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REVIEW ARTICLE

Benefits and Complications of Noninvasive Mechanical Ventilation for Acute Exacerbation of Chronic Obstructive Pulmonary Disease*

Benefícios e Complicações da Ventilação Mecânica Não-Invasiva na Exacerbação Aguda da Doença Pulmonar Obstrutiva Crônica

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SUMMARY

BACKGROUND AND OBJECTIVES: Chronic obstructive pulmonary disease (COPD) is defined as a syndrome characterized by usually progressive chronic airflow limitation which is associated to a bronchial hyperresponsiveness and is partially reversible. Noninvasive mechanical ventilation is an alternative treatment for patients with COPD exacerbations. The objective of the literature reviews was to verify noninvasive mechanical ventilation benefits and complications in acute exacerbations of chronic obstructive pulmonary disease in patients.

CONTENTS: This national and international's scientific literature review was developed according to criteria established for documentary research in the MedLine, LILACS, SciElo, PubMed and Cochrane, databases using the key words: chronic obstructive pulmonary disease and noninvasive mechanical ventilation. Inclusion criteria were articles published from 1995 to 2007; in English, Spanish and Portuguese; studies in the human model and with no gender restriction.

CONCLUSIONS: Noninvasive mechanical ventilation can reduce partial pressure of carbon dioxide, improve gas exchange, alleviate symptoms as dyspnea caused by fatigue of the respiratory muscles, reduce duration of hospitalization, decrease need for invasive mechanical ventilation, reduce number of complications and also lessen hospital mortality. The main complications found were: facial skin erythema, claustrophobia, nasal congestion, face pain, eye irritation, aspiration pneumonia, hypotension, pneumothorax, aerophagia, hypercapnia, gastric insufflation, vomit, bronchoaspiration, morning headaches, face injuries, air embolism and, last but not least, discomfort of the patient. Noninvasive mechanical ventilation can be more effective in patients with moderate-severe exacerbations of COPD and these complications can be minimized by an adequate interface also by the contribution of the physiotherapist experience.

Key Words: Chronic obstructive pulmonary disease, Noninvasive mechanical ventilation.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A doença pulmonar obstrutiva crônica (DPOC) é definida como uma síndrome caracterizada por obstrução crônica ao fluxo aéreo, geralmente progressiva, podendo ser acompanhada por hiper-responsividade brônquica e ser parcialmente reversível. A ventilação mecâ-

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nica não-invasiva é uma alternativa de tratamento para pacientes com exacerbação da DPOC. O objetivo deste estudo foi verificar os benefícios e as complicações da ventilação mecânica não-invasiva em pacientes com exacerbação aguda da doença pulmonar obstrutiva crônica.

CONTEÚDO: Realizou-se revisão de literatura científica nacional e internacional conforme os critérios estabelecidos para a pesquisa documental nas bases de dados MedLine, LILACS, SciElo, PubMed, Cochrane, com os unitermos: doença pulmonar obstrutiva crônica, ventilação mecânica não-invasiva. Os critérios de inclusão foram artigos publicados no período de 1995-2007; nas linguagens inglesa, espanhola e portuguesa; estudos em modelo humano e sem restrição de sexo.

CONCLUSÕES: A ventilação mecânica não-invasiva pode diminuir a pressão parcial de dióxido de carbono, melhorar a troca gasosa, aliviar sintomas como dispnéia ocasionada pela fadiga da musculatura respiratória, reduzir as internações hospitalares, a necessidade de intubação, o número de complicações, o tempo de internação e a mortalidade hospitalar. As principais complicações encontradas foram: eritema facial, claustrofobia, congestão nasal, dor facial, irritação nos olhos, pneumonia aspirativa, hipotensão, pneumotórax, aerofagia, hipercapnia, distensão abdominal, vômitos, broncoaspiração, dor de cabeça matinal, lesões compressivas de face, embolia gasosa e não adaptação do paciente. A ventilação mecânica não-invasiva pode ser mais efetiva em pacientes com moderada a grave exacerbação da DPOC e as complicações podem ser diminuídas pela utilização de adequada interface e experiência do fisioterapeuta.

Unitermos: Doença pulmonar obstrutiva crônica, Ventilação mecânica não-invasiva.

INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is defined as a syndrome characterized by chronic obstruction to airways flow resulting from chronic bronchitis or emphysema. Obstruction of the airways flow usually is progressive and may be accompanied by bronchic hyperresponsiveness and be partially reversible[1-3].

In Brazil, there has been an increase in the number of deaths in both genders by COPD in the last 20 years. In the decade of the eighties, mortality rate was 7.88/100,000 inhabitants increasing to 19.04/100,000 in the nineties, with a growth of 340% although, in the last years COPD has been ranked between fourth and seventh among the main causes of death in Brazil[4].

Patients with COPD are most often smokers with a history of at least one pack per day for at least twenty years and it is rarely found in non-smokers. Onset is typically in the fifth decade and often attention is called to a productive cough or acute respiratory disease. Although there may be wheezing, it is not an indicator of severity of the disease. Disorders of gas exchange and dyspnea become progressive and, erythrocytes and cyanosis may occur with hypoxemia. Development of morning headaches may signal onset of significant retention of carbon dioxide (CO_2). In the advanced disease, blood anomalies are severe, cor *pulmonale* may manifest through peripheral edema and water retention. Anxiety, depression and sleep disorders are frequent[1,5,6]. Main symptoms are effort dyspnea, wheezing and, usually productive cough[7].

Clinical diagnosis of CPOD should be considered in patients with dyspnea, chronic cough or pulmonary hypersecretion, and/or a history of exposure to risk factors for the disease, and may be confirmed by spirometry. Presence, post-bronchodilator forced expiratory volume in 1 sec (FEV1) / forced vital capacity (FVC) < 0.70 and FEV1 < 80% of the predicted, confirms presence of an airflow obstruction that is not totally reversible[1,2] .

Symptoms found in CPOD are nonspecific findings and may lead to diagnostic confusion. There are various respiratory diseases that serve as differential diagnosis. They are: bronchial asthma, brochiolitis, bronchioectasia, tuberculosis and congestive heart failure[4].

The patient with CPOD has chronic and daily symptoms, even during the stable period. Exacerbation crisis is defined by the presence of three signs or symptoms: increase of dyspnea; greater volume of sputum and purulent sputum. A mild crisis means presence of only one sign or symptom, moderate crisis when there are two of these manifestations and severe crisis when the three manifestations are associated. Other clinical manifestations such as cough, wheezing and fever may be present, but do not define or classify severity of the crisis. More recently, exacerbation crises, were also clas-

sified according to presence of risk factors and of chronic suppuration[8]. Exacerbations represent an enlargement of the inflammatory response in the airways of patients with CPOD and may be identified by bacterial or viral infection or by environmental pollutants. During exacerbation, there is an increased hyperinssuflation and air retention with decrease of the expiratory flow, promoting increase of dyspena. There is also a worsening of the abnormality of the relation ventilation/perfusion (V/Q) bringing about severe hypoxemia[2]. The principal cause is infectious. Mucus is a material rich in carbohydrates and bacteria with polysaccharides receptors may avidly adhere to mucus. This is the case of *Haemophilus influenzae, Streptococcus pneumoniae, Moraxella catarrhalis* and *Pseudomonas aeruginosa*. These bacteria may colonize the patient with CPOD in the stable period. After colonization, the epithelial barrier may be broken as a result of release of bacterial products able to paralyze the cilliary movements and break the intercellular junctions of the epithelium; however infection is superficial and restricted to the bronchial mucosa. Bacterial etiology corresponds to 50% of cases, and in the remainder are viruses, irritant and allergic[7-9].

Among the extrapulmonary factors of this decompensation of non-infectious causes of CPOD, it should be noted that most patients are elderly, smokers and hypoxemic with a greater probability of presenting with coronary failure, heart dysrhythmias and heart failure in addition to other factors such as the use of beta-blockers, opiods and other drugs. About 1/3 of the causes of severe exacerbations are not identified[5,7,8]. González et al.[10] showed that presence of cor *pumonale*, prolonged oxygentherapy, hypercapnia and the increase of the inspiratory work raise the risk of hospital admission due to exacerbation.

Yasuda et al.[11] disclosed that in stable conditions and exacerbations, concentrations of carboxihemoglobin in stage III patients is higher than in stage II patients while concentrations of carboxihemoglobin of stage IV patients is higher than in stage III patients and, in patients with exacerbation of CPOD, the carboxihemoglobin concentrations inversely correlate with FEV_1 and with partial oxygen pressure(PO_2).

However Franciosi et al.[12] reported in a review of literature that arterial carbon dioxide and the respiratory rate of patients with acutely ill CPOD varied according to the severity of exacerbation.

According to Hill et al.[13] patients with protein alfa-1 antitrypsin deficiency present exacerbations with high concentrations and consistency of secretions with a significant number of neutrophils that are probably a result of the high concentration of IL-8 and LTB4. They also reported that elastase activity was present in most of the samples analyzed and that enzyme activity was probably due to severe factors including neutrophil recruitment.

Standard treatment of acute exacerbation of CPOD consists of oxygen therapy, glucocorticoids, nebulization with bronchodilators and antibiotic therapy[1,4,8,14,15].

After comparing NIMV to IMV, studies have shown that the early indication of NIMV reduces need for tracheal intubation, time of ICU stay and occurrence of ventilator associated pneumonia VAP and mortality of patients with respiratory failure due to CPOD exacerbation. These studies further point to lesser need of intubation, lesser time of hospital stay, decrease in the number of complications, decrease of $PaCO_2$, relief of symptoms such as dyspnea due to respiratory muscle fatigue[15-25].

As such, noninvasive mechanical ventilation (NIMV) is a therapeutic alternative for patients with acute CPOD[8].

NIMV should be used for patients able to maintain upper airways permeability, as well as integrity of the swallow and the capacity to mobilize secretions. Severe hemodynamic instability, characterized by use of vasopressor amines and complex dysrhythmias are considered contraindications for use of NIMV. NIMV should not be used in patients with abdominal distension or vomiting because of risk of aspiration. Immediate esophageal surgery postoperative, facial trauma, acute injury and/or bleeding of the airways are also considered limitations for use of NIVM[26].

The main objective of this study was to describe benefits and complications of noninvasive mechanical ventilation in patients with acute exacerbation of chronic obstructive pulmonary disease.

NIMV BENEFITS AND COMPLICATIONS IN ACUTE EXACERBATION OF CPOD

Efficacy of NIMV in the treatment of acute exacerbation of CPOD was investigated by Brochard et

al.[16] in a randomized multicentric study carried out in 85 patients with exacerbated CPOD, comparing standard treatment (oxygen therapy and drugs) with NIMV. During hospital admission procedures, both groups disclosed similar characteristics. Use of NIMV significantly reduced need for tracheal intubation: 11 of the 43 patients (26%) of the NIMV group compared to 31 of 42 patients (74%) of the control group whose statistical significance was p< 0.001. Complications were significantly lower statistically in the NIMV (16% *versus* 48%, p = 0.001), as well as a statistically significant reduction in mean hospital stay for patients of the NIMV group (23 ± 17 days versus 35 ± 33 days, p = 0.005). Hospital mortality rate was significantly lower in patients of the NIMV group (9% of the NIMV group died in comparison of 29% of the control group p = 0.02).

Celikel et al.[15], in a randomized study compared use of NIMV with a control group. This study was carried out in 30 patients divided into 2 groups (NIMV and of standard treatment groups). In the standard treatment group only respiratory rate (RR). Showed a significant improvement However, in the NNIMV group PCO_2, pH and RR improved significantly when compared with the standard treatment group. Six hours after randomization, pH and RR of patients submitted to NIMV were significantly better than in the standard treatment group. Hospital stay was shorter for the NNIMV group (11.7 ± 3.5 days versus 14.6 ± 4.7 days, p < 0.05). Only one of the NIMV group was intubated. Six of the standard treatment group presented with worsening of the clinical condition and received NIMV, which was successful in four patients while the other two were intubated.

Brochard et al.[18] reported that NIMV brings about quicker resolution of the physiological disorder, reduces need for intubation, improves survival and reduces infectious complications. However Matuska et al.[23], reported that there was only reduction of tracheal intubation in the group using NIMV and there was no difference in mortality between NIMV and standard treatment groups. Carratu et al.[24] stated that NIMV reduces the need for intubation in 80% of patients with moderate to severe hypercapnic CPOD respiratory failure.

In patients with exacerbated CPOD use of CPAP with PEEP of 10-12 cmH_2O, reduced respiratory work and dyspnea[27-29].

Studies by Neme et al.[25] corroborated that use of CPAP with 3 cmH_2O combined with ventilatory support pressure improved the respiratory pattern, increased alveolar ventilation and reduced the respiratory work. For Cavalheiro[30] support pressure must be adjusted at levels that determine a tidal volume of 7 mL/kg.

Yosefy et al.[19] proved that use of BiPAP was effective and well tolerated by patients with respiratory disorder reducing tracheal intubation. However, studies carried out by Lien et al.[17] corroborate that early use of BiPAP in severe exacerbations of CPOD decreases activity of the accessory muscles and improves respiratory drive, reduces respiratory rate, improves blood gas and thoracoabdomial asynchrony.

NIMV may have some adverse effects and complications, such as discomfort, facial edema, claustrophobia, nasal congestion, facial pain, eye irritation, aspiration pneumonia, hypotension, and pneumothorax. Problems such as aerophagia, hypecapnia, abdominal distension, vomit, bronchoaspiration, morning headaches, face compression injuries; gas embolism and lack of adjustment of patients are inherent to the method and may restrict use[1,29-35].

Raghavan et al.[35] showed that patients with severe CPOD treated with anticoagulants are at higher potential risk of pulmonary barotraumas and hemorrhage during treatment with NIMV. The authors reported a clinical case of a patient who developed hemopneumothorax as a NIMV complication.

Wood et al.[36] reported that prolonged use of NIMV causes accretion of thick secretions.

Keenan et al.[37] did not find important benefits that justified routine use of NIMV for mild exacerbation of CPOD.

Keenan et al.[21] showed that such benefits were not demonstrated in patients with milder CPOD exacerbations, stressing the concept that NIMV is indicated for patients with more severe exacerbations accompanied by hypercapnia and respiratory acidosis. Hess[38], showed that NIMV is beneficial for reducing need of intubation and mortality in patients with CPOD exacerbation.

In tables 1 and 2 some of the complications and benefits of NIMV in acute exacerbation of CPOD are described.

Table 1 – Summary of Complications of NIMV in Acute Exacerbation of CPOD

Authors	Year	N. of Patients	Types of Study	Complications
Jasmer et al.[33]	1997	-	Review of literature	Facial ulceration and gastric distention
Criner et al.[31]	1999	40	Clinical case	Skin irritation, aerophagia and discomfort with the mask
Wood et al.[36]	2000	1	Case report	Accrual of thick secretions in prolonged use.
Mehta e Hill[28]	2001	-	Review of literature	Discomfort, facial erythema, claustrophobia, nasal ulceration, nasal congestion, pain, dry mouth, eye irritation, gastric insufflation, brochoaspiration, hypotension, pneumothorax.
Hill[32]	2004	-	Review of literature	Nasal congestion, dry mouth, gastric insufflation irritation to the conjunctive, sleep disorders, dyspnea, fatigue, morning headaches
Raghavan et al.[35]	2004	1	Case report	Pneumothorax, increase of respiratory work, gastric distention, embolysm, barotrauma.

Table 2 – Summary of the Benefits Obtained by NIMV in Acute Exacerbation of CPOD

Authors	Year	N. of Patients	Type of Study	Complications
Brochard et al.[16]	1995	85	Randomized clinical trial	Reduction of tracheal intubation, decrease of complications, decrease of hospital stay
Lien et al.[17]	1996	10	Clinical trial	Decrease of accessory muscle activity and better respiratory drive, reduction of respiratory rate, improvement of blood gas and of thoraco-abdominal asynchrony
Celikel et al.[15]	1998	30	Randomized clinical trial	Improvement of PO_2, of PCO_2, of pH and RR, decreased hospital stay, decrease of tracheal intubation.
Brochard et al.[18]	2002	-	Literature review	Faster resolution of physiological disorder, lesser need for intubation, increases survival and reduces infectious complications.
Yosefy et al.[19]	2003	30	Clinical trial	Decreases need for tracheal intubation..
Lightowler et al.[20]	2003	-	Systematic review	Decreases need for tracheal intubation, and reduces hospital mortality.
Keenan et al.[21]	2003	-	Systematic review	Decreases need for tracheal intubation and reduces mortality and hospital stay.
Ram et al.[22]	2004	-	Systematic review	Decreases need for tracheal intubation and reduces hospital mortality.
Carratu et al.[23]	2005	122	Clinical trial	Decreases need for tracheal intubation by 80%
Matuska et al.[24]	2006	30	Randomized clinical trial	Reduces tracheal intubation, no difference related to mortality.
Neme et al.[25]	2007	18	Clinical trial	Improves respiratory pattern, increases alveolar ventilation and reduces respiratory work.

CONCLUSION

Studies analyzed after this review disclosed that NIMV seems to be more effective in moderate to severe exacerbation of CPOD. Main benefits were better pulmonary gas exchange, reduction of dyspnea, less respiratory muscular work, less intubation and invasive ventilatory support and decrease of mortality. The main complications found were facial erythema, claustrophobia, nasal congestion, facial pain, eye irritation, aspiration pneumonia, hypotension, pneumothorax, aerophagia, hipercapnia, abdominal distension, vomit, bronchoaspiration, morning headaches, face compression injuries, gas embolism and lack of adaptation of patients. However these complications may be reduced with the use of adequate interface and with the experience of the physiotherapist.

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