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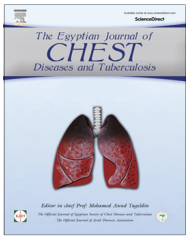

ORIGINAL ARTICLE

Non invasive spontaneous dual ventilation in critically ill patients with chronic obstructive pulmonary disease

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KEYWORDS

Non-invasive ventilation;
Volume-assured pressure support;
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Abstract *Background:* Effective non-invasive ventilation (NIV) is dependent on optimal ventilator settings for alveolar ventilation. Volume-assured pressure support (VAPS) is a mode of servoventilation, providing constant automatic adjustment of pressure support (PS) to achieve a target ventilation. Our aim is to evaluate the effectiveness of the new dual spontaneous mode of ventilation named intelligent volume assured pressure support (iVAPS) in comparison with conventional pressure support using S/T mode in-patients with acute hypercapnic respiratory failure due to acute exacerbation of COPD.

Patients and methods: Forty patients with hypercapnic respiratory failure and respiratory acidosis due to acute exacerbation of COPD after failure of conventional medical treatment including oxygen therapy were recruited into the study. Patients were categorized into two groups, Group I ventilated with S/T mode and Group II ventilated with iVAPS mode. Patients were fitted with an oronasal mask (Ultramirage, ResMed) connected to VPAP ST(ResMed).

Results: Both groups were comparable on admission. The successful outcome was achieved in 15 patients (75%) in the PS group vs 16 patients (80%) in the iVAPS group. Both groups show significant ($p < 0.01$) improvement after 1 h NIV compared with preventilatory level in respiratory rate (25.7 ± 1.6 vs 34.5 ± 1.8 for PS and 27.9 ± 4.8 vs 34.6 ± 1.3 for iVAPS) without significant difference between the two groups. In the iVAPS group, there were a significantly ($p < 0.01$) higher pH (7.34 ± 0.02 vs 7.31 ± 0.02 for PS group) and significantly ($p < 0.001$) lower $PaCO_2$ (74.00 ± 2.3 vs 79.00 ± 3.7 for PS group) after 1 h NIV. There was a significant ($p < 0.01$) higher minute ventilation and significant ($p < 0.001$) lower peak inspiratory pressure in the iVAPS group after 1 h, and 6 h NIV.

Abbreviations: ABGs, arterial blood gases; AVAPS, average volume assured pressure support; COPD, chronic obstructive pulmonary disease; EPAP, expiratory positive airway pressure; FiO_2, Fraction of inspired oxygen; IPAP, inspiratory airway pressure; iVAPS, intelligent volume-assured pressure support; Va, alveolar ventilation; VE, minute ventilation; NIV, non-invasive ventilation; $PaCO_2$, Partial pressure for arterial carbon dioxide; PaO_2, Partial pressure for arterial oxygen; PIP, peak inspiratory pressure; PS, pressure support; $PtCO_2$, transcutaneous partial pressure of CO_2; RR, respiratory rate; SpO_2, Oxygen saturation measured by pulse oximetry; VAPS, volume-assured pressure support

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Conclusion: Non invasive spontaneous dual ventilation using intelligent volume assured pressure support (iVAPS) is characterized by stable alveolar ventilation with lower and variable inspiratory pressure and earlier improvement of respiratory acidosis when compared with conventional pressure support.

Introduction

Noninvasive ventilation (NIV) has gained increasing acceptance as a way to avoid intubation and improve outcomes in selected patients with acute respiratory insufficiency [1]. Compared with optimum medical treatment plus oxygen therapy, NIV can reduce duration of intensive care unit stay and decrease complication in patients with chronic obstructive pulmonary disease (COPD) exacerbations [2].

Prospective randomized controlled trials of the use of NIV in acute exacerbation of COPD have been performed in a variety of different locations and healthcare systems and in patients with exacerbations of varying severity. A meta analysis of these studies has shown more rapid improvements of in respiratory rate and pH, a reduction in the need for intubation and improved survival, reduced complications and length of hospital stay [3].

Pressure support (PS) can assist spontaneous ventilation and can be used in-patients with stable ventilatory requirements or during weaning. Once breath is initiated, pressure rises rapidly to a preset plateau where it is held for the duration of inspiration. The end of inspiration occurs when inspiratory flow falls below a certain level, usually 25% of peak inspiratory flow [4]. In most new ventilators, there are different levels of flow cycling that can be adjusted and not fixed. The patient therefore determines respiratory frequency and timing of each breath and if the patient fails to make respiratory effort, no respiratory assistance will occur [5]. Tidal volume is variable from breath to breath.

Volume assured pressure support (VAPS) is a new spontaneous dual mode using closed loop technique to obtain target tidal volume or alveolar ventilation with variable pressure support from breath to breath [6]. Two generations of VAPS are developed: average volume assured pressure support (AVAPS) with target tidal volume and variable pressure support; and intelligent volume assured pressure support (iVAPS) with target alveolar ventilation (Va) and variable pressure support.

In iVAPS, patients receive the minimum pressure required to maintain optimal Va and hence it is called intelligent volume assured pressure support [7].

Objective

To evaluate the new dual spontaneous mode of ventilation named intelligent volume assured pressure support (iVAPS) in comparison with conventional pressure support using S/T mode in-patients with acute hypercapnic respiratory failure due to acute exacerbation of COPD.

Patients and methods

The study was conducted from June 2013 to January 2015 at Respiratory intensive care unit of Assiut university hospital.

Patients

Patients were offered enrollment into the study if they had acute hypercapnic respiratory failure due to acute exacerbation of COPD despite standard medical treatment including O_2 therapy via venturi mask delivering FiO_2 35% with worsening dyspnea and at least one of the following: (1) pH <7.35 but >7.10; (2) SpO_2 $<90\%$; (3) Respiratory rate >30 breath/min.

Patients were excluded if they met any of the following criteria: shock (mean blood pressure <60 mmHg); upper airway obstruction; facial trauma; bulbar paralysis; haemoptysis; upper gastrointestinal bleeding; polycythemia; serum albumin <30 gm/L; hypokalemia; severe underlying illness likely to be terminal as hepatocellular or renal failure.

Patients were categorized into two groups, Group I ventilated with S/T mode and Group II ventilated with iVAPS mode.

Initiation of non invasive ventilation (NIV)

Patients were fitted with oronasal mask (Ultramirage mask, ResMed) connected to VPAP-ST(ResMed). Group I was adjusted to S/T mode which is a combined mode; pressure support (S) and pressure control (Timed or T). PS was begun at an expiratory pressure (EPAP) of 4 cm H_2O and increased to maximum 8 cm H_2O according to $PaCO_2$ level where increasing EPAP help CO_2 wash, and inspiratory pressure (IPAP) set at a level that maintains IPAP – EPAP $\geqslant 8$ cm H_2O as a pressure support. Then IPAP level was increased to maintain tidal volume 8 ml/kg and O_2 saturation $>90\%$. We try to set IPAP not more than 20 cm H_2O to prevent gastric insufflation.

Timed mode (T) in S/T is a time triggered pressure limited, time cycled mode (pressure controlled ventilation). This ensures that patients will receive a minimum number of breaths per minute in the event that the spontaneous breathing rate drops below the rate setting. If the patient fails to initiate an inspiration within the interval determined by rate control, the unit triggers a timed breath resulting in a pressure controlled (pressure limited, time cycled) breath at the Set IPAP level (equal IPAP in S mode). The duration of each timed breath is controlled by an inspiratory time control. Respiratory rate was set at 15 breaths/min.

Group II was adjusted to iVAPS mode. Adjust EPAP as in Group I. iVAPS settings included height, patient target rate, target alveolar ventilation (Va), minimum and maximum PS.