Chapter 116

Physiotherapeutic Approach In The Treatment Of Lung Injuries Caused By Electronic Cigarettes: An Integrative Review

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ABSTRACT
Electronic cigarettes emerged as an alternative to replace conventional cigarettes, however, their consumption has grown among youth and non-smoking adults, and little is known about their real harms to the body as a whole, but especially to the respiratory system. The objective of this research was to highlight the contributions of respiratory physiotherapy in the treatment of Lung Injury Associated with Electronic Cigarette Use (EVALI). This study is characterized as an integrative review of literature of a basic nature of the descriptive and qualitative type. Thus, it aimed to show how the physiotherapist can intervene in EVALI. In this context, it is understood that their interventions are related to the clinical manifestations present in individuals, because their recurrent consumption causes damage to the lung, allowing the generation of pathophysiological processes caused by inflammation and aggression of the epithelium.

Keywords: Electronic cigarette, Lung injury, Respiratory Physiotherapy, Evali, Respiratory System.

1 INTRODUCTION

Electronic cigarettes (EC) emerged as an alternative to replace conventional cigarettes, currently these devices have been widely used by the adult-young nonsmoking population, however with the due price of developing a respiratory syndrome, entitled Lung Injury Associated with Electronic Cigarette Use (EVALI). From the perspective of Vargas et al. (2021), little is known about its real harms to the organism as a whole, but especially to the respiratory system.

Thus, several cases of EVALI have been reported by health authorities concerned with the establishment of a public health problem for users, who are susceptible to this syndrome. The syndrome can be considered as emerging in recent years. According to Chiesa (2021), it is an acute or subacute respiratory disease that may progress to death.

According to Goniewicz et al. (2014), although electronic cigarettes "seem harmless, they are harmful to the health of their consumers, because the vapors generated by the device have toxic and harmful products, such as heavy metals, volatile compounds and carcinogens. Also according to the author, there is a destructive potential in the chemical components present in ECs to human biology, especially to the lungs, which may result in pulmonary fibrosis and pneumonia, and evolve to respiratory failure, resulting in the patient needing admission to an Intensive Care Unit (ICU).

Thus, from this perspective, the purpose of this review was to identify and analyze the approaches of respiratory physiotherapy in the rehabilitation and treatment of EVALI . The delineation of the objectives is justified by contributing to the advancement of respiratory physiotherapy, showing itself as a fertile field for new scientific discoveries.

The methodological approach consists of an integrative literature review, of exploratory, retrospective, descriptive and argumentative character, based on qualitative methods of selection. The research was developed with the authors' resources and has an international character as it included scientific articles in Portuguese and English, focusing mainly on the contributions of respiratory physiotherapy in the rehabilitation of patients affected by EVALI.

The execution of this work was based on scientific articles, technical documents, laws and decrees of the federal and state spheres, published in the last 8 years, from 2014 to 2022, selected from the Scielo, PubMed, Google Scholar, and Lilacs databases. The selection of studies was made by reading the titles for qualitative analysis. The descriptors available in the DeCS/MeSH database of the Virtual Health Library (VHL) were used to search for articles. The descriptors highlighted are: EVALI, Respiratory Physiotherapy, Respiratory Mechanics, Lung Injury, Electronic Cigarettes.

The inclusion criteria were all articles related to the proposed theme without restriction on the type of study. In the search process 35 findings were found, however, according to the selection process, based on the inclusion criteria, 18 studies were selected and used to guide the synthesis of discussion on the theme

2 DEVELOPMENT

The first EC was produced and patented by Herbert A. Gilbert in 1963, however, it was never marketed due to the lack of available technology at the time. However, the Chinese Hon Lik, founder and CEO of *Dragonite International* Ltd, produced and marketed, in 2003, the first model for today's electronic cigarettes (INCA, 2016).

ECs are also known as electronic smoking devices (ESD), e-cigarettes, and vaporizers (VAPE). According to Martin et al. (2022) the EC system assumes heating of the substances which leads to the

change of state from liquid to vapor. Thus, these substances are released in vapor form, resembling conventional cigarette smoke, delivering to the user and third parties, nicotine and derivatives in aerosol form.

In the structure of the EC there is "a lithium battery, a sensor, a microprocessor, refill or cartridge, a liquid solution (also called e-liquids), an atomizer responsible for heating and vaporizing this liquid solution, and a mouthpiece for inhalation" (MARTIN et al., 2022).

Castro et al. (2022) explains that vaporization in the EC is an exothermic chemical reaction, and as such presents solvent, which is water in a mixture with flavorings and additives, and the solute in the form of oil, especially nicotine and derivatives, plus propylene glycol and glycerin. The products of this reaction are in the form of volatile organic compounds such as formaldehyde, acrolein, acetaldehyde, acetone, heavy metals and nitrosamines derived from tobacco. There are more than 7,000 flavors and other chemical constituents that have been identified in the composition of EC. These substances are considered extremely harmful to human and environmental health, and can cause various poisoning, allergies, and upper airway irritation (INCA, 2016; VARGAS et al., 2021; MARTIN et al., 2022).

In Brazil, under the responsibility of ANVISA, there is a ban on the marketing, importation, and advertising of ECs, according to Resolution No. 46, of August 28, 2009. Even so, the sale of the product is carried out illegally and clandestinely, both on the internet and in the streets, parties and commercial environments (ANVISA, 2016).

The first reports in the scientific literature of still isolated cases of EVALI began in 2012. And only in 2019 did the first previously healthy patients with EVALI begin to appear. Thus, the Illinois Department of Public Health (IDPH) and the Wisconsin Department of Health Services (WDHS) began an investigation into the syndrome (CASTRO et al., 2022).

According to Chiesa (2021), EVALI was described in 2019 by the United States Centers for Disease Control and Prevention (CDC), which defined it as an acute or subacute respiratory illness. As for pathogenesis, there is little consensus. However, the pathological findings are: acute fibrinous pneumonitis, diffuse alveolar damage or organizing pneumonia, usually bronchiolocentric and accompanied by bronchiolitis (VARGAS et al., 2021).

Due to the relevance of the topic, the CDC has published diagnostic guidelines for EVALI that consider, primarily, the use of electronic cigarettes within 90 days before the onset of symptoms, accompanied by changes in the physical examination of the patient such as: tachycardia, hypoxia, and tachypnea. Most frequently cited pulmonary changes are the appearance of fibrin in the interalveolar space, diffuse alveolar damage, alveolar hemorrhage, lipoid pneumonia, and acute eosinophilic pneumonia. Imaging tests show a predominance of pulmonary infiltrates (ground-glass opacities) in both lungs. In laboratory tests there is a predominance of hemograms with leukocytosis for C-reactive protein (in PCR) and in liver enzymes there are values above those considered normal (ROCHA et al., 2021).

The use of EC alters the entire normal respiratory mechanics of the human body, damaging not only the lungs, but the entire respiratory system. From the perspective of D'Almeida et al. (2020), the patient with lung injury caused by EVALI will present respiratory failure, function disturbance caused by toxic agents, besides weakness

of the ventilatory muscles, hemodynamic instability and respiratory complications, favoring increased risk of reduced lung compliance. However, this can be explained by the lack of oxygenation that modifies ventilation and perfusion, and affecting lung volumes and capacities, leading to the development of alterations in oxygenation and consequently resulting in the complication of other pulmonary pathologies.

According to D'Almeida et al. (2020), the patients manifested tachypnea, hypoxemia and other various acute or subacute respiratory symptoms, encompassing the clinical picture of fatigue, chest pain, fever, cough, expectoration, dyspnea. Thus, there are difficulties in gas exchange with alterations in all the patient's normal respiratory mechanics, associated with gastrointestinal symptoms such as nausea, vomiting, and abdominal pain, in addition to impairment in quality of life.

According to Martin et al (2022) glycerol and propylene glycerol inhalation can lead to impaired lipid homeostasis and immune defense, since they can alter gene expression, resulting in high levels of matrix metalloproteinase-9, which can cause tissue injury and inflammation. Vitamin E acetate, which can also be at high levels, can be detrimental to pulmonary surfactant function, causing respiratory disorders due to an inability to break down large molecules, and can accumulate in the vacuoles of alveolar macrophages, leading to an inflammatory response and consequent acute lung injury.

According to Martin et al (2022) nicotine aerosols:

> "... has the potential to adversely affect lung defense mechanisms (e.g. impairment of mucociliary function and dysregulation of Th1 immune responses to lipopolysaccharide) and may be associated with bronchial hyperreactivity and development of chronic obstructive pulmonary disease (COPD)."

It is noteworthy that smokers considered passive smokers, i.e., those who inhale the smoke coming from smokers, also suffer from inhalation of EC vapors. The review study by Hess et al. (2016), points out that of the 16 articles surveyed, most report that passive smokers report having their health affected after exposure to EC fumes (MARTIN et al., 2022). Thus, it was observed the importance of knowing the pathological mechanism of EVALI, in addition to the structures and substances that make up the electronic cigarette, demonstrating that they are extremely harmful and harmful to human health.

In principle, Pneumofunctional Physiotherapy is one of the areas of performance that employs specific skills for the respiratory system, playing a key role in the treatment of diseases caused by EC, in order to preserve or restore the integrity of the respiratory system. Therefore, the professional specialist in this area has as one of its objectives to evaluate respiratory mechanics for the ascertainment of lung function in the generation of adequate volumes and capacities (SARMENTO, 2016). Consequently, respiratory physiotherapy acts as an integral part in the management of the treatment associated with EVALI, having

fundamental importance in the application of conducts and techniques that adapt to the patient's needs (VIEGAS, 2019).

Pereira and Veneziano (2021, p. 254) highlight the decree GM/MS nº 3.432 of 12 August 1998, which establishes that for every 10 beds, a physical therapist must be assigned to the care required by the Ministry of Health. This is due to the role of the physiotherapist to reduce complications and the hospitalization period through his/her intervention.

According to the study by Rivoredo and Meija (2016, p. 08) based on ASSOBRAFIR (Brazilian Association of Cardiorespiratory Physiotherapy and Physiotherapy in Intensive Care), the physiotherapist in the ICU acts broadly in the administration of the performance of the respiratory system and all respective activities associated with the improvement of ventilatory function, performing the optimization of ventilatory support by monitoring pulmonary gases and the devices that offer oxygen to supply the patient's deficiency, in addition to preventing and treating cardiopulmonary and muscular diseases, restricting possible worsening.

To reduce the damage caused by EVALI, Non Invasive Ventilation (NIV) stands out, which translates into providing ventilatory support with positive pressure to the lungs, without the need for an invasive endotracheal airway. Pereira and Veneziano (2021) emphasize that this technique efficiently improves acute respiratory failure (ARF), present in patients with EVALI, avoiding complications associated with endotracheal intubation (IS), such as conventional invasive mechanical ventilation (IMV) and ventilator-associated acquired pneumonia.

Costa et al. (2021) reports that NIV has been a strongly used resource in patients with lung injury who develop persistent failure in weaning from IMV, during the spontaneous breathing test, performed in three consecutive attempts. At the same time, it acts as an adjuvant in early release from IMV, reducing the length of stay in this condition, as well as the incidences of complications (septic shock or ventilator-associated pneumonia). Early extubation and immediate application of NIV to patients who meet the weaning criteria may be useful approaches to increase weaning success rates and may reduce patient mortality.

Masip et al. (2014) demonstrate that patients undergoing NIV showed improvement in gas exchange as well as other symptoms with the use of noninvasive pressure support ventilation (NIPSV) when compared to conventional oxygen therapy (COT), especially in patients with moderate or severe decompensation (pH 7.35 and hypercapnia). Therefore, it must be started early in order not to evolve into severe acidosis. However, although the pH is a determining factor in deciding on the institution of NIPSV, other clinical factors such as tachypnea, use of respiratory muscles, and severity of dyspnea should also be considered.

In order to achieve NIV success, it is necessary to monitor respiratory rate, oxygen saturation (to adjust FO) as well as pH and PaCO2 (to assess effectiveness). One of the main factors that determine tolerance to NIV is the optimal synchrony during spontaneous respiratory activity performed by the patient;

in addition, the parameters set by the ventilator, explained as "patient-ventilator interaction" (COSTA et al, 2021).

NIV is stopped when recovery is satisfactory or when it shows signs of failure. When successful, the next step depends on the duration and cause of NIV. In the medium to long term, weaning is often initiated, involving a progressive decrease in PEEP and ventilator settings. If the patient worsens with the cessation of NIV, therapy is resumed; otherwise, NIV may be discontinued (COSTA, et al, 2021).

Also performed are breathing exercises for patients with complications from the use of ECs, which are fundamental in the pulmonary rehabilitation phase, with the purpose of working the respiratory muscles and improving gas exchange. The exercises of deep inspiration, fractionated inspiration, diaphragmatic activation exercise and labial frenum are implemented, with the purpose of increasing lung capacity and respiratory activity, directed to exclude the activity of accessory muscles, strengthen the diaphragm and promote improved oxygenation and ventilation of hospitalized patients (PEREIRA, VENEZIANO, 2021).

The professional physiotherapist acts both in the prevention and treatment of respiratory diseases, using techniques aiming to restore lung capacity, in the administration of treatments that aim to improve ventilation, increase oxygenation, mobilize and remove retained secretions (ALMEIDA, 2022). Therefore, the use of ECs is extremely harmful to the human body, especially to the respiratory system and the role of the professional physiotherapist is essential in pulmonary rehabilitation of individuals affected by complications caused by the use of ECs (SANTOS et al., 2019).

3 CONCLUSION

It is understood that EC use is a public health problem in Brazil. It is known that ECs emerged to promote smoking cessation, but the exacerbated use by the adult-young nonsmoking population has increased every year and the evidence on their long-term harmfulness still needs further in-depth studies, including the chemistry and toxicology of these components that cause EVALI, which provides changes in the respiratory system, and the development of physical and functional disabilities for individuals who smoke.

This review aimed to demonstrate how the physiotherapist can act in the rehabilitation and treatment of EVALI from the choice of intervention technique. In this context, it is understood that interventions are related to lung damage, as in the pathophysiological processes of inflammation and aggression of the respiratory epithelium.

It is necessary to know that the role of the physiotherapist in the treatment of EVALI aims to improve respiratory function, promoting adequate levels of oxygenation in blood circulation, preserving lung and motor function. The physiotherapeutic intervention through the use of NIV presents satisfactory results in improving respiratory mechanics of hospitalized patients with EVALI, showing how the physiotherapist can contribute to the rehabilitation of this new syndrome.

The EVALI is considered a recent respiratory syndrome, which was evidenced by the Centers for Disease Control and Prevention (CDC) in 2019, the same agency investigates the EVALI outbreak. Thus, there are still few studies in the literature about this syndrome, making more studies on this topic necessary.

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