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The Pharma Innovation

ISSN: 2277- 7695
TPI 2016; 5(7): 95-98

www.thepharmajournal.com
Received: 05-05-2016
Accepted: 06-06-2016

Feshchenko YI
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Iashyna LA
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Ignatieva VI
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Zvol IV
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Opimakh SG
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Polianska MO
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Moskalenko SM
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Correspondence
Opimakh SG
State Organisation National Institute of Phthisiology and Pulmonology named after F. G. Yanovskyi, National Academy of Medical Sciences of Ukraine

Clinical and functional effectiveness of auto-cpap therapy in patients with chronic obstructive pulmonary disease combined with obstructive sleep apnea-hypopnea syndrome

Feshchenko YI, Iashyna LA, Ignatieva VI, Zvol IV, Opimakh SG, Polianska MO and Moskalenko SM

Abstract
The article presents the results of research of influence of auto-Cpap therapy on clinical symptoms and respiratory disorders during sleep parameters in patients with chronic obstructive pulmonary disease (COPD) in combination with the obstructive sleep apnea-hypopnea syndrome (OSAHS).
Was proved that the attribute characteristic of sleep disordered breathing in patients with COPD clinical groups B and D combined with SOAHS according to polysomnography (PSG) are: increase in apnea-hypopnea index (IAH) to II – III severity level, high desaturation index, reducing the average and minimum SpO_2 per night. Additional appointment of auto-Cpap therapy to the basic inhalation treatment improves the course of the clinical symptoms both COPD and OSAHS and has positive effect on the basic parameters of sleep disordered breathing, gas exchange and disease course.

Keywords: chronic obstructive pulmonary disease, obstructive sleep apnea-hypopnea syndrome, auto-Cpap, sleep disordered breathing

Introduction
Chronic obstructive pulmonary disease (COPD) is one of the most serious health and social problems in Ukraine and around the world. The urgency of this problem is due to a growing level of morbidity and progressive course of disease, which leads to high rates of disability, mortality, very significant economic and social burden.
According to epidemiological studies from 8 to 22 % of adults aged over 40 suffer from COPD. At the present state of medicine COPD is considered as a disease which can be prevented and treated, and therefore the issue of prevention, early diagnosis and providing adequate treatment is particularly relevant [4].
COPD – a pathology which is based on non-specific systemic inflammation. Along with lung COPD leads to significant extrapulmonary systemic effects and related comorbidities that complicates the disease in some patients. Standards of care for patients with COPD mainly set internationally manual diagnosis and treatment of COPD – GOLD [4]. However, despite the implementation of modern principles of diagnosis and treatment of COPD in practice, prevention of the progression of the disease not achived. Often this is due to the presence of comorbidity, which is not always diagnosed in a timely manner, resulting in patients not receiving adequate medical care.
In providing medical care to patients with COPD is not enough attention payed on diagnosis and treatment of obstructive sleep apnea-hypopnea syndrome (OSAHS), which is an important cause of severe disease course. Wherein OSAHS most often diagnosed in patients who have excessive body weight.
OSAHS affects the quality of sleep, impairs the course of the underlying disease and is an additional risk factor for depression, cardiovascular disease, hypothalamic-pituitary disorders, reducing the effectiveness of rehabilitation programs and the quality of life of patients. Therefore, early detection and treatment of associated SOAHS in patients with COPD is relevant [3, 6]. However, to date no standardized program effectively treat patients with this comorbidity.
SOAHS clinically manifested by a combination of excessive daytime sleepiness and the presence of respiratory disorders during sleep, caused by multiple repeated episodes of upper airway closure. This can be observed as episodes of apnea or hypopnea [3, 6]. Apnea is the full upper respiratory tract closure with the 10-second or longer pulmonary ventilation cessation. Hypopnea - a partial upper airway collapse with the 10 -second or longer decrease in pulmonary ventilation by 50 percent or more. In OSAHS observed episodes of obstructive apnea/hypopnea as a decrease in upper respiratory tract, when the patient's respiratory effort is saved.
The "gold" standard of OSAHS treatment is Cpap therapy – support continuous positive airway pressure

[1, 5, 7], so that air pneumatic stent in oropharynx created that prevent to airway closure and episodes of apnea occurrence. This additional pressure in hypopharynx shifts to the front of the tongue, expands the cross-sectional width of the throat and stabilizes the moving soft palate and uvula, which leads to the disappearance of the phenomenon of sound of snoring.
In addition, creating a positive pressure in the airways of patients with COPD helps reveal alveoli collapse and reduce lung hyperinflation. Before beginning Cpap therapy conduct titration of therapeutic pressure in conditions of polisomnography laboratory [1, 8], which is necessary for the determination of the level of pressure at which will be reduced to a minimum episodes of apnea and hypopnea, snore and desaturation during all sleep stages [7]. This procedure was simplified after the introduction of the medical practice of modern automatic Cpap therapy (auto-Cpap) devices. Thanks to new technology, auto-Cpap minimizes the average night pressure required to treat OSAHS [5, 9], which is the main advantage of this method. This is due to the ongoing registration of signals from sensors airflow and snore and automatic correction of therapeutic pressure in response to changes in airway resistance during therapeutic night.
Thus, it is reasonable to assume that the additional purpose of auto-Cpap to the standard basic therapy COPD in patients with comorbidity, will help improve the course both COPD and OSAHS.

The aim of this study was: to investigate the impact of auto-Cpap therapy on clinical symptoms and of respiratory disorders during sleep parameters in patients with chronic obstructive pulmonary disease in combination with obstructive sleep apnea-hypopnea syndrome (OSAHS).

Object of study
The influence of auto- Cpap therapy on clinical symptoms and polysomnography indices was studied in 20 patients with COPD combined with SOAHS (16 men and 4 women, average age (53,7 ± 3,0) years, FEV_1 – (61,6 ± 3 2)%, FEV_1/FVC – (63,2 ± 3,1)%). All patients received basic therapy according to clinical COPD group of the disease according to current standards of treatment, which was held for 4 weeks before inclusion in the study.

Methods of study
Selection of patients with COPD conducted in accordance with basic international guidance on diagnosis and treatment of COPD - GOLD [4].
To determine the severity of the disease and determine clinical groups of COPD patients were asked to fill out the scale of dyspnea Medical Research Council (Modified Medical Research Council (mMRC) Dyspnea Scale) and COPD Assessment Test (CAT), determine the frequency of exacerbation of COPD [2]. For all patients pulmonary function test and polysomnography on "SomnoStar Pro" complex "Cardinal Health" company (Germany) were performed.
To determine the presence of daytime sleepiness patients were asked to fill Epworth sleepiness scale [3]. Sleepiness Score on a scale Epworth carried out as follows: 0-5 points – the normal; 6-8 points – the initial stage of sleepiness, 9-12 points – moderate, 13-18 points – marked, 19 and more – extreme degree of sleepiness.
In order to establish the diagnosis, determine the degree of bronchial obstruction and lung ventilation function for all patients were performed spirometry with the forced expiratory "flow-volume" curve analysis and bodyplethyzmohraphy on the complex for respiratory system study "Master Screen Pneumo" and on the unit "Master Screen PFT" of "Cardinal Health" company (Germany). The study was conducted in accordance with the requirements ATS/ERS, in the morning, after fulfilling the terms of medication washout. Bronchial reversibility test was conducted by conventional method with 4 short-acting bronchodilators inspiration is stated (salbutomol).
OSAHS diagnosis was confirmed by polysomnography. Polysomnography (PSG) study (electroencephalogram, electrooculogram, electrocardiogram – ECG, electromyogram, including electromyogram which is registered from patient's limb, abdominal breathing effort, breast breathing effort, air breathing flow, pulse-oxymetry) was conducted on the machine "SomnoStar Pro" "Cardinal Health" company (Germany).
The following parameters were analyzed: the of apnea-hypopnea index (AHI) - number of episodes of apnea + hypopnea per hour, the desaturation index (number of episodes desaturations per hour), average SpO2 per night (%), minimum SpO2 per night %. These parameters were testified as OSAHS aggravates the course of COPD.
All the data accumulated in the developed database, which became the basis package "Excel". In calculations performing commonly used statistical and mathematical function program Excel, which made it possible to consider the results of using the methods of variation and correlation analysis.
Since we were dealing with small groups of patients to assess the reliability of differences of average values of samples used in the t-Student test (for independent observations and a series of related cases), and Fisher's criterion (for not normal distributed and the number of observations < 30) and Mann-Whitney criterion (when comparing quality indicators).

Methods of treatment: For treatment patients with COPD in combination with OSAHS conducted an open, randomized study.
For the treatment of studied patients was recommended two modes of therapy conducted sequentially. The first mode of therapy the patients followed the first 14 days of observation. It called for continued supplementation basic treatment of COPD in daily doses according to current standards of treatment that patients treated for 4 weeks prior to enrollment. Then for the same patients administered second mode of therapy. It provided basic drug therapy at daily doses in accordance with the current standards of treatment in combination with auto-Cpap therapy (while sleeping). For the auto-Cpap therapy device used for the treatment of snoring and sleep apnea with humidifier SOMNO smart 2 of SOMNO click Smart PAP (auto-Cpap). The duration of combination therapy was 14 days. Then again, patients

switched to the first mode of therapy in which surveillance is conducted within 14 days.

Design of the study consisted of five visits, study conducted in "National institute of Phthisiology and Pulmonology named after F.G. Yanovsky NAMS of Ukraine". Patients were examined in the beginning of the study – visit 1, after 14 days of observation for the basic treatment of COPD – visit 2, of the first therapeutic nights with auto-Cpap – visit 3, after 14 days from the start of complex therapy – visit 4, 14 days after completion of complex therapy – visit 5.

Results and discussion

Before the treatment significantly marked clinical symptoms of COPD in terms of the questionnaire CAT - (21,8 ± 1,3) points and a scale mMRC - (2,2 ± 0,2) points (table 1) were recorded in studied patients. The severity of symptoms in the studied patients was due to a significant cough and sputum, a sense of compression in the chest, shortness of breath when climbing uphill and limited activities, sleep disturbances and decreased vigor.

Among the 20 examined patients with comorbidity 17 (85%) were related to the clinical group B and 3 patients (15%) – to Group D by GOLD clinical classification of COPD [4]. Thus there was high level of daytime sleepiness on an Epworth sleep scale – (15, 3 ± 0,8) points (table. 1). All patients noted the excessive daytime sleepiness, short of falling asleep at monotonous work, increased daytime fatigue, loud night snore and apnea during sleep (which reported by relatives), restless sleep with frequent awakenings, engine response during sleep (restless limb movements, twisting in his sleep), night awakening due to claims to urinate, morning headaches. Some patients have noted nocturnal heartburn, dry mouth and throat upon awakening, changes in blood pressure and cardiac abnormalities, potency changes or other sexual disorders.

Table 1: Analysis of the questionnaire results in patients with COPD combined with OSAHS during treatment (M ± m)

Indexes	Visit 1 (the beginning of the study)	Visit 2 (14 days observation at the basic treatment of COPD)	Visit 4 (14 days from the start of complex therapy)	Visit 5 (14 days after finish of complex therapy)
The questionnaire CAT, points	21,8 ± 1,3	20,0 ± 1,3	16,0 ± 1,0*$^{2\_4}$	13,5 ± 0,8*$^{2\_5}$
- cough, point	2,6 ± 0,2	2,4 ± 0,2	2,1 ± 0,1	1,9 ± 0,1*$^{2\_5}$
- sputum, points	2,8 ± 0,2	2,4 ± 0,2	2,1 ± 0,2*$^{2\_4}$	1,8 ± 0,1*$^{2\_5}$
- chest compression, points	2,6 ± 0,2	3,9 ± 1,6	1,8 ± 0,2	1,5 ± 0,2*$^{2\_5}$
- shortness of breath when climbing the hill, points	3,0 ± 0,2	2,8 ± 0,2	2,2 ± 0,2*$^{2\_4}$	2,0 ± 0,2*$^{2\_5}$
- restriction, points	2,6 ± 0,2	2,4 ± 0,2	2,1 ± 0,2*$^{2\_4}$	1,5 ± 0,2*$^{2\_5}$
- confidence, points	2,5 ± 0,2	2,5 ± 0,3	2,0 ± 0,2*$^{2\_4}$	1,5 ± 0,2*$^{2\_5}$
- sleep, points	3,0 ± 0,2	2,6 ± 0,2	1,8 ± 0,2*$^{2\_4}$	1,8 ± 0,2*$^{2\_5}$
- energy, points	2,8 ± 0,2	2,5 ± 0,3	1,9 ±0,2*$^{2\_4}$	1,6 ± 0,1*$^{2\_5}$
The questionnaire mMRC, point	2,2 ± 0,2	2,2 ± 0,2	1,9 ± 0,1*$^{2\_4}$	1,5 ± 0,1*$^{2\_5}$
Scale Epworth, points	15,3 ± 0,8	15,1 ± 0,9	9,8 ± 0,9*$^{2\_4}$	8,1 ± 0,7*$^{2\_5}$

Notes:

1. *$^{2\_4}$ – statistically significant difference rate between 2 and 4 visits (p<0,05).
2. *$^{2\_5}$ – statistically significant difference rate between 2 and 5 visits (p<0,05).

During the basic treatment (from 1 to 2 visit) there were not noted the significant difference of studied parameters.

With additional appointments Cpap therapy within 14 days (4 visit) has been a reliable comparable to second visit relatively positive trend in terms of symptom questionnaire CAT - reducing the symptoms from (20,0 ± 1,3) points to (16,0 ± 1,0) points (p<0,05) due to significant reduction of sputum, shortness of breath when climbing uphill, sleep disorders and improve the performance and energy. Improving CAT questionnaire was not only statistically but also clinically significant (minimum clinically important difference CAT questionnaire is 2 points). Shortness of breath on a scale mMRC also significantly decreased from (2,2 ± 0,2) points to (1,9 ± 0,1) points, p<0,05. At follow-up the positive dynamics of symptoms between 2 and 5 visits was saved. High levels of sleepiness on a scale Epvorta succeeded only after the appointment of Cpap therapy to the basic drug therapy of COPD - from (15,1 ± 0,9) points (visit 2) to (9,8 ± 0,9) points (on 4 visit), p<0,05 preserving positive dynamics during follow-up (5 visits).

For all patients with COPD combined with OSAHS polysomnography study were performed (table. 2). The data analysis demonstrated that at the baseline of the surveyed patients there were significant disturbances of PSG. High AHI (37, 8 ± 5,9) / hour was determined, indicating the presence of a II – III grade OSAHS severity in majority of the patients. Such frequent and prolonged decrease upper airway and pulmonary ventilation termination led to an increase desaturation index (number of desaturation episodes, h) to (40,7 ± 6,7) / h, a decreasind the average SpO_2 level at the night to (89,2 ± 1,3) % and minimum SpO_2 level at the night to (75,5 ± 2,2) %. This may mean that intermittent hypoxia that occurred during desaturation in the studied patients, combined with persistent hypoxia in COPD, which led to a deterioration of gas exchange and further aggravate the state of the patients with comorbidity.

Table 2 - PSG indicators in patients with COPD combined with OSAHS during treatment (M ± m)

Indexes	Visit 1 (the beginning of the study)	Visit 2 (14 days observation at the basic treatment of COPD)	Visit 4 (14 days from the start of complex therapy)	Visit 5 (14 days after finish of complex therapy)
AHI, / h	37,8 ± 5,9	25,7 ± 6,4	9,4 ± 2,1*$^{2\_3}$	10,1 ± 3,9*$^{2\_4}$
Desaturation Index, /h	40,7 ± 6,7	46,6 ± 6,9	22,0 ± 5,5	11,3 ± 3,8*$^{2\_4}$
Mean SpO_2 level during night, %	89,2 ± 1,3	86,5 ± 2,4	99,2 ± 1,0*$^{2\_3}$	92,2 ± 0,8
The minimum level SpO_2 during night %	75,5 ± 2,2	71,5 ± 3,3	82,6 ± 2,0*$^{2\_3}$	81,0 ± 4,6*$^{2\_4}$

Notes:
1. *$^{2\_3}$ – statistically significant difference rate between 2 and 3 visits (p<0,05).
2. *$^{2\_4}$ – statistically significant difference rate between 2 and 4 visits (p<0,05).

After 14 days of observation under the basic treatment of COPD (2 visit) statistically significant dynamics of PSG studies were not found. But after the first night of the auto-Cpap therapy in combination with basic treatment of COPD (visit 3) PSG indices' improvement was observed – namely the reduction of AHI from (25,7 ± 6,4) / h before to (9,4 ± 2,1) / h after therapy (p<0,05), reducing desaturation index from (46,6 ± 6,9) / h to (22,0 ± 5,5) / h, increasing the average level of SpO_2 during night from (86,5 ± 2,4) % to (99,2 ± 1,0) % (p<0,05), increasing the minimum SpO_2 level per night from (71,5 ± 3,3) % to (82, 6 ± 2,0) % (p<0,05). Durinf 14 days from the start of combined therapy (visit 4) there was a further PSG indices' improvement compared to second visit: reducing desaturation index from (46,6 ± 6,9) / h to (11,3 ± 3,8) / h (p<0,05) and increased the minimum SpO_2 level during night from (71,5 ± 2,4)% to (81,0 ± 4,6)% (p<0,05).

In pulmonary function test parameters reliable dynamics was not observed. FEV_1 increased from (61,8 ± 2,9)% at 2 visit to (63,1 ± 2,8)% at visit 4, FEV_1/FVC - from (62,9 ± 3,4)% at visit 2 to (63,7 ± 3,7)% at visit 4.

Thus, the addition of auto-Cpap therapy to standard basic treatment of patients with COPD combined with OSAHS led both to improve the course of clinical symptoms of comorbide conditions and functional parameters of PSG - namely occurred a significant decrease of AHI, desaturation index, a significant increase average SpO_2 level at night and minimum SpO_2 level during night.

Conclusions

1. The typical breathing disorders during sleep in patients with clinical groups B and D COPD combined with OSAHS according PSG are: AHI increasing to II - III grade severity, high desaturation index, reducing the average and minimum SpO_2 level during night.
2. Additional appointments of the auto-Cpap therapy to the basic inhalation treatment improves the course both clinical symptoms of COPD and OSAHS, as evidenced by a significant decrease in CAT questionnaire points, mMRC scale and reduction of daytime sleepiness on a Epworth sleep scale.
3. Combined treatment with the use of auto-Cpap therapy positively affects the basic parameters of respiratory disorders during sleep according to night polysomnography - a reduction of AHI from (25,7 ± 6,4)/ h before to (9,4 ± 2,1) / h after therapy (p<0,05), reducing desaturation index from (46,6 ± 6,9) / h to (22,0 ± 5,5) / h, increasing the average level of SpO_2 during night from (86,5 ± 2,4) % to (99,2 ± 1,0) % (p<0,05), that may indicate an improvement in gas exchange during sleep and in comorbidity course.

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