results were: 12 (3.9%) mild, 127 (41.9%) moderate and 164 (54.1%) severe OSA. The mean NOSE score was 24.3 ± 22.8. Forty-two patients (13.8%) had $>$ 50 NOSE scores. ►**Table 1** shows population characteristics and the results of CPAP titration.

There were differences between those with NOSE scores $>$ or $<$ 50 in terms of age (54.3 ± 10.0 vs. 59.4 ± 11.9 years,

Table 1 Characteristics of study population and CPAP titration test.

Population characteristics	
Patients	n: 303
Men (n; %) *	226 (74.5)
Age (years)	58.7 ± 11.7
BMI (kg/m2)	33.2 ± 6.1
Epworth Sleepiness Scale (ESS)	9.2 ± 5.6
Respiratory Polygraphy-based diagnosis (n; %)	230 (75.9)
Polysomnography-based diagnosis (n; %)	73 (24)
Mild OSA (n; %)	12 (3.9)
Moderate OSA (n; %)	127 (41.9)
Severe OSA (n; %)	164 (54.1)
Neck circumference (cm)	42.8 ± 3.6
NOSE score	24.3 ± 22.8
NOSE > 50	42 (13.8)
NOSE < 50	261 (86.1)
CPAP compliance (minutes)	360 ± 95.5
Residual apnea index (ev/h)	3.5 ± 3.0
Leaks (liters(minute)	21.1 ± 12
Effective titration pressure (cm of H2O)	8.6 ± 1.8
Nasal mask (n; %)	193 (63.7)
Nasal pillow (n; %)	91 (30)
Full face mask (n; %)	19 (6.3)

BMI: body mass index. OSA: Obstructive sleep apnea. CPAP: Continuous Positive Airway Pressure.
*Percentage and number of patients. Values expressed as mean and standard deviation (±).

p: 0.008) and ESS (11.4 ± 6.7 vs. 8.8 ± 5.4 points, p: 0.014). ►**Table 2**.

Mask type selection was not correlated to > or < 50 NOSE (p > 0.5) as shown in ►**Figure 1**.

No differences were observed between groups in terms of compliance and efficacy indicators during titration with home-based auto-adjusting CPAP: compliance (5.9 ± 1.3 vs. 5.8 ± 1.4 hours) p: 0.41 (►**Figure 2A**), therapeutic pressure (9.1 ± 2.0 vs. 8.8 ± 1.6 cm of H_2O) p: 0.23 (►**Figure 2B**), residual AHI (2.3 ± 1.8 vs. 2.8 ± 2.6 events/hour) p: 0.25 (**figure 2C**), no leaks (20.5 ± 10.6 vs. 21.3 ± 10.7 liters/minute) p: 0.64. ►**Figure 2D** and ►**Table 3**.

In an adjusted multiple regression model, a > 50 NOSE score was not a predictor of mask selection. ►**Table 4**.

Discussion

NOSE scores suggestive of symptomatic nasal obstruction (> 50) were not associated with the type of mask selected for home-based CPAP titration. In our experience, the selection of full-face masks and a high NOSE score were infrequent.

Sleep care centers may incorporate systematized questionnaires like NOSE to identify nasal ventilatory failure, select the type of mask and estimate the extent to which symptoms may affect tolerance to CPAP.[8,10,11] In a similarly designed study conducted on 198 patients, Lebret et al. used NOSE at the beginning of CPAP treatment. After 4 months, they reported that a > 50 NOSE score was independently associated to full face masks[8] (sensitivity; 34.8%; specificity; 87.5%). In our study, however, the use of full-face masks was low (6% vs. 11%.) with a higher proportion (12.8%) in the > 50 NOSE group, which corresponded to titration tests of a few nights. These differences may influence the performance of the questionnaire. Other variables like the prevalence of obesity, OSA severity, and CPAP implementation may impact symptom perception and influence mask selection.

Notably, in our study, patients with a high NOSE completed a successful, multiple-night CPAP test, with no differences in leak rates or residual AHI. Moreover, we found no differences in therapeutic pressures, which means that nasal ventilatory failure is neither directly correlated to airway resistance nor determines patient's comfort during CPAP.[9]

A common mistake made during demonstrations of mask use is to choose full face masks for patients who report mouth breathing. Evidence suggests that full face masks are associated with higher-pressure demands, leaks, intolerance, less comfort, and poorer compliance.[9] The fact that our

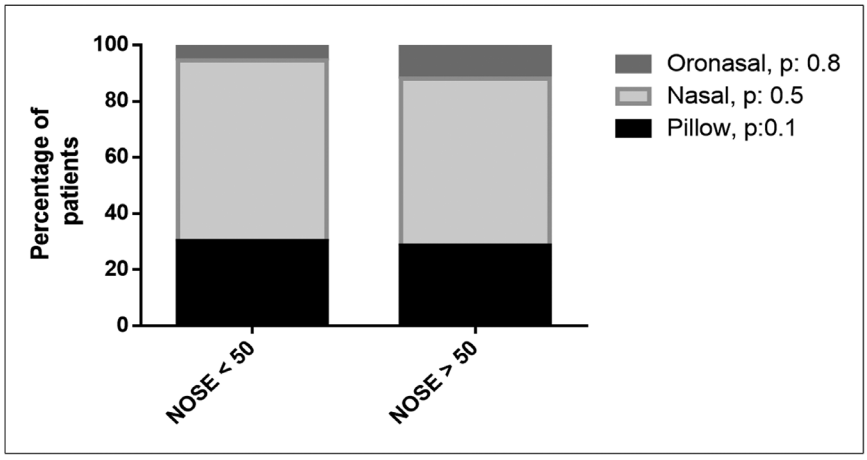

Fig. 1 Indicators of compliance and efficacy of home-based auto-adjusting CPAP titration for both groups.

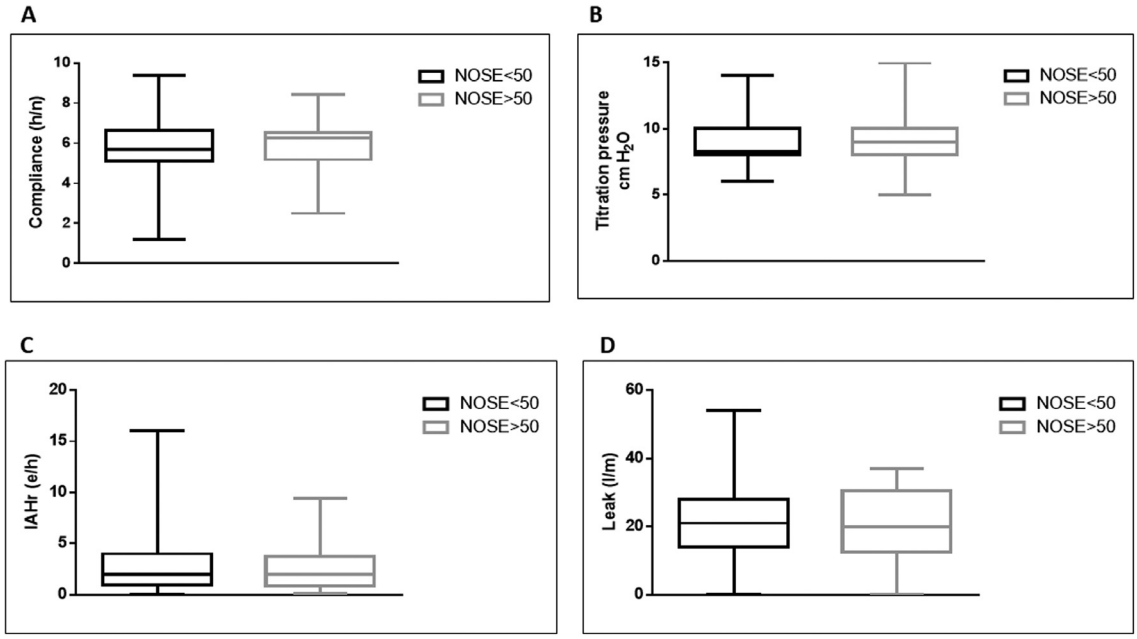

Fig. 2 Correlation between mask type and > or < 50 NOSE score.

protocol prioritizes nasal masks[12,13] may have affected the results of our study. To the best of our knowledge, there is no NOSE score capable of predicting interface selection during CPAP titration. We chose > or < 50 because this value is interpreted as significant nasal obstruction, as suggested by other authors.[8] In addition to nasal symptoms, a history of otorhinolaryngological surgery and smoking may be factors to consider in the decision-making process.

An important limitation to this study is that comorbidities, anatomical abnormalities and associated treatments (including previews surgery or procedures in upper airway) were not completely documented; another is that the small number of

Table 2 Difference between patients with > or < 50 NOSE score.

Clinical variables	< 50 NOSE (n: 261)	> 50 NOSE (n: 42)	p
Men (n; %)	192 (73.6)	32 (76.2)	0.899
Age (years)	59.4 ± 11.9	54.3 ± 10.0	0.008
BMI (kg/m2)	32.3 ± 8.1	32.0 ± 6.6	0.802
BMI >30 kg/m2 (n; %)	180 (68.9%)	29 (69%)	0.991
Epworth Scale	8.8 ± 5.4	11.4 ± 6.7	0.014
Neck (Ncirc)	42.7 ± 3.6	43.6 ± 3.9	0.080
Baseline AHI	35.0 ± 17.7	38.1 ± 19.4	0.076

Table 3 Variables of CPAP titration in patients with < or < 50 NOSE scores.

Titration Variables	< 50 NOSE (n: 261)	> 50 NOSE (n: 42)	p
Titration period (nights)	3.8 ± 1.4	4.1 ± 1.7	0.001
Compliance (min)	359.7 ± 98.2	365.5 ± 81.3	0.696
Compliance (hours)	5.8 ± 1.4	5.9 ± 1.3	0.415
Mean pressure (H2O cm)	9.8 ± 3.2	10.0 ± 3.2	0.429
Therapeutic pressure (cm of H2O)	8.8 ± 1.6	9.1 ± 2.0	0.236
Residual AHI (ev/h)	2.8 ± 2.6	2.3 ± 1.8	0.258
Leaks (liters/min)	21.3 ± 10.7	20.5 ± 10.6	0.642
Full face mask	5.3%	11.9%	0.126
Nasal	64.3%	59.5%	0.561
Pillow	30.2%	28.6%	1.010

Table 4 Logistic regression adjusted for mask predictors based on > or < 50 NOSE score.

Variables	Odds Ratio	CI 95%*		p
Full-face mask	2.57	0.84	7.85	0.090
Nasal	0.68	0.34	1.37	0.285
Pillow	1.08	0.51	2.27	0.838
Baseline AHI	1.01	0.99	1.02	0.127
Obesity (BMI > 30 kg/m2)	0.98	0.49	1.98	0.121

Exhibit. NOSE scale (in Spanish).
In the last month, how much of a problem were the following conditions?
Choose the correct answer:

	Not a problem	Very mild problem	Moderate problem	Fairly bad problem	Severe problem
Nasal congestion stuffiness	0	1	2	3	4
Nasal blockage or obstruction	0	1	2	3	4
Trouble breathing through the nose	0	1	2	3	4
Trouble sleeping	0	1	2	3	4
Unable to get enough air through the nose during exercise or exertion	0	1	2	3	4

observations limited the predictive analysis to a few variables. On the other hand, our study has 2 strengths: first, a significant number of patients who started on CPAP had symptoms suggestive of nasal respiratory failure and tolerated masks with adequate compliance and efficacy. Secondly, NOSE is not a predictor of interface selection during titration.

Larger studies with more patients and multiple clinical prediction variables are needed to identify—through the use of questionnaires—those who need a multidimensional approach to facilitate CPAP therapy through a healthy nose.

Conclusion

A > 50 NOSE score was not a predictor of mask selection in CPAP titration, and it was not correlated to titration test performance.

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Conflict of Interest
None declared.

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