

## Efficacy and adherence of auto-CPAP therapy in patients with obstructive sleep apnea: a prospective study

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### ABSTRACT

**Introduction:** The use of auto-continuous positive airway pressure (auto-CPAP) therapy has been recommended for subjects with moderate-to-severe obstructive sleep apnea (OSA) without significant comorbidities. This study is aimed at evaluating the efficacy and adherence of auto-CPAP therapy in subjects with OSA.

**Methods:** It was a perspective and descriptive study. All study subjects who had apnea-hypopnea index (AHI) > 30/h, measured by polysomnography, were included. They were treated with auto-CPAP and followed-up for 6 months for evaluating the effect of CPAP-therapy on clinical and biological features and treatment adherence.

**Results:** One hundred and thirty-nine subjects with severe OSA were accepted for auto-CPAP therapy at inclusion. BMI was  $28.4 \pm 3.8$  kg/m<sup>2</sup>; neck and abdomen circumferences were  $38.2 \pm 6.4$  and  $85.7 \pm 11.6$ . Epworth and Pichot scores were  $18.4 \pm 6.3$  and  $28.3 \pm 4.5$ , respectively; AHI was  $39 \pm 7$ /h and arousal index was  $39 \pm 13$ /h. At 6<sup>th</sup> month, 96.4% of study subjects continued to use auto-CPAP-therapy within  $6.5 \pm 2.4$  h/night. There was a significant correlation between the modification ( $\Delta$ ) of Epworth scores and ( $\Delta$ ) AHI after 3 and 6 months of auto-CPAP-therapy ( $R=0.568$  and  $p=0.003$ ;  $R=0.745$  and  $p=0.002$ ; respectively). At 6<sup>th</sup> month follow up, the main side effects of auto-CPAP were difficult sleeping, dry mouth or nose, skin marks or rashes, discomfort when breathing, and nasal congestion (36.1%, 32.0%, 20.8%, 16.0%, and 11.9%, respectively).

**Conclusion:** Auto-CPAP is effective in treatment of Vietnamese patients with severe OSA in short term follow up.

**Key words:** Obstructive sleep apnea; apnea-hypopnea index; Epworth; Pichot; Auto-CPAP.

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**Ethics approval and consent to participate:** The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Lam Dong Medical College Institutional Review Board (no. CDYT-LD.04.16). All study subjects had signed Informed Consent approved by Institutional Review Board (IRB) of Lam Dong Medical College.

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## Introduction

Obstructive sleep apnea (OSA) is one of the sleep disorders affecting a large number of population worldwide [1-3]. OSA is manifested mainly by snoring associated with episodes of interrupted breathing due to the partial or total collapse of upper airways during sleep [4]. The recovery of normal breathing from apnea-hypopnea episodes during sleep occurs after respiratory efforts within arousal, resulting in sleep fragmentation, sleep quality impairment, and daytime sleepiness. In addition, OSA with intermittent hypoxia that happens during sleep, increases oxidative stress production, cardiovascular events, and metabolic disorder [5,6]. For subjects with OSA, the accurate treatment according to pathophysiology is to maintain the opening of upper airways during sleep.

Since 1981, when the first publication of OSA treatment with continuous positive airway pressure (CPAP) was published, this method is considered as standard therapy for symptomatic or moderate-to-severe OSA, diagnosed by polysomnography (PSG) with apnea-hypopnea index (AHI) >15/h [7-9]. Previous studies showed that in subjects with OSA treated by CPAP there was a significant improvement of daytime sleepiness and fatigue, nocturia, snoring, and quality of life [10,11]. CPAP therapy also improves the cardiovascular events and the risk of traffic accidents [12,13].

The current guidelines recommend overnight PSG for the diagnosis of OSA and laboratory-titrated CPAP for treatment of subjects with OSA [13-16]. However, in-laboratory titration CPAP therapy is labor intensive, expensive, and burdensome. Previous studies also demonstrated the beneficial role of auto-CPAP therapy in treatment of patients with OSA [17-19]. Therefore, in emerging countries where the number of sleep laboratories is very limited, the use of auto-adjusting CPAP at home might be an alternative method for treatment of subjects with OSA. The present study was conducted to evaluate the efficacy and side effects of auto-CPAP in patients with severe OSA and their adherence.

## Methods

### Patients

All adult subjects with severe OSA diagnosed by PSG (AHI >30/h) and treated with CPAP were included in the present study after meeting the inclusion criteria. All subjects gave their informed consent for inclusion before they participated in the study. The study was conducted in accordance with the Declaration of Helsinki, and the protocol was approved by the Ethics Committee of Lam Dong Medical College Institutional Review Board.

### Inclusion criteria

Subjects more than 18 years old who were diagnosed with severe OSA (AHI >30/h) without significant comorbidities (congestive heart failure, chronic respiratory failure such as severe chronic obstructive pulmonary disease, neuromuscular disease, hypoventilation syndrome, or central sleep apnea) and accepted to be treated with auto-adjusting CPAP (thereafter auto-CPAP) were included in the present study.

### Exclusion criteria

Subjects with moderate-to-severe OSA who had one of the following comorbidities or conditions were excluded from the present study: congestive heart failure, significant chronic respiratory diseases such as uncontrolled asthma or chronic obstructive pulmonary disease, neuromuscular disease, central sleep apnea syndrome, or chronic opiate use.

## Study design

It was a perspective and descriptive study. The anthropometric and clinical, functional, and biological parameters were recorded for analysis. All study subjects underwent clinical examination, lung function testing for eliminating other obstructive airway diseases, biochemical blood tests, and PSG. The questionnaire about symptoms of OSA, sleep habit and quality, snoring at night, daytime sleepiness and tiredness were completed by study subjects. The severity of daytime sleepiness and tiredness were assessed by Epworth sleepiness scales (0-24 points) and Pichot tiredness scales (0-32) for each patient [20,21]. The severity of OSA was assessed by AHI (mild: 5-14/h, moderate: 15-30/h, and severe >30/h). All subjects with moderate-to-severe OSA were treated by auto-CPAP and setting min – max pressures were 4-20 cmH<sub>2</sub>O, respectively. The use of patients' interface (nasal or facial mask) depended on own choice after auto-CPAP-therapy trying.

## Laboratory techniques

*Lung function testing (LFT):* LFT was done by Body Box 500 (Medisoft, Sorinnes, Belgium) for whole-body plethysmography. For subjects with respiratory obstructive disorders (Forced expiratory volume in one second - FEV<sub>1</sub>/ forced vital capacity - FVC <0.70), the bronchial reversibility was evaluated after 15 min using 400 mcg of salbutamol in MDI as recommended by American Thoracic Society (ATS)/European Respiratory Society (ERS) [22].

*Polysomnography (PSG):* In-laboratory overnight PSG was performed for each study subject as recommended by the American Academy of Sleep Medicine (AASM) and previously described [7,15]. PSG was done for each study subject with the use of Alice PSG (Philips, USA). The recording time was from 9 PM to 6 AM of the day after. The recorded parameters were electroencephalography (EEG), chin electromyography (EMG), electrocardiography (ECG), nasal and oral air flows, thorax-abdomen movements, sleeping posture, apnea-hypopnea index (number/h), type of apnea (central, obstructive, or mixed apnea), mean oxygen saturation (SpO<sub>2</sub>), and minimum SpO<sub>2</sub> (nadir SpO<sub>2</sub>). The severity of OSA was defined by AHI as mild OSA (AHI = 5-15/h), moderate OSA (AHI = 16-30/h), or severe OSA (AHI >30/h). Subjects with severe OSA who were eligible for inclusion criteria, were included in the present study for auto-CPAP therapy.

*Auto-adjusting CPAP at home:* Eligible study subjects underwent an unattended automatically adjusting CPAP (auto-CPAP) titration at home by using the REMstar Auto (Philips-Respironics, Murraysville, PA, USA) or RESMED AutoSet S9 (ResMed, Bella Vista, Australia). The pressure was set to start automatically, ranging from 4 cm of water pressure (cwp) up to a maximum of 20 cwp. Sleep laboratory staff was in contact directly or indirectly by telephone with study subjects during the first week auto-titration and for troubleshooting. During the home-based auto-PAP, study subjects completed a basic sleep checklist indicating at what time they fell asleep and when they woke up as described previously [19]. The successful auto-CPAP therapy was defined by residual AHI <5/h with optimal pressure, measured by the device algorithm.

## Statistical analyses

All recorded parameters were analyzed by using IBM-SPSS 22.0 software (Chicago, IL, USA). Categorical variables were expressed as numbers or percentages. Continuous variables were presented as mean ± SD. Normal distribution was tested by using the Skewness-Kurtosis manner. Mann-Whitney U test was used for mean pair-comparison between two groups and Kruskal-Wallis test was used for pair comparison of more than two groups.  $p < 0.05$  was considered as significant difference.

## Results

### Characteristics of study subjects with OSA

From January 2015 to January 2018, 139 subjects with diagnosed severe OSA who accepted to be treated with auto-CPAP were included in the present study. The mean age of study subjects was  $51.3 \pm 16.4$  years with male/female ratio of 3.2. The mean BMI was  $28.4 \pm 3.8$  kg/m<sup>2</sup> and neck and abdomen circumferences were  $38.2 \pm 6.4$  and  $85.7 \pm 11.6$ , respectively (Table 1). The Epworth scores and Pichot scores were  $18.4 \pm 6.3$  and  $28.3 \pm 4.5$ , respectively. The means of SBP (systolic blood pressure) and DBP (diastolic blood pressure) of study subjects were higher than normal level ( $152 \pm 28$  mmHg and  $94 \pm 12$  mmHg; respectively). 84% of study subjects had one of other comorbidities (Table 1). There was no respiratory obstructive disorder in these study subjects in LFT (lung function testing). The mean AHI was  $39 \pm 7$ /h with arousal index (ARI) of  $39 \pm 13$ /h. The levels of glucose, total cholesterol, LDL cholesterol, and triglycerides were higher than normal limits (Table 1).

### Modification of study subjects' characteristics after auto-CPAP therapy

There was no significant difference concerning anthropometric parameters of study subjects at inclusion at 3<sup>rd</sup> month and 6<sup>th</sup> month after auto-CPAP therapy (Table 2). The means of SBP and DBP were significantly decreased after auto-CPAP. The Epworth and Pichot scores were significantly ameliorated at 3<sup>rd</sup> month and 6<sup>th</sup> month in the comparison to at inclusion (Epworth:  $12.6 \pm 4.5$  and  $8.8 \pm 4.6$  vs  $18.4 \pm 6.3$ ; Pichot:  $21.2 \pm 5.3$  and  $25.4 \pm 4.7$  vs  $28.3 \pm 4.5$ , respectively; Table 2 and Figure 1). The levels of glucose and total cholesterol and LDL were significantly decreased after 6<sup>th</sup> month of auto-CPAP therapy. The AHI registered by auto-CPAP machine was significantly reduced at 3<sup>rd</sup> month and 6<sup>th</sup> month under auto-CPAP therapy, compared to that measured by PSG at inclusion ( $12 \pm 6$  and  $7 \pm 3$  vs  $39 \pm 7$ ;  $P < 0.001$  and  $P < 0.001$ , respectively; Figure 1). At inclusion, there was 61.8% of study subjects who chose nasal mask but after 3<sup>rd</sup> and 6<sup>th</sup> month there was only 52.9% and 50.7% of them using nasal mask respectively due to air leaking through the mouth (Table 2).

### Correlation among modification of AHI, clinical and biological parameters

The result showed that there were significant correlations for the modifications of AHI ( $\Delta$  AHI) and  $\Delta$  Epworth scores and  $\Delta$  Pichot scores at inclusion and after 3<sup>rd</sup> - 6<sup>th</sup> month (Figure 2). The correlation between  $\Delta$  AHI and  $\Delta$  Epworth scores at 6<sup>th</sup> month ( $\Delta$  [inclusion - 6<sup>th</sup> month]) was higher than that between  $\Delta$  [inclusion - 3<sup>rd</sup> month] ( $R = 0.745$  and  $p = 0.002$  vs  $R = 0.568$  and  $p = 0.003$ ; Figure 2). There were no significant differences among  $\Delta$  AHI and the modifications of blood pressures, fasting glucose, total cholesterol or LDL at inclusion vs 6<sup>th</sup> month ( $R = 0.236$  and  $p = 0.132$ ;  $R = 0.105$  and  $p = 0.168$ ;  $R = 0.098$  and  $p = 0.087$ ;  $R = 0.118$  and  $p = 0.134$ , respectively).

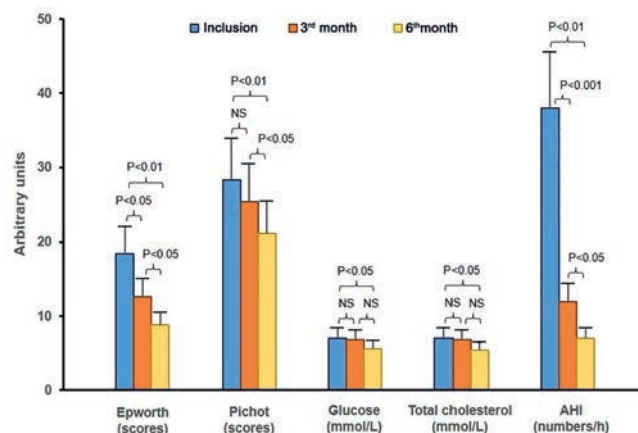
### Comparison of auto-CPAP adherence at 3<sup>rd</sup> and 6<sup>th</sup> month of study subjects

The result showed that the percentage of study subjects who used auto-CPAP therapy at night  $< 30$  days/month (but  $> 20$  days/month) was 20.5% at 3<sup>rd</sup> month and reduced significantly to 8.8% at 6<sup>th</sup> month ( $p < 0.01$ ; Table 3). After 6 months, the number of days with auto-CPAP usage at night in study subjects was higher than that after 3 months but it was not significantly different ( $26.6 \pm 1.8$  vs  $25.4 \pm 2.2$ ;  $p > 0.05$ ). The percentage of study subjects who used auto-CPAP therapy from 4-5 h/night at 6<sup>th</sup> month was

**Table 1.** Characteristics of study subjects with OSA at inclusion.

Characteristics	Subjects with OSA (n = 139)		
	Mean $\pm$ SD	Min-Max	95% CI
<b>Anthropometric parameters</b>			
Age, years	$51.3 \pm 16.4$	35-67	47.5-56.7
Male/female, ratio (n)	3.2 (106/33)	-	-
Height, cm	$162.3 \pm 7.4$	155-178	158.3-166.4
Weight, kg	$68.5 \pm 12.3$	55-82	65.7-72.8
BMI, kg/m <sup>2</sup>	$28.4 \pm 3.8$	24.5-2.5	26.6-30.3
Neck circumference, cm	$38.2 \pm 6.4$	32-45	35.7-41.2
Abdomen circumference, cm	$85.7 \pm 11.6$	74-98	82.5-89.6
<b>Clinical symptoms</b>			
Smoking, %	32.4	-	-
Snoring, %	88.2	-	-
Epworth scores, (0-24)	$18.4 \pm 6.3$	12-24	16.7-21.4
Pichot scores*, (0-32)	$28.3 \pm 4.5$	24-32	16.5-30.2
<b>Blood pressures</b>			
SBP, mmHg	$152 \pm 28$	124-180	147-156
DBP, mmHg	$94 \pm 12$	80-110	89-97
Comorbidities <sup>o</sup> , %	84	-	-
<b>Lung function parameters</b>			
FEV <sub>1</sub> , % predicted	$86.4 \pm 8.5$	78-95	83.6-90.2
FVC, % predicted	$88.7 \pm 9.3$	78-98	86.3-89.6
FEV <sub>1</sub> /FVC, %	$77.4 \pm 6.7$	70-82	74.5-81.4
TLC, % predicted	$89.3 \pm 7.4$	82-98	86.4-92.7
<b>Polysomnography parameters</b>			
AHI, numbers/h	$39 \pm 7$	32-69	45.5-51.6
ARI <sup>h</sup> , numbers/h	$39 \pm 13$	25-54	36.7-42.8
Mean SpO <sub>2</sub> , %	$87 \pm 4$	84-91	85.2-89.9
Nadir SpO <sub>2</sub> , %	$79 \pm 6$	72-84	77.4-82.1
<b>Biological parameters</b>			
Glucose, mmol/L	$6.6 \pm 0.8$	6.2-7.4	6.2-6.9
Total cholesterol, mmol/L	$6.3 \pm 0.9$	5.2-7.1	5.9-6.5
LDL cholesterol, mmol/L	$4.1 \pm 0.8$	3.3-4.9	3.8-4.3
Triglycerides, mmol/L	$2.7 \pm 0.5$	2.2-3.2	2.5-2.9

OSA, obstructive sleep apnea; CI, confidence interval; BMI, body mass index; FEV<sub>1</sub>, forced expiratory volume in 1 s; FVC, forced vital capacity; TLC, total lung capacity; PSG, polysomnography; AHI, apnea-hypopnea index; ARI, arousal index; LDL, low-density lipoprotein; \*Pichot scores for tiredness; <sup>o</sup>having at least one comorbidity (hypertension, diabetes mellitus, coronary disease, atrial fibrillation); <sup>h</sup>measured by Alice PSG auto report.



**Figure 1.** Modification of clinical and biological parameters of study subjects treated with auto-CPAP. OSA, obstructive sleep apnea; CPAP, continuous positive pressure; AHI, apnea-hypopnea index.

significantly higher than that at 3<sup>rd</sup> month (39±4 vs 28±3;  $p<0.05$ ; Table 3). At 6<sup>th</sup> month, the mean duration of auto-CPAP therapy at night was significantly higher than that at 3<sup>rd</sup> month (6.5±2.4 vs 5.2±2.2 h;  $p<0.05$ ; Table 3). The number of AHI registered automatically by auto-CPAP machine at 6<sup>th</sup> month was significantly lower than that at 3<sup>rd</sup> month (7±3 vs 12±6;  $p<0.05$ ).

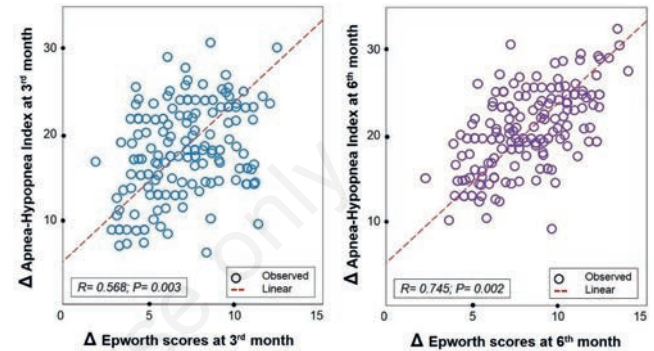
Among study subjects, there were 74 subjects with severe OSA who started to be treated with REMstar Auto and 65 subjects treated with Autoset S9 at inclusion; after 3 and 6 months, there were 72 subjects treated with REMstar vs 64 subjects treated with Autoset S9 and 72 subjects treated with REMstar vs 62 subjects treated with Autoset S9, respectively. There was no significant difference between the two groups of subjects treated with the two kinds of auto-CPAP for efficiency (residual AHI index) and adherence (days and hours with auto-CPAP used at night and side effects) after 3<sup>rd</sup> month and 6<sup>th</sup> month.

### Comparison of auto-CPAP side effects at 3<sup>rd</sup> and 6<sup>th</sup> month in study subjects

The main side effects of auto-CPAP therapy at 3<sup>rd</sup> month were dry mouth or nose, difficult sleeping, skin marks or rashes, and discomfort breathing (78.6%, 65.4%, 41.1%, and 25.7%, respectively; Table 3). The other side effects with lower percentage were nasal congestion, dry eyes, aerophagy or flatulence, and claustrophobia (13.2%, 11%, 7.3%, and 1.4%, respectively; Table 3). At 6<sup>th</sup> month, the percentage of the main side effects such as dry mouth or nose, difficult sleeping, skin marks or rashes, and discomfort breathing were reduced significantly ( $p<0.001$ ,  $p<0.001$ ,  $p<0.001$ , and  $p<0.05$ ). There were no significant differences for other minor side effects such as nasal congestion, dry eyes, aerophagy or flatulence, or claustrophobia between 3<sup>rd</sup> month and 6<sup>th</sup> month (Table 3).

## Discussion

The results of the present study showed that: 1) Daytime symptoms of severe OSA, measured by Epworth and Pichot scores, were significantly improved after 3 and 6 months of auto-CPAP therapy and associated with the correlation of  $\Delta$  values of AHI; 2) biological disorders in subjects with severe OSA were ameliorated after 6 months of auto-CPAP therapy; 3) subjects with severe OSA had an acceptable adherence with auto-CPAP therapy with some side effects related to CPAP machine and interface devices.



**Figure 2.** Correlation between delta ( $\Delta$ ) Epworth scores and  $\Delta$ AHI at 3<sup>rd</sup> - 6<sup>th</sup> month vs at inclusion in study subjects treated with auto-CPAP. AHI, apnea-hypopnea index; CPAP, continuous positive pressure.

**Table 2.** Characteristics of study subjects at inclusion and after being treated with auto-CPAP therapy.

Characteristics	Subjects with OSA (n=139)			p
	At inclusion	After 3 months treatment with auto-CPAP	After 6 months treatment with auto-CPAP	
Number of subjects	139	136	134	-
<b>Anthropometric parameters</b>				
Age, years	51.3±16.4	51.6±15.8	51.9±16.7	NS <sup>○,‡,^</sup>
Male/female, ratio (n)	3.2 (106/33)	3.3 (105/31)	3.4 (104/30)	NS <sup>○,‡,^</sup>
BMI, kg/m <sup>2</sup>	28.4±3.8	27.6±4.3	27.3±3.9	NS <sup>○,‡,^</sup>
Neck circumference, cm	38.2±6.4	38.1±5.8	38.2±5.9	NS <sup>○,‡,^</sup>
Abdomen circumference, cm	85.7±11.6	84.6±12.4	84.3±11.3	NS <sup>○,‡,^</sup>
<b>Clinical symptoms - Blood pressures</b>				
SBP, mmHg	152±28	134±16	133±15	<0.05 <sup>○,‡,^</sup> ; NS <sup>^</sup>
DBP, mmHg	94±12	82±8	84±9	<0.05 <sup>○,‡,^</sup> ; NS <sup>^</sup>
Epworth scores, (0-24)	18.4±6.3	12.6±4.5	8.8±4.6	<0.05 <sup>○,^</sup> ; <0.01 <sup>‡</sup>
Pichot scores*, (0-32)	28.3±4.5	25.4±4.7	21.2±5.3	NS <sup>○</sup> ; <0.01 <sup>‡</sup> ; <0.05 <sup>^</sup>
<b>Biological parameters</b>				
Glucose, mmol/L	6.6±0.9	6.2±1.0	5.6±0.8	NS <sup>○,^</sup> ; <0.05 <sup>‡</sup>
Total cholesterol, mmol/L	6.3±1.0	6.1±1.2	5.4±1.1	NS <sup>○,^</sup> ; <0.05 <sup>‡</sup>
LDL cholesterol, mmol/L	4.1±0.8	3.8±0.7	3.5±0.9	NS <sup>○,^</sup> ; <0.05 <sup>‡</sup>
Triglycerides, mmol/L	2.7±0.5	2.6±0.7	2.6±0.6	NS <sup>○,‡,^</sup>
<b>OSA parameters</b>				
AHI, numbers/h	39±7	12±6	7±3	<0.001 <sup>○,^</sup> ; <0.05 <sup>‡</sup>
Auto-CPAP tolerance				
Acceptance rate, %	100	97.8	96.4	NS <sup>○,‡,^</sup>
<b>Interface</b>				
Nasal mask	61.8	52.9	50.7	<0.05 <sup>○,‡</sup> ; NS <sup>^</sup>
Full mask	38.2	47.1	49.3	<0.05 <sup>○,‡</sup> ; NS <sup>^</sup>

OSA, obstructive sleep apnea; CPAP, continuous positive pressure; BMI, body mass index; SBP, systolic blood pressure; DBP, diastolic blood pressure; LDL, low-density lipoprotein; AHI, apnea-hypopnea index; \*Pichot scores for tiredness; <sup>○</sup>3<sup>rd</sup> month vs inclusion; <sup>‡</sup>6<sup>th</sup> month vs inclusion; <sup>^</sup>6<sup>th</sup> month vs 3<sup>rd</sup> month.

The present study showed that study subjects with severe OSA had the typical symptoms of OSA with daytime sleepiness and tiredness (Table 1). These symptoms were evaluated objectively by Epworth and Pichot scores. Beside these symptoms, they also had high blood pressure (HBP). HBP is a very common symptom in subjects with OSA and the mechanism of the relationship between OSA and HBP has been still discussed [23,24]. It might be mainly due to the increase of sympathetic activity at wake up due to intermittent hypoxia during sleep [25]. In addition, in the present study, the subjects with severe OSA had also the biological characteristics of metabolic disorders with increasing fasting glucose, total cholesterol and LDL cholesterol (Table 1). Previous studies have also reported glycemic and lipid disorders in non-obese OSA patients and that was correlated with sleep fragmentation or severity of nocturnal hypoxia [26,27]. These authors suggested that metabolic status could be disrupted in OSA even in the absence of obesity.

In the present study, at inclusion, there were 139 study subjects with severe OSA who accepted to do auto-CPAP therapy at home; but after 3 months, 136 subjects (97.8%) followed this treatment while three subjects had withdrawn auto-CPAP therapy due to the adherence problem related to discomfort breathing. For subjects with auto-CPAP therapy, the use of CPAP at night helped to improve OSA-related symptoms during the day with a significant reduction of Epworth and Pichot scores after 3 months of follow up (Table 2). However, the improvement of biological disorders concerning high levels of fasting glucose, total cholesterol and

LDL was only improved after 6 months of auto-CPAP therapy (Table 2; Figure 1). The role of CPAP therapy in patients with severe OSA has been demonstrated in many studies. The favorable effect of CPAP therapy in reduction of blood pressure [28,29] and its beneficial effect on metabolic syndrome have been reported [30,31]. However, there are few studies comparing the effect of auto-CPAP and fixed-CPAP on metabolic syndrome in subjects with severe OSA. In patients with severe OSA, the metabolic syndrome has been known as the consequence of OSA and it has been related to oxidative stress produced by intermittent hypoxia during sleep. The result of the present study showed that the biological disorder was improved later than clinical symptoms. Interestingly, there was a significant correlation between the level of AHI modification ( $\Delta$ AHI) and  $\Delta$ Epworth scores after 3 and 6 months with auto-CPAP therapy (Figure 2).

The present study showed that auto-CPAP therapy in short-term follow up (6 months) had a good adherence from patients with severe OSA. After 3 months and 6 months of auto-CPAP therapy, three subjects (at 3<sup>rd</sup> month) and then two more subjects (at 6<sup>th</sup> month) refused to use the CPAP machine due to the problem of uncomfortable sleep at night. The result concerning auto-CPAP therapy at 3<sup>rd</sup> and 6<sup>th</sup> months showed that the side effects were improved over the time with acceptable tolerance (Table 3). At 3<sup>rd</sup> month of auto-CPAP therapy, more than 50% of study subjects had dry mouth or nose and difficult sleeping; however, it was significantly reduced at 6<sup>th</sup> month (Table 3). The side effects of CPAP

**Table 3. Auto-CPAP therapy adherence and side effects at 3<sup>rd</sup> and 6<sup>th</sup> month of study subjects.**

Parameter	At 3 months (n=136)	At 6 months (n=134)	p
Days without auto-CPAP usage at night			
Accumulated days/month, day, 95%CI (min - max)	4.3±1.4 3.9-4.8 (3-6)	3.5±1.2 3.1-3.9 (2-5)	NS
Percentage of subjects, %	20.5	8.8	<0.01
Days with auto-CPAP usage at night			
Accumulated days/month, days, 95%CI (min - max)	25.4±2.2 24.1-26.5 (22-30)	26.6±1.8 25.2-27.4 (24-0)	NS
≥5h/night, % subjects/month	64±5	67±6	NS
4-5 h/night, % subjects/month	28±3	39±4	<0.05
3-4 h/night, % subjects/month	8±2	4±1	NS
Hours of auto-CPAP usage per night			
Min, hours	2.3±0.4	3.8±0.5	<0.05
Max, hours	7.8±1.6	8.6±1.5	NS
Average, hours, 95%CI (min - max)	5.2±2.2 4.6-5.9 (2-10)	6.5±2.4 5.7-7.2 (3-10)	<0.05
Attained auto-CPAP pressure during sleep			
Min, cmH <sub>2</sub> O	5.3±1.2	5.8±1.6	NS
Max, cmH <sub>2</sub> O	16.4±4.6	15.2±5.4	NS
Average, cmH <sub>2</sub> O, 95%CI (min - max)	12.7±6.8 10.3-14.6 (4-20)	11.5±6.9 9.4-13.6 (4-18)	NS
Respiratory events under auto-CPAP			
OA, number/h	14±6	8±4	<0.05
Hypopnea, number/h	10±4	6±3	NS
AHI, number/h	12±6	7±3	<0.05
Auto-CPAP related side effects			
Dry mouth or nose	78.6	32.0	<0.001
Nasal congestion	13.2	11.9	NS
Dry eyes	11.0	10.4	NS
Discomfort breathing	25.7	16.0	<0.05
Claustrophobia	1.4	0.7	NS
Aerophagia or flatulence	7.3	6.7	NS
Skin marks or rashes	41.1	20.8	<0.001
Difficult sleeping	65.4	36.1	<0.001

therapy and adherence were also reported in previous studies [32,33]. Finally, at the end of the study (6 months), there was 96.4% (134/139) of study subjects who continued to use auto-CPAP at night. In the Home PAP Study, Rosen *et al.* [19] showed that 97% of OSA patients treated with auto-adjusting CPAP completed month 1 visits, 87% completed month 3 visits, and 84% completed both visits. These authors concluded that autoadjusting CPAP increased access to treatment with the potential to decrease healthcare expenditures and patient burden.

Recently, AASM (American Academy of Sleep Medicine) recommends positive airway pressure (PAP) therapy be initiated by using either auto-PAP (APAP) at home or in-laboratory PAP titration in adults with OSA and no significant comorbidities [16]. The AASM clinical guidelines have stated that the potential benefits of using APAP in the home setting include lower cost, reduced time away from home, faster initiation of treatment and greater access to care [16]. Previous studies also suggested the use of auto-CPAP as an alternative method for laboratory-titrating CPAP therapy [34,35].

The present study has some important limitations, namely due to the small number of study subjects, short-term follow up, and lack of control group treated with in-laboratory titration CPAP therapy. Therefore, more studies about the role and benefits of auto-CPAP therapy in patients with moderate-to-severe OSA should be realized in the near future to evaluate and predict the long-term adherence and quality of life of auto-CPAP therapy in this population.

## Conclusions

Auto-CPAP therapy has a beneficial role in the treatment of Vietnamese patients with severe OSA. The adherence of auto-CPAP therapy in short term follow up is promising in the majority of patients with severe OSA. However, more longitudinal cohort studies on auto-CPAP therapy in patients with severe OSA should be instituted to confirm the efficacy of this treatment.

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## List of abbreviations

*AASM, American Academy of Sleep Medicine; AHI, apnea-hypopnea index; ARI, arousal index; BMI, body mass index; DBP, diastolic blood pressure; LDL, low density cholesterol; LFT, lung function testing; OSA, obstructive sleep apnea; PAP, positive airway pressure; PSG, polysomnography; SBP, systolic blood pressure.*

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