

Use of non-invasive mechanical ventilation in adults with acute respiratory distress

Uso de la ventilación mecánica no invasiva en adultos con distrés respiratorio agudo

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ABSTRACT

Acute respiratory failure is one of the presentation forms of dissimilar diseases. For treating acute respiratory failure, the patient requires life support measures, by adequately trained personnel, together with a well-equipped service. Non-invasive mechanical ventilation is one of the variants of ventilatory support that helps and improves the patient's condition. Controversies exist regarding the use of noninvasive mechanical ventilation in subjects suffering from acute respiratory distress. This disease has high morbidity and mortality, especially when it does not receive adequate and timely management. Studies on non-invasive mechanical ventilation and acute respiratory distress are not abundant in the international literature. In Cuba there is lack of multicenter studies, which adjust to our health system and our current conditions. Therefore, the present paper was carried out with the aim of analyzing how patients with acute respiratory distress can benefit from this modality of life support.

Keywords: non-invasive ventilation; acute respiratory distress syndrome; behavior; driving.

RESUMEN

La falla respiratoria aguda es una de las formas de presentación de disímiles enfermedades. Para su tratamiento, el paciente requiere medidas de soporte vital, de un personal adecuadamente adiestrado, junto a un servicio bien equipado. La ventilación mecánica no invasiva es una de las variantes de soporte ventilatorio que auxilia y mejora el estado del paciente. Existen controversias en cuanto al uso de la ventilación mecánica no invasiva en personas que sufren de distrés respiratorio agudo. Esta enfermedad presenta una alta morbimortalidad, y más cuando no recibe el manejo adecuado y oportuno. Los estudios realizados sobre ventilación mecánica no invasiva y distrés respiratorio agudo no son tan abundantes en la literatura internacional. En Cuba hay carencia de estudios multicéntricos, que se ajusten a nuestro sistema de salud y a nuestras condiciones actuales. Se realizó, por tanto, el presente trabajo con el objetivo de analizar cómo los pacientes con distrés respiratorio agudo pueden beneficiarse de esta modalidad de soporte vital.

Palabras clave: ventilación no invasiva; síndrome de distrés respiratorio agudo; comportamiento; manejo.

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Introduction

Noninvasive mechanical ventilation (NIMV) is a vital support measure,⁽¹⁾ it represents a variety of ventilatory support that allows to increase alveolar ventilation, keeping intact the airways, not requiring endotracheal intubation or tracheotomy, so avoiding several complications such as invasive mechanical ventilation associated pneumonia and it reduces the necessity of sedation. It represents a more physiological ventilation and less aggressive, allowing to improve respiratory rate, diminishing sensation of dyspnea and increasing patient comfort.⁽²⁾

Noninvasive ventilation is increasingly used over the past two decades in patients with Acute Respiratory Distress Syndrome (ARDS). Whether, during NIV, the usefulness of the categorization of ARDS severity based on the PaO₂/FiO₂ Berlin criteria remains still unknown. The evidence supporting NIV use in patients with ARDS remains relatively sparse.

Potential advantages of NIV in the management of patients with ARDS are mainly related to the avoidance of complications linked to sedation, muscle paralysis, and ventilator-associated complications associated with endotracheal intubation and invasive mechanical ventilation. As such, there is not specific treatment in this entity, being the majority of the support measures mainly based on the pharmacological point of view, but none seems to have been able to show utility. Despite established ventilatory strategies, there are still severe problems related to oxygenation disorders. Initially, the use of NIV in patients with ARDS focused on immunocompromised patients such as those with hematologic malignancies. However, NIV has been used in a broader selection of ARDS patients. This syndrome is usually associated with high morbidity and mortality, which usually ranges between 30 to 60 % with hypoxemia due to inflammatory damage to the alveolocapillary membrane, which imbricates several processes and can lead to multiorgan failure. Of the total number of patients admitted to the Intensive Care Units, up to 10 - 15 % are supposed to have this syndrome. The evidence supporting NIV use in patients with ARDS is based on relatively small samples.^(3,4,5) The main advantages of noninvasive over invasive mechanical ventilatory support are the reduced need for sedation and prevention of ventilator-associated pneumonia. Noninvasive mechanical ventilation can be interrupted easily, and thus has the potential to shorten the time the lungs are subjected to the harmful effects of mechanical support. There is not now sufficient evidence that the use of non-invasive ventilation in ARDS is therapeutically positive. The intent of this paper is analyzing how these patients can benefit from this modality of life support.

Benefits of noninvasive ventilation in Acute Respiratory Distress Syndrome

Non-invasive ventilation (NIV) can be an alternative that improves gas exchange in selected patients and can prevent intubation and use of invasive ventilation with its associated risks, such as upper airway trauma and nosocomial infections. It is defined as the delivery of positive, continuous or intermittent pressure through an interface without the need for an endotracheal tube or tracheostomy cannula. It can be a continuous positive pressure on the airway (CPAP) or a respiratory support bilevel that includes a positive expiratory pressure (EPAP) and a positive inspiratory pressure (IPAP) which is triggered by the spontaneous inspiratory effort of the patient. These pressures are delivered through nasal cannulas, facial masks or helmets. It presents great flexibility in its application and removal and preserves the defense mechanisms of the airway.^(6,7,8)

From the pathophysiological point of view in a respiratory pathology, airway inflammation, occupation and alveolar collapse favor an alteration of the V / Q ratio, Shunt effect, air trapping that will determine a decrease in respiratory system compliance and increase of airway resistance, hypoxemia and increased respiratory work that can lead to fatigue of respiratory muscles, with hypoxemia and even secondary hypercapnia. NIV can improve alveolar recruitment, reduce respiratory work and therefore muscle fatigue, helping to prevent intubation.⁽⁹⁾

While some literature suggests that NIV may best be reserved for patients with mild ARDS (i.e. patients with a PaO₂/FiO₂ ratio of 200 - 300 mmHg), it is not always the case in practice.^(10,11,12,13) While some factors leading to NIV failure in patients with ARDS are better understood, relatively few patients have been studied to date. The impact of NIV on outcome in ARDS is therefore not well understood. In particular, concerns have been raised regarding the impact of prolonged NIV in the absence of respiratory status improvement, potentially delaying tracheal intubation and invasive MV.⁽¹³⁾

Non-invasive mechanical ventilation (NIMV) in patients with respiratory distress has not been very well studied. There is an observational study that includes 10 patients with lung damage or respiratory distress in which VMNI is used as the first respiratory therapy. 66% did not require intubation and 70% could be discharged from the hospital. There are no controlled clinical trials evaluating

the effect of the use of NIMV on morbidity and mortality, so, until there are more studies, it cannot be recommended as a therapy at the moment. NIMV could be used early in mild cases of distress as an attempt to avoid intubation, however, its use would not be recommended in patients with multi-organ dysfunction with a high probability of needing prolonged ventilatory support.^(14,15)

Noninvasive mechanical ventilatory support by face mask was found to affect neither intubation rates nor clinical outcomes in a randomised controlled trial of 123 acute respiratory distress patients, otherwise helmet ventilation was found to reduce the need for intubation when compared to oxygen therapy in a multicenter randomised controlled trial of 81 acute respiratory distress patients, and to reduce intubation rates and even to improve survival when compared to a face mask in a single-center randomised clinical trial of 83 acute respiratory distress patients.⁽¹⁶⁾

Taking into account some investigations, three large randomised controlled trials comparing high with low positive expiratory airway pressure in acute respiratory distress patients, the ALVEOLI trial in 549 acute respiratory distress patients,⁽¹⁷⁾ the LOVS trial in 983 acute respiratory distress patients,⁽¹⁸⁾ and the EXPRESS trial in 767 acute respiratory distress patients,⁽¹⁹⁾ revealed that a ventilation strategy using a high positive expiratory airway pressure does not improve mortality, despite improved lung function. One meta-analysis using individual patient data from these three randomised controlled trials showed ventilation with high positive expiratory airway pressure to be associated with better survival. However, it is important to say that the mortality benefit of using high positive expiratory airway pressure was almost exclusive in patients with moderate or severe acute respiratory distress, and ventilation with high positive expiratory airway pressure was associated with prolonged duration of ventilation in patients with mild acute respiratory distress. Ventilation with high positive expiratory airway pressure balances between potential benefit (i.e. recruitment) and harm (i.e. overdistension), and individual responses to positive expiratory airway pressure are very variable. A test comparing several positive expiratory airway pressure levels could help select the best positive expiratory airway pressure level for an individual patient: positive expiratory airway pressure

titrations may be based on the extent of lung recruitability and changes in transpulmonary pressures.^(20,21)

It has been demonstrated for some time that both Positive Airway Pressure and Continuous Positive Airways Pressure appeared to constitute a true solution and carry out a revolution in ventilation, allowing to begin to solve many of the so-called refractory hypoxemias, despite that the application technique has not changed much since its emergence, much has been discussed about the best ways to use them, and this discussion still persists. All of which constitutes one of the main reasons why this article is made.

The application of a mechanical maneuver with the use of PEEP or CPAP causes that both the airway pressure and the intrathoracic pressure do not drop to the level of the atmospheric pressure in either of the two phases of the respiratory cycle, so that it remains a certain degree of positive intrapulmonary pressure, at the end of expiration, which can be manually adjusted; and from it the inspiratory cycle will be mechanically produced.

The positive airway pressure in spontaneous ventilation is called Continuous Positive Airway Pressure normal circumstances at the end of expiration, the pulmonary elastic recoil pressure is equal to the atmospheric pressure, whose value is zero, reaching both Residual Volume and Residual Functional Capacity its resting values, Therefore, any situation that increases the values of the Residual Volume or the Residual Functional Capacity above normal, is capable of causing a level of positive airway pressure (Auto - PEEP). In the acute respiratory distress syndrome, the elastic lung forces increase and the CFR decreases, which would be one of the pathophysiological principles for the use of Continuous Positive Airway Pressure.⁽²¹⁾

In addition, a sub-analysis of the LUNG SAFE study,⁽²²⁾ showed that the mortality rate of patients with a $\text{PaO}_2/\text{FIO}_2 < 150$ was actually greater in patients treated with NIV than in those treated with invasive mechanical ventilation. It is important to acknowledge, however, that both studies were not randomized controlled trials. Moreover, a word of caution was shed by Hill et al on the results of a single randomised controlled trials comparing noninvasive ventilation to high flow nasal therapy (HFNT) and standard oxygen in acute hypoxemic respiratory failure.⁽²³⁾ As a matter of fact, further randomised controlled trials would be

necessary to determine if noninvasive ventilation improves or worsen outcomes, and this has not yet been done.^(24,25)

Nonetheless, the rate of intubation (primary outcome), was significantly less (18%) with the helmet compared to a full-face mask (62%) before abandon the use of NIV, some considerations should be done. First, measurement of VTe may be misleading using conventional pneumotacographic mode during NIV in presence of non-intentional leaks. Other options of VTs measurements, as inductive pletismography, should be considered to reliably measure VTe in randomised controlled trials in which VTs are challenged.⁽²⁶⁾ Second, interfaces as helmet allowing continuous NIV application and, possibly, a higher positive airway pressure may be important for noninvasive ventilation success and contribute to better outcomes. More randomised controlled trials are needed comparing noninvasive ventilation delivered by helmet or oro-nasal mask. By virtue of its effectiveness at oxygenation and greater tolerability, we should also need studies comparing continuous HFNT vs continuous application of helmet Continuous Positive Airway Pressure.⁽²⁴⁾

Continuous Positive Airway Pressure is able to reduce the venous mixture, and intrapulmonary shunt (Q_s / Q_t), especially patients with Acute Respiratory Distress Syndrome, the reduction of Q_s / Q_t can be facilitated by the reduction of blood flow to non-ventilated or hypoventilated lung regions, increases ventilation in hypoventilated lung regions and facilitates the recruitment and ventilation of previously non-ventilated alveoli. It is well known that when ventilating a patient with ARDS, lung areas or regions can be inaccurately divided into three zones: well-ventilated alveoli areas, collapsed alveolus areas that can be recruited with certain levels of Positive Expiratory Airway Pressure, and collapsed alveolus areas that do not respond to high levels of Positive Expiratory Airway Pressure.

In the presence of Acute Respiratory Distress Syndrome, noninvasive mechanical ventilation could be used as an effective and safe tool, since both Positive Expiratory Airway Pressure and Continuous Positive Airway Pressure are able to reinflate many of these previously collapsed alveoli depending on the increase in pressures at the end of expiration and depending on the magnitude alveolar recruitment that occurs, will therefore improve; CFR, gas exchange, oxygenation

and will reduce Q_s / Q_t , improving thoracopulmonary compliance with the consequent decrease in respiratory work.

Conclusions

Through the deep analyses made, it is clear that we cannot rely too much on single Randomised Controlled Trials to guide Intensive Care Units management, so further studies are urgently needed to sort out the relative merits of noninvasive ventilation delivered via a face mask, or helmet versus prompt intubation in the therapy of Acute Respiratory Distress Syndrome. The application for this type of respiratory failure has even been termed “the final frontier” for noninvasive mechanical ventilation to treat acute respiratory failure. The few studies carried out taking into account its reliability and safety only certainly guarantee the use of noninvasive ventilation in patients with mild Acute Distress Respiratory Failure according to the Berlin Classification. The battle of applied science in daily medical practice continues.

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Conflicts of interest

The author declares there is no conflicts of interest.