Evidence of non-invasive ventilation in Acute Pulmonary Edema: an integrative review

Evidências da ventilação não invasiva no Edema Agudo de Pulmão: uma revisão integrativa

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ABSTRACT
Introduction: Acute pulmonary edema is a multifactorial clinical syndrome in which there is accumulation of fluid in the pulmonary interstitium and alveolar spaces. It is considered a clinical emergency and one of the main causes of hospitalization, represents one of the main causes of hypoxemic acute respiratory failure, and its severity will depend on the amount of fluid accumulated in the lungs. Initially, when the individual has lower accumulations, he/she will present aquidyspnea, shorthand, and bilateral basal stumour in pulmonary auscultation. Objective: To verify in the literature the existence of evidence of the use of non-invasive mechanical ventilation in the reversibility of acute pulmonary edema. Methodology: Through the 6 phases of the integrative review, we were able to organize the research in a way that is understandable and accessible so that the data are used as evidence in clinical practice. In order to answer the question presented for the review, bibliographic research of publications indexed in the following databases was performed: MEDLINE/PubMed, Web of Science and Scopus. Results: A total of 1,584 studies were found in the databases, with only 3 articles being included in the discussion because they better answered the research question. Conclusion: On the available literature, it is suggested that therapy may benefit patients with cardiogenic pulmonary edema, and that a greater number of studies may elucidate the best treatment of individuals affected by the disease using non-invasive ventilation as a more assertive resource.

Keywords: Pulmonary Edema, physical therapy, non-invasive ventilation.

RESUMO
Introdução: Edema pulmonar agudo é uma síndrome clínica multifatorial na qual há acúmulo de fluido nos espaços interstício e alveolar pulmonar. É considerada uma emergência clínica e uma das principais causas de internação hospitalar, representa uma das principais causas da insuficiência respiratória aguda hipóxêmica, e sua gravidade dependerá da quantidade de fluido acumulada nos pulmões. Inicialmente, quando o indivíduo tiver menos acúmulo, ele apresentará taquidispneia, taquicardia e rales basais bilaterais na auscultação pulmonar. Objetivo: Verificar na literatura a existência de evidências do uso de ventilação mecânica não invasiva na reversibilidade do edema pulmonar agudo. Metodologia: Através das 6 fases da revisão integrativa, foi possível organizar a pesquisa de forma compreensível e acessível, para que os dados sejam utilizados como evidência na prática clínica. De modo a responder à pergunta apresentada para a revisão, foi realizada uma pesquisa bibliográfica de publicações indexadas nas seguintes bases de dados: MEDLINE/PubMed, Web of Science e Scopus. Resultados: Foram encontrados 1.864 estudos nas bases de dados, tendo apenas 3 artigos sido
incluídos na discussão por terem melhor atendido à pergunta do trabalho. Conclusão: Com base na literatura disponível, sugere-se que a terapia pode beneficiar pacientes com edema pulmonar cardiogênico, e que um maior número de estudos pode elucidar o melhor tratamento para indivíduos acometidos pela doença usando a ventilação não invasiva como recurso mais assertivo.

Palavras-chave: Edema Pulmonar, fisioterapia, ventilação não invasiva.

1 INTRODUCTION

Acute pulmonary edema (APE) is a multifactorial clinical syndrome in which fluid buildup occurs in the pulmonary interstitium and alveolar spaces. It is considered a clinical emergency and one of the main causes of hospitalization (MURRAY, 2011). To perform the clinical diagnosis it is necessary to consider two stages. In the first stage, it is necessary to verify whether there is severe pulmonary congestion and, if confirmed, the best way to stabilize this condition should be found. In the second stage, it is where the etiology of the clinical syndrome is sought, using electrocardiogram, chest X-ray, echocardiogram and arterial blood gas analysis (CASTRO, 2003).

APE represents one of the main causes of hypoxemic acute respiratory failure (ARF), and its severity will depend on the amount of fluid accumulated in the lungs. Initially, when the individual has lower accumulations, he/she will present aquidyspnea, shorthand, and bilateral basal stumour in pulmonary auscultation. When there is greater accumulation of fluid, the patient will manifest signs of anxiety, agitation, pallor, cold sweating, frank dyspnea, paradoxical pattern, cyanosis in extremities and diffuse rales throughout the lung bilaterally. In the most severe form of APE, there is extravasation of foamy fluid through the nose and mouth, which can lead to drastic consequences if the patient does not receive a rapid intervention (MACIEL, 2009; MATSUNO, 2012; SANTANA; CARVALHO, 2005).

The APE of cardiogenic origin can happen as the revelation of a previous disease that until then was asymptomatic, which becomes decompensated and presents hemodynamic changes such as increased plasma volume, intravascular hydrostatic pressure and cardiac output and reduction of colodoismotic pressure of plasma and oncotic pressure. As non-cardiac causes, complications inherent to pregnancy, renal failure, hyperthyroidism, or lymphatic insufficiency may be related. In general, both types have as characteristic the increase in ventilatory effort, hypoxemia, reduction of ventilation/perfusion ratio and reduction of pulmonary complacency (MACIEL, 2009).
The main cause of cardiogenic APE is heart failure. Prevalence studies estimate that 23 million people worldwide have heart failure and that two million new cases are diagnosed annually. The increase in the incidence of heart failure is related to therapeutic advances in the treatment of acute myocardial infarction, hypertension and even heart failure, which causes longer survival and, consequently, increased prevalence and hospitalizations for this syndrome, generating high costs for countries whose elderly population is increasing. Therefore, heart failure is currently recognized as an important public health problem. According to data from the Department of Informatics of the Brazilian National Health System, there are about two million patients with heart failure in Brazil, and 240,000 cases are diagnosed each year. Projections indicate that by 2025 Brazil will have the sixth largest elderly population, approximately 30 million people (15% of the total population). This should result in the multiplication of cases of heart failure and spending on this syndrome (NOGUEIRA; RASSI; CORRÊA, 2010).

The insertion of the physiotherapist in the emergency room and in the conducts related to emergency ventilatory treatment in some Brazilian hospitals is recent and has been bringing resolution with the multidisciplinary team avoiding the worsening of the clinical picture of the patient in the emergency department, having as main objective the rapid and efficient support in cardiorespiratory dysfunctions (MORAIS et al., 2022; OLIVEIRA JUNIOR; AZEREDO; MAIA, 2017).

The physical therapist’s performance in the Emergency Room in Brazil was recently approved by Resolution 509 published in 2019, in which the Federal Council of Physiotherapy and Occupational Therapy recognizes the performance of this professional in this environment, considering that the physiotherapist is a member of health teams in several hospital sectors such as: Intensive Care Units, Emergencies, Emergency Services and other sectors, working in the use of invasive mechanical ventilation, oxygen therapy and non-invasive mechanical ventilation (CONSELHO FEDERAL DE FISIOTERAPIA E TERAPIA OCUPACIONAL, 2019).

In the treatment of patients with APE we have the integrated performance of the multidisciplinary team, where each has their own function. For this patient it is essential to use diuretic and antihypertensive drugs to control intravascular pressure, in addition to oxygen therapy. But some patients will not respond well immediately and when hypoxemia is persistent even with supplemental oxygen the use of non-invasive ventilation (NIV) is indicated. NIV can be defined as one of the treatment devices for respiratory failure in ARF through positive pressure supplementation in the absence of
the artificial airway, which is implemented through masks and its most diverse models. The technique aims to correct hypoxemic or hypercapnic disorders depending on the pathophysiology characteristics of each event (PIRAINO, 2019).

According to the guidelines of the European Respiratory Society / American Thoracic Society, in 2017, the indications and recommendations on the application of NIV in the ARF are: exacerbated chronic obstructive pulmonary disease; thoracic trauma, with precautionary measures in relation to the pressure sent; post-extubation; cardiogenic APE; dyspnea with signs suggestive of respiratory muscle fatigue; respiratory acidosis (partial pressure of arterial carbon dioxide [PaCO₂] above 45 mmHg, hydrogen potential [pH] below 7.35) and persistent hypoxemia with supplemental oxygen) (CONSELHO FEDERAL DE FISIOTERAPIA E TERAPIA OCUPACIONAL, 2019; OLIVEIRA JUNIOR; AZEREDO; MAIA, 2017; PIRAINO, 2019; ROCHWERG et al., 2017).

Contraindications to the use of NIV are: due to the need for emergency intubation; in the presence of cardiac arrest or respiratory failure; in the face of neurological instability with a Glasgow coma scale below eight points, trauma or facial deformity, inability to cooperate, to protect the airways; abundant secretions; severe gastrointestinal bleeding; facial or neurological surgery; high risk of aspiration and upper airway obstruction (SOUZA, 2018).

Among the criteria necessary to achieve success in NIV are: knowledge about the appropriate indication of therapy to the patient; the identification of the time to initiate and interrupt NIV and the full mastery of interfaces, ventilatory modalities, adjustments and monitoring methods. Success is expected in the hypercapnic population with the use of NIV in 75% of cases and hypoxemic in 50% of cases (OLIVEIRA JUNIOR; AZEREDO; MAIA, 2017).

This research is justified by the importance of non-invasive positive pressure ventilation in mechanical ventilation and death if it is not properly treated. Based on what has been presented so far, a question arises in the research: is there evidence in the literature about the use of non-invasive mechanical ventilation in the reversibility of APE?

The general objective of the study is to verify in the literature the existence of evidence of the use of non-invasive mechanical ventilation in the reversibility of APE. The specific objectives of the study are: a) to review the scope on topics addressing the use of NIV in APE; and b) to analyze the criteria for indication of the technique during exacerbation of the disorder.
2 METHODOLOGY

The integrative review includes the analysis of relevant research that supports decision-making and improvement of clinical practice, enabling the synthesis of knowledge of a given subject, in addition to pointing out gaps of knowledge that need to be filled with the realization of new studies (LOPES; FRACOLLI, 2008).

It is affirmed that this type of research has been an important resource that has been widely used in the health area, because it synthesizes existing studies on a given theme and thus directs evidence-based practice that contributes to the scientific scenario and to the deepening of knowledge of the investigated theme (GALVÃO; SAWADA; TREVIZAN, 2004).

According to Botelho, Cunha and Macedo (2011), the integrative review acts within the field of systematic reviews, but with the difference that it may contain the clinical practice of the author being taken into account to add to the research through the author’s opinion.

In order to develop a relevant integrative review that can support the implementation of effective interventions in patient care, it is necessary that the steps to be followed are clearly described (LOPES; FRACOLLI, 2008).

For the preparation of the integrative review, at the first moment the reviewer determines the specific objective, formulates the questions to be answered or hypotheses to be tested, then performs the search to identify and collect the maximum relevant research within the inclusion and exclusion criteria previously established (LOPES; FRACOLLI, 2008).

The reviewer critically evaluates the criteria and methods used in the development of the various studies selected to determine whether they are methodologically valid. This process results in a reduction in the number of studies included in the final phase of the review. The data collected from these studies are systematically analyzed. Finally the data are interpreted, synthesized and conclusions are formulated from the various studies included in the integrative review (LOPES; FRACOLLI, 2008).

2.1 STEPS OF INTEGRATIVE REVIEW

Through the six phases of the integrative review, we were able to organize the research in a way that is understandable and accessible and so that the data are used as evidence in clinical practice. Such phases are organized in the following order and with these objectives:
2.1.1 1st Step: Problem definition

This phase occurred with greater importance, because from it, we were able to delimit the research and decide on the studies to be included, the means of identification and information from the chosen studies. This includes the definition of the participants, the research question, the interventions to be evaluated and the results to be measured. (SOUZA; SILVA; CARVALHO, 2010).

To answer the question presented for the review, we performed the bibliographic search of the publications indexed in the following databases: MEDLINE/PubMed, Web of Science and Scopus. The Medical Subject Headings (MeSH) descriptors that were adopted were: ventilation APE, non-invasive ventilation, emergency. The boolean operators OR and AND were used to help in the search for a greater number of publications.

2.1.2 2nd Step: Establishment of Inclusion and Exclusion Criteria

After having already defined the theme and the research question, the search began; and with this, the definition of inclusion and exclusion criteria began. The research began in a more embracing way, but ended up turning to the initial question and how comprehensible it would be, knowing that it should be linked to the inclusion criteria of the research (BOTELHO; CUNHA; MACEDO, 2011).

The inclusion criteria were: papers published in the last five years, original research, from January/2017 to January/2022, systematic reviews in the literature, both terms in English and both sexes, whose keywords were contained in the titles or abstracts of publications, in studies that related critical and emergency care to the respiratory and cardiovascular systems, of open access and free reading.

<table>
<thead>
<tr>
<th>Table 1. Presentation of the strategy/search question</th>
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</thead>
<tbody>
<tr>
<td>MeSH descriptors – PubMed/MEDLINE</td>
</tr>
<tr>
<td>(((ventilation acute pulmonary edema) OR (noninvasive ventilation) AND (ventilation acute pulmonary edema) AND (noninvasive ventilation) and emergency))</td>
</tr>
<tr>
<td>Scopus Descriptors</td>
</tr>
<tr>
<td>(((emergency and ventilation AND acute AND pulmonary edema AND noninvasive AND ventilation AND phisioteraphy))</td>
</tr>
<tr>
<td>Web of Science Descriptors</td>
</tr>
</tbody>
</table>
The reading and systematization of the articles found was initiated, which consisted of the careful reading of the titles, abstracts and keywords of all publications located by the search strategy, verifying their adequacy to the inclusion criteria of the study. In cases where the title, summary, and keywords were not sufficient to define the selection, the search was extended to the full article. From the conclusion of this step, a table was elaborated with the studies preselected for the integrative review on a basis for the recording of the data ensuring the scope of the contemplated in the following order: title, databases, authors, year, type of research, objective, methodology and results (OLIVEIRA JUNIOR et al., 2021).

2.1.4 4th Step: Categorization of Selected Studies

The fourth step summarized and documented the information obtained from the publications found in the previous steps (OLIVEIRA JUNIOR et al., 2021).

2.1.5 5th Step: Analysis and Interpretation of Results

This step brought the discussion of the results found in the texts presented in the reviews, where the data was interpreted by the finders (OLIVEIRA JUNIOR et al., 2021).

2.1.6 6th Step: Presentation of the Review

This stage consisted in the preparation of the document that contemplated the description of the steps covered by the reviewer and the main results evidenced from the analysis of the included articles. It is a work of extreme importance since it produces impact due to the accumulation of existing knowledge on the theme researched (LOPES; FRACOLLI, 2008).
3 RESULTS

Figure 1. Identification of databases and their results

Total studies found in the databases: 1,864
PubMed: 158
Web of Science: 1,556
Scopus: 150

Search results in the databases consulted

Source: Elaborated by the authors, 2023.

Table 2. Characteristics of the studies included

<table>
<thead>
<tr>
<th>Title and authors</th>
<th>Database, year and search type</th>
<th>Objectives</th>
<th>Methodology</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-invasive positive pressure ventilation (CPAP or bilevel NPPV) for cardiogenic pulmonary oedema. BERBENETZ, N. et al.</td>
<td>PubMed / MEDLINE / 2019 / Systematic review with meta-analysis.</td>
<td>Evaluate the safety and effectiveness of NIV compared to clinical treatment in adults with APE.</td>
<td>Blind and non-blind randomized controlled trials on the use of NIV in adults with APE were included.</td>
<td>The study provides evidence that NIV reduces the need for orotracheal intubation plus invasive mechanical ventilation in selected patients.</td>
</tr>
<tr>
<td>Non-invasive positive pressure ventilation for acute cardiogenic pulmonary edema and chronic obstructive pulmonary disease in prehospital and emergency settings. ABUBACKER, A. P. et al.</td>
<td>PubMed / MEDLINE / 2021 / Systematic review.</td>
<td>To verify the effectiveness of NIV in reducing orotracheal intubation rates, hospital stay and mortality reduction.</td>
<td>We included review studies with randomized and non-randomized trials that addressed the need for NIV in APE and exacerbated chronic obstructive pulmonary disease.</td>
<td>The study shows the efficacy of the use of NIV in reducing orotracheal intubation rates and mortality when therapy is applied early in cases of APE.</td>
</tr>
<tr>
<td>Should noninvasive ventilation be used for treatment of acute cardiogenic pulmonary edema?: a Cochrane Review summary with commentary. HESS, D. R.</td>
<td>Web of Science / 2020 / Review.</td>
<td>Evaluate the efficacy and safety of NIV compared to clinical treatment in adults with acute cardiogenic lung edema.</td>
<td>Review studies were presented to compare the use of NIV in Bi-Level vs CPAP mode in patients with APE.</td>
<td>This review shows that the use of NIV in CPAP mode reduces mortality outcomes and the need for orotracheal intubation.</td>
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</table>

APE: Acute pulmonary edema; CPAP: Continuous positive airway pressure; NIV: Non-invasive ventilation.

Source: Elaborated by the authors, 2023.
4 DISCUSSION

In this section, the use of NIV in EAP will be analyzed, presenting results and outcomes related to the therapy. This study included in its results three review studies from 2019 to 2021, and aimed to identify the available evidence on non-invasive mechanical ventilation in APE. The studies seem to confirm the results obtained in the “Official ERS/ATS clinical practice guidelines: noninvasive ventilation for acute respiratory failure” (ROCHWERG et al., 2017).

In the systematic review with meta-analysis, in the follow-up of Berbenetz et al. (2019) were included 24 randomized clinical trials with a total of 2,664 patients. The primary outcome was to evaluate whether NIV in adults with acute cardiogenic pulmonary edema reduces mortality rates. The secondary outcomes presented were: endotracheal intubation, treatment intolerance length of hospital stay and in the Intensive Care Unit, acute myocardial infarction rates and rates of adverse events and these were
compared to clinical treatment with the use of NIV. The study demonstrated that NIV can reduce hospital mortality as well as endotracheal intubation. NIV probably has little or no influence on the reduction of acute myocardial infarction rates compared to conventional treatment. The same study does not mention whether NIV intervention reduces hospital stay. When considering ventilatory modes, the included studies did not show significant differences between continuous positive airway pressure (CPAP) and Bi-Level compared to clinical treatment (BERBENETZ et al., 2019). Thus, it is reasonable to consider the onset of NIV in individuals with acute cardiogenic pulmonary edema at the beginning of clinical interventions. Limitations in the evidence did not allow the identification of subgroups of patients who obtained more benefit from the onset of NIV.

The study by Abubacker et al. (2021), in which the efficacy of NIV was analyzed, presented a reduction in the need for orotracheal intubation in the hospital emergency as a primary outcome, and in a secondary way there was a decrease in mortality rates and hospital stay. No significant differences were found between the ventilatory modes of CPAP and Bi-Level in related emergency interventions, thus corroborating the objectives of our research.

Hess (2020), in his review, included 24 studies involving 2,664 patients over 18 years of age with respiratory distress due to APE with cardiogenic origin who did not require immediate mechanical ventilation, with the objective of evaluating the efficacy and safety of NIV compared to clinical treatment for adults with acute cardiogenic pulmonary edema. The author concluded that the review provided information for the clinical application of NIV support to APS, improving outcomes such as hospital mortality and the need for endotracheal intubation. NIV is considered a safe intervention presenting rates of adverse events that may be similar to conventional clinical treatment alone. Future researches are needed to determine whether specific subgroups could have greater benefits.

As a result of information presented in this discussion, it is recommended that NIV in CPAP or Bi-Level mode have as a favorable outcome the reduction of orotracheal intubation and mortality in patients with APE of cardiogenic origin, according to (ABUBACKER et al., 2021; BERBENETZ et al., 2019; HESS, 2020), thus reaching the possibilities investigated herein.
5 CONCLUSION

Supported by scientific evidence presented in this study, the implementation of NIV as a technique should be considered for a group of patients who would benefit from the possible disposal of orotracheal intubation and reduction of mortality due to cardiogenic pulmonary edema. More studies may elucidate the best treatment for individuals affected by the disease, using NIV as a more assertive resource.
REFERENCES


MORAIS, J. R. et al. Hospitalization targeting of patients with COVID-19: analysis of


