

Physiotherapy Management of Copd Exacerbations

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Physiotherapy remains an important tool in the treatment of chronic obstructive pulmonary disease (COPD) and especially when this disease presents exacerbations that lead to hospitalize our patients. In this article we will analyze how the physiotherapist can help these patients through respiratory therapy using, non-invasive ventilation (NIV), positioning, aerosol therapy, humidification and assistance in fibrobroncoscopy.

Keywords: Physiotherapy; COPD; COPD Exacerbations; NIV**Introduction**

Airflow limitation is usually progressive and associated with an abnormal inflammatory response of the lungs to noxious particles or gases [1]. The global initiative for chronic obstructive lung disease is a global entity that published in 2001 a consensus and global strategy reports for the diagnosis and prevention of chronic obstructive pulmonary disease (COPD). The reports published in 2013, 2014, 2015 and 2017 were based on the scientific literature published since 2011, but maintain the same paradigm of treatment. Only in 2015 the Global Initiative for Chronic Obstructive Lung Disease (GOLD) and The Global Initiative for Asthma (GINA) approved the agreements prepared by a scientific committee for the management of Asthma and COPD overlap syndrome. Now we can see that COPD definition until 2017 has been change progressively in the limitation of the air flow and that is associated to an unexpected inflammatory answer of lungs caused by gases or noxious particles.

COPD is a common, preventable and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation that is caused by airway and/or alveolar abnormalities usually caused by significant exposure to noxious particles or gases². Since the definition of GOLD 2017, they acknowledge that it is an abnormal inflammatory response and define it as a frequent, preventable and treatable disease. It is also characterized by persistent respiratory symptoms and by limitation of air flow, kept from the previous definition. Also defines that this limitation must result in anomalies in the respiratory and alveolar airways caused by exposure to particles and harmful agents. This definition is roughly similar but should clarify that COPD is associated with an inflammatory response, that is a thing of the past.

Exacerbations (definition, diagnosis and treatment) are extensively reviewed, recommendations are given for acute treatment and its prevention, and criteria for follow-up after discharge are given. Analyzing deeper the GOLD report, it highlights the importance of symptomology during lung growth and development. This report of 2017 exhaustively checks COPD exacerbations, giving a definition to them, diagnosis and recommendations for their treatment, prevention and criteria for after-following up of patients. Pharmacological and non-pharmacological therapies are revalued and updated. It includes sections for the treatment of emphysema, self-management, pulmonary rehabilitation, revision of the inhalation technique, oxygen therapy and non-invasive mechanical ventilation. Here it distinguishes the importance of pulmonary rehabilitation through physical therapy, the additional oxygen therapy must be used during exercise and the importance of a good education for the inhalation technique. The importance of examining symptoms and the risk of future exacerbations for the treatment of stable COPD is emphasized; Changes to a more personalized approach to treatment with pharmacotherapeutic treatment strategies (step up and down) are included. The importance of non-invasive ventilation (NIV), what is a main theme to develop, and the improvement of pharmacological treatment in COPD exacerbations. In fact, one of the changes that they proposed is the early treatment with two long action broncodilators now you can ask what is the best way of aerosol administration, which we will discuss later.

Epidemiology

In the United States, COPD affects men more than women, almost doubling it, 4 - 6% of men and 1- 3% of women. The prevalence of COPD is two million, the second cause of invalidity and the fourth cause of death. This prevalence and mortality has increased in the last 25 years. In Chile COPD causes ten percent of hospitaliza-

tions in adults. Is also the 9th cause of death in our country, which means between four to five daily deaths. Santiago, the capital of Chile, is a city with great environmental pollution, that increases in winter affecting 9% of the population. The prevalence is greater in senior population, males over 40 years, smokers and exhibitors. The costs involving public health of each country is important and the European Union has estimated that a 6% of the total budget in health is spent by respiratory diseases and 56% of this 6% is spent in COPD, which corresponds (by 2014 ERS and ELF data) to approximately 380 billion euros. In 2004, COPD was the 13th morbidity cause discribed by the world classification and it is expected that by 2030 will be the 5th cause of morbidity at world level.

Pathways to the diagnosis of COPD

In COPD we can observe different symptoms and risk factors. Especially during the anamnesis we must ask about: respiratory difficulty, chronic cough, secretion increase, tobacco habit, patient work type and environmental characteristic [2]. Spirometry is important to establish diagnosis, but it must be complemented with other exams, such us x-rays and computerized axial tomography. Spirometry in a normal patient has a forced vital capacity (FVC) of 5 liters and a forced expiratory volume (FEV₁) of 4 liters. This changes in a COPD patient, were his FVC is 3.2 liters and the FEV₁ of 0.8 liters [3] (Figure 1).

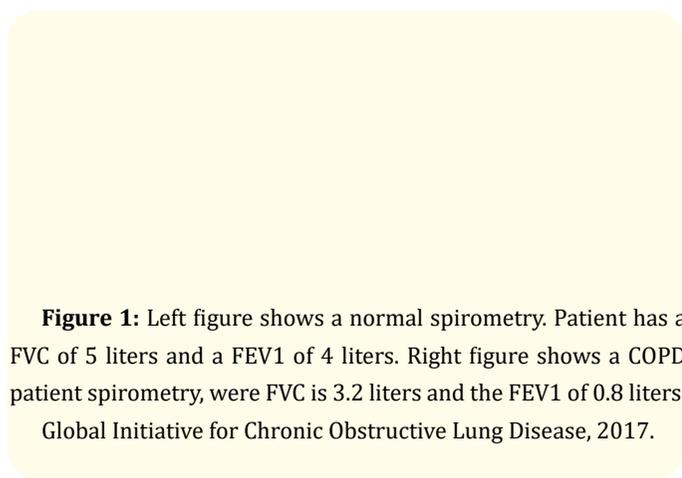


Figure 1: Left figure shows a normal spirometry. Patient has a FVC of 5 liters and a FEV1 of 4 liters. Right figure shows a COPD patient spirometry, were FVC is 3.2 liters and the FEV1 of 0.8 liters. Global Initiative for Chronic Obstructive Lung Disease, 2017.

Respiratory mechanical alteration

As to the amendment of the respiratory mechanic of our patients, this point is of great importance to analyze and we, as physiotherapists, have the duty to know very well how the diaphragm works and what our treatment goal should be. these types of patients have an increase in functional residual capacity due the air entrapment. We should remember extremely well the diaphragm biomechanic, which is the main muscle of breathing. We know that patients with COPD have a different pattern of the diaphragm and therefore the biomechanic effectiveness of this muscle will be at disadvantage, given by the decrease of the aposition area. Therefore one of the most important objectives of physiotherapists should be giving a good point of support for the diaphragm to increase the appointment zone to improve muscle excursion. This can be made by manual therapy, giving a small resistance in the low cost zone (Figure2).

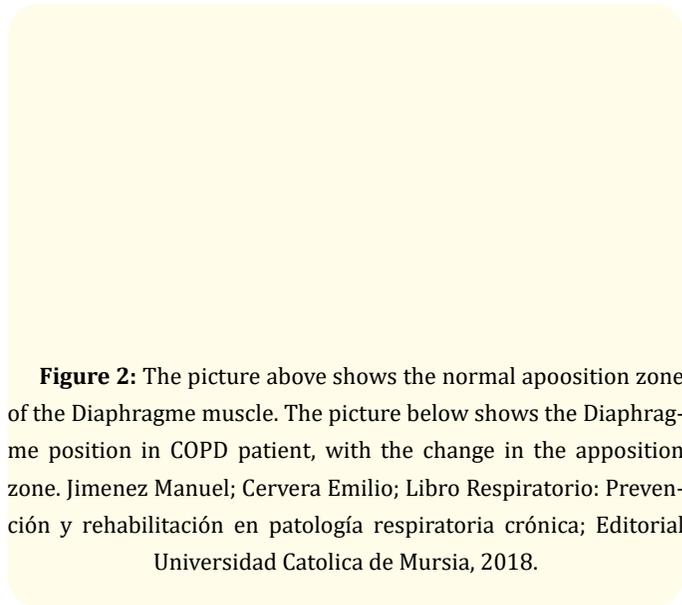


Figure 2: The picture above shows the normal apposition zone of the Diaphragme muscle. The picture below shows the Diaphragme position in COPD patient, with the change in the apposition zone. Jimenez Manuel; Cervera Emilio; Libro Respiratorio: Prevención y rehabilitación en patología respiratoria crónica; Editorial Universidad Catolica de Mursia, 2018.

Not only we know that the pattern of the diaphragm is the responsible for air flow increase. We also know that patients have an increase of inflammation reaction and edema on small airway, mainly given by irritation. Similar to eye irritation when is in contact with smoke, that irritates and cries. This will produce increase in resistance and greater air traffic. COPD patients also have a decrease in mucociliary scaler movements, which leads to greater number of mucocellular plugs at bronchioles [4].

The mucocillary climber has a normal oscillatory cile movement called metacronal. In COPD the sun layer dehydrates and produce a decrease in ciliar movement [5]. This produces that normal physiological mechanisms fails and therefore diminishes the ability to eliminate secretions. Specialty COPD patients which produce more secretions because of cellular irritation and poor mucociliary scaler movement. This is why it is so important to maintain adecuate humidification when using NIV.

Exacerbation of COPD

In the last guide published by the European Respiratory Society with the American Thoracic Society in 2017, exacerbations are clinically defined as episodes of increased respiratory symptoms, particularly dyspnea, cough and sputum production, with increased purulence. COPD exacerbations (EA) have a negative impact in quality of life, accelerating disease progression, which may lead to frequent hospitalizations and death [6]. Definition has been kept similar, but was recently added the increase of purulence on secretions.

NIV therapy decreases intubation rate, mortality, eliminates the complications associated with therapy and decreases ICU and hospital length of stay in Patients with acute exacerbation of chronic respiratory insufficiency. Due to this reasons, NIV significantly diminishes economic expenses in care units and public health.

Osadnik, 2017 in a Cocrane systematic review identified 17 studies. This highlights that only few studies specified if the re-

spiratory failure was hypoxemic or hypercapnic. In the studies it has been made a comparison between usual treatment versus NIV treatment. The results of the patients who received only NIV showed:

1. NIV decreases mortality risk in 46% (RR 0,54, ci 95% 038 - 076).
2. As regards the likelihood of intubation, NIV decreases 65% (RR 036, 95% CI 028 - 046).
3. Hospital stay also decrease in patients with NIV (MD -3.39days, 95% CI-5.93 - 0.85).
4. Complication unrelated to NIV (RR0 26,95%CI 013 - 053).

Therefore, the european society and the american society recommendations related NIV use in hospitalized patients with acute respiratory failure due to COPD is strong, A type evidence.

The etiology of COPD exacerbations, are the small airway increase inflammation, present in approximately 8% of viral or bacterial infections. A lower percentage is because environmental pollution or treatment breach.

It is important to mention that another symptom that has not beenformaly described in literatur is anguish wich makes more difficult to manage clinical symptoms. Patients with COPD exacerbation may be aggravated, even more, if you added co-morbidity as: pneumonia, bronchial cancer with atelectasias, cardiac insufficiency, pulmonary embolism or pneumothorax [7].

Airway damage is caused by the factors mentioned above, which may be aggravated by smoking habit. Cigarette smoke will damage the mucocilar scale and can enhance bacterial colonization, increasing mucus production, inflamation given by enzymes and cytokines that increases the elastic activity in the lung by producing an alteration in the balance of elastasa and anti elastasa [8] and perpetuating a vicious cicle.

Therefore, who experience frequent exacerbations of COPD have increased mortality, reduced exercise capacity, and muscle atrophy [9].

The clinical management of COPD exacerbations is broncodilators use.

It is known that broncodilators success depends on the application technique, because it is possible to lose up to 9% of the medicinal product. That is why we have to optimize the application and there are different devices: measured dose inhaler, dry powder, jet nebulizer and last the most efficient device is the mesh inhaler. The new GOLD 2017 establishes the treatment of broncoodilatation as the main pharmacological treatment and the evidence of support is based on diverse combinations of double broncoodilatation therapy. We must also apply corticosteroidal and antibiotic therapy for management.

Oxygenotherapy is also fundamental, because it doubles life expectancy of COPD patients, delaying its natural evolution up to two years, reduces disnea and miocardious work, which makes it an excellent complement for rehabilitation. NIV use also improves bronchial hygiene which is of great importance for respiratory therapy. A good respiratory therapy helps patients on the reduction of secretions and reliefs respiratory work.

Physiotherapy goal should be, to prevent and to treat complications of prolonged hospital length of stay and of COPD exacerbations. This is given due to reduce movement asociated to dysnoea fatigue and reduced functional capacity.

Here we have to intervene with specific respiratory objectives to maintain the permeable airway through bronchial drainage, cough assistance, huffins and suction when cough is weak. Improving the strength of respiratory muscules with exercises and devices such as treshold IMT valve™. Improving ventilatory mechanic with seated position or at least forty-five degrees to reduce bronco aspiration risk and pneumonia [10]. Respiratory exercises are fundamental to prevent physical design. Today in numerous publications early mobilization is described supported by electro stimulation passive movement, to prevent deep venous thrombosis with antiembolic tightts. The importance of passive mobilization from the first hours of hospitalization to avoid muscular breakdown, which are going to impair the rehabilitation.

Some of the treatment techniques suggested in the GOLD guide 2017 are the following:

1. Pulmonary rehabilitation improves disnea excersise tolerance in stable patients.
2. Oxygen therapy has a good level of evidence A, since its administration in the long term, increases survival in patients with severe chronic hypoxemy.
3. Patients with stable COPD and moderate functional capacity or exercise-induced arterial desaturation, long term oxygen prescription by itself does not decrease death rate, hospitalization or provide sustained benefits in health status, lung function and six minute walk distance. Moderate evidence level.
4. Traveling by airplane can increase hypoxemia level supported by low evidence (C)
5. Withing the ventilatory support, specifically the NIV, the GOLD review proposes that improves survival as domiciliary treatment in selected patients that come from recent hospitalization, particularly in patients with persistent hypercapnia with a paCO_2 of 52 mmHg. This affirmation has an evidence level B.

The next point to treat is NIV treatment with an A evidence level. That is why NIV is recommended as a first ventilation mode to be used in patients with COPD with acute respiratory failure. NIV does not have contraindications and helps improving gas exchange and

work of breath. NIV will also decrease hospitalization days and improve survival [2].

NIV indications according to the GOLD [2], our patients must present at least one of the following symptoms:

1. Respiratory acidosis. PCO_2 should be greater than 45mmHg or 6 kPa. Ph should be lower than 7,35.
2. Disnea with clinical signs like respiratory musculature fatigue, with an increase of respiratory work. This can be observed when there is use of accessory musculature, paradox breathing or intercostal retraction. Therefore, it is highly important to observe our patients during the clinical exam.
3. Persistence of hypoxemia or desaturation despite using oxygen therapy.

Nevertheless, NIV is not the final solution in COPD treatment, that is why it is very important to reevaluated the patient after 1 - 2 hours, and if the patient does not improve, intubation and mechanical ventilation should be the next step [11].

Invasive mechanical ventilation indications are [12]:

1. Not tolerated or failed NIV after 1 - 2 hours.
2. Respiratory or cardiac arrest.
3. Decreased consciousness, psychomotor agitation or when sedation is not able to manage patients effort and dysnea.
4. Patients that present aspiration or vomiting, and airways protection is needed.
5. To help eliminate an abundant amount of secretions. This is controversial because it will depends on good respiratory therapy that can manage this.
6. Hemodynamic instability, management of water balance and vasoactive drugs.
7. Patients with serious ventricular or supra ventricular arritmia.
8. Treatment of serious hypoxemia in patients with $PaO_2/FiO_2 < 146$ in which NIV should not be used.

Our group on 2015, in a review [13] describe that in COPD, NIV must be the first line treatment, giving a chance to avoid intubation, NIV have evidence 1A on hypercapnic failure, immunodepressed patients and pulmonary edema. Almost NIV have good evidence in IMV weaning of patients with COPD diagnosis.

NIV can also be used in other diagnosis such as pneumonia, distress and during bronchoscopy procedure. In a prospective study our group developed in 2018 [14] in 28 patients, in need of diagnostic and/or therapeutic bronchoscopy in patients with some type of respiratory pathology. Of the 28 patients, 7 had COPD diagnosis and we founded that none of this COPD patients had IMV needs 24 hours after the procedure, there were no deaths and the average duration of the procedure was 7 minutes. With this results we could consider NIV as an alternative to avoid orotraqueal intubation in COPD patients that requires a bronchoscopy procedure, that may increase morbimortality in this group of patient.

How the NIV helps COPD patients

In a normal patient, the diaphragm contraction produces negative intrathoracic pressure, this generates an air flow from the outside to the alveoli. We know that inspiration is the result of muscles activity, but this does not happen in expiration. Expiration is a passive process that is given by elastic retraction of the thoracopulmonary system, generating the release of inspired air. The expiratory flow is enable until the airway pressure equals to atmosphere pressure. Where this occurs is called equal pressure point (EPP) that in a normal person is located in the pharynx, given to this a sufficient distance from the carina (Figure 3).

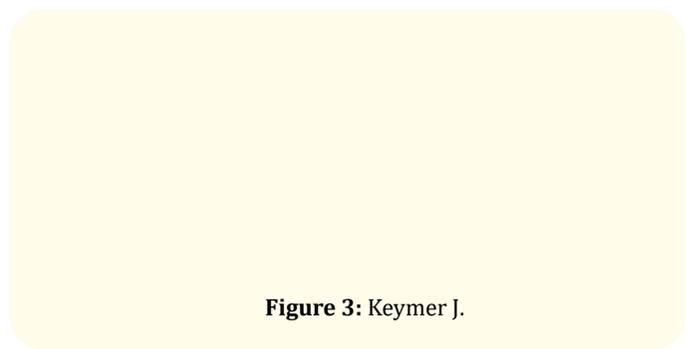


Figure 3: Keymer J.

COPD patients lack alpha 1 antitrypsin enzyme in the peripheral airway walls, losing its elastic properties which makes it collapse. This is why COPD patients have air trapping and CO₂ retention. While expiration is a passive process, having their peripheral airway damaged, collapse puts resistance to airway flow avoiding its entire release, and the equal pressure point is reached early in the collapsible airway, closer to the carina (Figure 4).

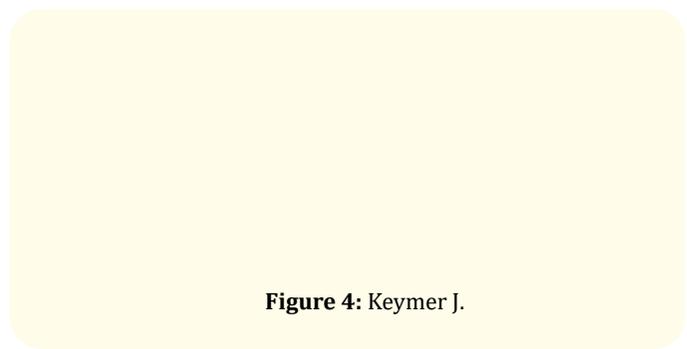


Figure 4: Keymer J.

In a COPD patient who has NIV, positive pressure stabilizes the central and peripheral airway collapse [15]. Air flows from outside to alveoli during inspiration by diaphragmatic contraction, and during expiration, that is passive, we do not have our peripheral and central support, and positive pressure decreases the airway resistance and allows lungs to fully deflate. The equal pressure point is restored near the pharynx, decreasing air intake and CO₂ retention (Figure 5).

Respiratory management of the patient with acute respiratory failure

NIV indications in COPD exacerbations are:

1. Moderate to severe dyspnea.

2. Tachypnea (24 bpm in hypercapnia failure and 30 bpm in hypoxemic failure).
3. Increase work of breathing with accessory muscles use.
4. PaCO₂ > 45 mmHg in hypercapnia, and 50 mmHg in hypoxemic patients.
5. pH < 7.35.
6. PaO₂/FiO₂ < 200.

NIV must be a bedside decision and need an exhaustive evaluation, where patient NIV tolerance, reduce work of breath and therapy efficacy should be considered.

Arterial gases examination should also be done. If patient does not improve their arterial gases in 1 - 2 hours and keeps its clinical signs, it should be intubated. If patient improves its arterial gases within the hour and decreases its clinical signs, we should continue with NIV therapy, always observing patients failure signs.

NIV weaning must be done when patients are clinically stable, tolerate NIV pressure decrease and tolerate hours without NIV during the day.

In another work that we published in the chilena journal of intensive medicine in 2010 [16], we try to prove that the NIV was able to avoid intubation in patients that entered in our ICU, where 14% of patients had COPD diagnosis. In this study 75% of the patients were rescued with NIV and only 25% failed and must be connect to invasive mechanical ventilation. Patients with acute respiratory failure that fail in the NIV present a significantly lower PaO₂/FiO₂ previous and during NIV therapy. Therefore, the initial PaO₂/FiO₂ and its not improve in the first 2 hours of NIV would be good predictors of need of intubation.

Humidification and aerosoltherapy in NIV

Cerpa, *et al.* 2015, in an active humidification in NIV patients review [17], describe that clinic gases are dry, patients respiratory frequency should be normal or high, and NIV used is prolonged makes the arway dry. The NIV high unidirectional flow dries the upper airway and make that heat and moisture were lost. The lower diameter of the nasal airways induces an increase respistance in NIV inspiratory flow. This may affect the tolerance of NIV. All these affects ciliar activity, mocous secretion, decrease local blood flow and nasal air resistance, that finally may produce epithelium queratinization and mucocillary scaler effectiveness.

Therefore, the use of active overweight humidification in NIV is recommended, where fisher and paykel MR 810TM that is not servo-controlled is the most frecuently used.

It is recommended to install active humidification in patients with continouse need of NIV, for more than 24 hours, airway bleeding, hypothermia and patients that have amount or thick secretions.

Aerosol therapy must be delivery in NIV patients, but is not an easy task. There is necessary to minimize aerosol losses through the mask, circuit and upper airway levels [18]. To optimize the drug delivery to the lungs, there are some devices that make this more eficent. Measured dose inhaler (MDI) with aerochamber, jet or mesh nebulizer, must go between the mask and the circuit exalatory port. The nebulization is very important and must go in combination with the NIV, the mask must not be removed when you need to nebulize a patient. Mesh nebulizer is the better option in NIV patients because it does not need additional air flow and deliver more homogeneous and lower drug size particles [19].

Conclusion

The physiotherapy is fundamental in the management of COPD patient, not only for respiratory and general exercises (not mentioned in this article). The physiotherapy has a fundamental rol in the management of NIV, since its instalation, setting, monitorization and weanning. Along with this, have to control the correct patient positioning, aerosoltherapy, humidification and assistance in procedures like boncoscopy.

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