

Pressure support ventilation vs Continuous positive airway pressure for treating of acute cardiogenic pulmonary edema: A pilot study

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ABSTRACT

Non-invasive ventilation is usually adopted as a support to medical therapy in patients with acute pulmonary edema, but which modality between Pressure Support Ventilation (PSV) and Continuous Positive Airway Pressure (CPAP) has better favourable effects is not been yet well known. Aim of this observational study was to provide data on these different non-invasive ventilation modalities in the management of acute cardiogenic pulmonary edema. One-hundred-fifty-three patients consecutively admitted to the Emergency Room of two different Center were enrolled and randomly assigned to CPAP or PSV. Data relative to mortality, need of endotracheal intubation, sequential blood gas analysis were compared. Furthermore, there were no significant differences regarding mortality in the two groups, but patients treated with PSV had a significant lower rate of endotracheal intubation and a higher improvement of blood gas analyses parameters. In conclusion, our data support only a slight advantage in favour to PSV versus CPAP.

1. Introduction

Acute cardiogenic pulmonary edema (ACPE) is one of the most common medical emergencies. The main therapeutic targets for patients with ACPE are the improvement of hypoxemia and respiratory distress. Conventional medical therapy is based on diuretics; vasodilators and high-flow oxygen. From many years; non-invasive ventilation (NIV) has been used as support to medical therapy. In patients with ACPE; NIV has been shown to reduce mortality; need for endotracheal intubation (ETI) and improve gas exchange compared with standard therapy alone (Bersten et al., 1991; Masip et al., 2000; Agarwal et al., 2005); and its use is recommended by current guidelines (McMurray et al., 2012; Weintraub et al., 2010). In this setting; the most frequently utilized modalities of NIV are Continuous Positive Airway Pressure (CPAP) and Positive Support Ventilation (PSV). It has been hypothesized that PSV may confer an advantage in treatment of ACPE compared to CPAP; since the pressure support administered during inspiration could reduce the work of breathing (WOB) (Chadda et al., 2002). Nevertheless; comparative studies demonstrated no significant differences in mortality; need of ETI (Bellone et al., 2005; Ferrari et al., 2010); and onset of complications (Winck et al., 2006) between these two NIV modalities. However; there are only few evidences comparing

PSV versus CPAP. Even a recent meta-analysis did not solve this controversy highlighting the paucity of data available and the presence of confounding factors (Ho and Wong, 2006).

Aim of the present study was to compare the effects of CPAP versus PSV for treatment of ACPE on early improvement of gas exchanges, NIV failure (need for ETI or change modality of NIV), and mortality.

2. Material and methods

This is a multicenter observational pilot study. Two center of Southern Italy were involved: Cardarelli Hospital and San Paolo Hospital. Patients consecutively admitted to the Emergency Department with diagnosis of ACPE between April 2016 and September 2017 were enrolled. Inclusion criteria were: age > 18 years, diagnosis of ACPE, admission to the Emergency Room. Diagnosis of ACPE was defined by the association of sudden onset of dyspnoea; presence of bilateral rales on auscultation; no medical history of pulmonary aspiration, infection or chronic obstructive pulmonary disease; congestion at chest radiograph or B profile at lung ultrasound (LUS) (Lichtenstein and Mezière, 2008). Exclusion criteria were considered: ETI before admission, acute coronary syndrome and absence of B profile at LUS.

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2.1. Study design

Medical therapy and NIV modality were chosen by physicians according to clinical judgment and current guidelines. In all patients, EKG, chest X ray, LUS, venous sample for routine blood tests and troponin, and arterial blood gas analysis at admission (T0) and after 30 min (T30') were performed. The available devices for NIV were Ventukit, Mask of Boussignac, mechanical ventilator (Monnal T75 Air liquide medical system, Drager Evita). Primary endpoint was the mortality rate. Secondary endpoint included NIV failure, increase of arterial oxygen/inspiratory oxygen fraction ratio (PaO₂/FiO₂), reduction of pCO₂ and clearance of lactate. NIV failure was defined as PaO₂/FiO₂ ratio less than a value of 100 within 30 min; inability to improve respiratory distress or/and arterial blood gas after 30 min; worsening of hemodynamic status, mask intolerance. The study design was approved by Institutional Ethics Committee "Cardarelli-Santobono" of Naples (n°557).

2.2. Statistical analysis

Student *t*-test, Kolmogorov-Smirnov and Mann-Whitney *U* test were performed to compare continuous variables, chi-square with Yates correction or Fisher-exact test to compare categorical variables. Statistical significance was defined when "p < 0.05" in a "two-tailed" test with a 95% Confidence Interval. Statistical analyses were performed using the Statistical Program for Social Sciences (SPSS®) ver.20.0 for Macintosh® (SPSS Inc., Chicago, Illinois, USA).

3. Results

One-hundred-fifty-three patients were enrolled from April 2016 to September 2016. Eighty-eight were treated with CPAP and 65 with PSV.

Baseline characteristics of the study population according to NIV modalities are summarized in Table 1.

Comparing the two groups an higher rate of male sex, a younger age, an higher respiratory rate and a lower level of pCO₂ were found in CPAP group.

Two patients died during the study, 1 in CPAP group and 1 in PSV group. NIV failure occurred in 10 patients in CPAP group and 1 patient in PSV group (11.2% vs 1.5%, p = .02) (Table 2). After 30 min of ventilation, in CPAP group and in PSV group, PaO₂/FiO₂ improved respectively by 38 and 50 (p = .2) (Fig. 1). At admission lactic acidosis (lactate > 2 mmol/l) occurred in 75 patients, 45 in CPAP group and 30 in PSV group. Clearance of lactate was respectively 44% and 47%

Table 1

Demographic characteristics and physiological measurements at baseline of 153 patients with acute cardiogenic pulmonary edema.

	CPAP	PSV	p-value
Patients (n)	88	65	
Age (years)	75 ± 11	80 ± 9	0,003
Male (n,%)	52 (58.4)	33 (41.8)	0,011
Systolic Blood Pressure (mm Hg)	174 ± 33	182 ± 33	0,163
Diastolic Blood Pressure (mm Hg)	97 ± 18	97 ± 17	0,869
Breath Frequency (bfm)	37 ± 6	33 ± 7	0,003
pH	7.23 ± 0.13	7.19 ± 0.13)	0,204
P/F (mean)	175 ± 70	156 ± 73	0,128
pCO2 (mmHg)	53 ± 19	60 ± 17	0,043
pO2 (mmHg)	62 ± 26	61 ± 24	0,885
FiO2 (%)	0.40 ± 0.20	0.43 ± 0.16	0,286
Blood Bicarbonate (mEq/L)	20.9 ± 4.5	22 ± 4.6	0,192
Blood Lactate (mmol/L)	4.6 ± 2.8	3.8 ± 2.7	0,137

Continuous variable are expressed as mean ± Standard Deviation, discrete variables as percentage. CPAP: Continuous Positive Airway Pressure; PSV: Pressure Support Ventilation; P/F: pO2/FiO2.

Table 2

Patients outcomes.

	CPAP (n = 88)	PSV (n = 65)	p-value
Endotracheal intubation	5 (5,6%)	0 (0%)	0.054
In-hospital death	1 (1,1%)	1 (1,5%)	0.814
Change in ventilation mode	5 (5,6%)	1 (1,5%)	0.202
Failure of ventilation mode ^a	10 (11.2%)	1 (1,5%)	0.022

^a Evaluated as a clinical deterioration entailed any change in ventilation mode (including endotracheal intubation).

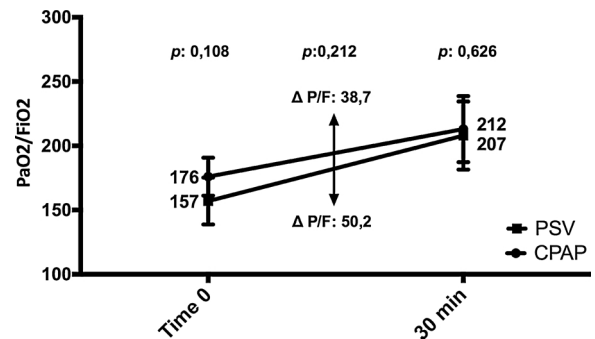


Fig. 1. Evaluation of improvement in PaO₂/FiO₂ ratio on all patients during treatment with the two different modality of ventilation (PSV; CPAP), evaluated at time 0 and after 30 min of therapy. No statistical differences were found between the two groups and, moreover, the Δ P/F was not statistically dissimilar. CPAP: Continuous positive airway pressure; Δ P/F: difference PiO₂/FiO₂; PSV: Pressure support ventilation.

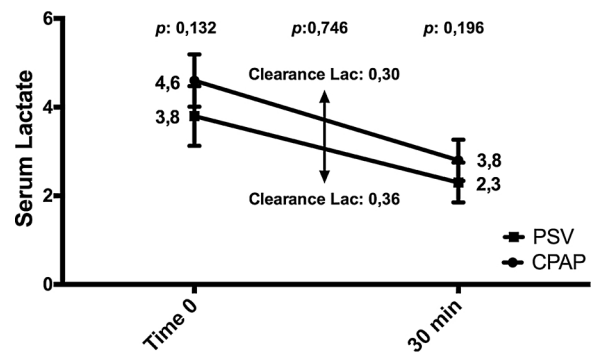


Fig. 2. Evaluation of improvement in serum lactate on all patients during treatment with the two different modality of ventilation (PSV; CPAP), evaluated at time 0 and after 30 min of therapy. No statistical differences were found between the two groups. CPAP: Continuous positive airway pressure; Clearance LAC: clearance of lactate; PSV: Pressure support ventilation.

(p > 0.05) (Fig. 2). At admission 100 patients were hypercapnic (pCO₂ > 40 mmHg), 59 in CPAP group and 41 in PSV group. After 20 min of ventilation, in CPAP group the pCO₂ was reduced by 9 mmHg and in PSV group was reduced by 17 mmHg (p = .01) (Fig. 3).

4. Discussion

The choice of NIV modality still represents a controversial theme in the treatment of ACPE. This study compared two modalities of NIV, CPAP and PSV, in the treatment of patients affected by ACPE, confirmed by clinical presentation and LUS that allowed to exclude other causes of sudden dyspnoea (the B profile suggests the diagnosis of hemodynamic pulmonary edema, with 97% sensitivity and 95% specificity) (Lichtenstein and Mezière, 2008).

In this trial, no difference were shown in mortality rates between two groups, according to other studies (Bellone et al., 2005; Ferrari et al., 2010; Winck et al., 2006). Only two patients died during the

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