Non invasive ventilation versus synchronized intermittent mandatory ventilation with pressure support in weaning of COPD patients: Comparative study

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KEYWORDS
Weaning;
Mechanical ventilation;
Non invasive ventilation;
SIMV-PS

Abstract Background: A combination of early extubation and non invasive positive pressure ventilation is a good alternative for weaning from invasive ventilation in COPD patients.

Objective: To evaluate the effectiveness of non invasive ventilation as a weaning method in COPD patients on mechanical ventilation in comparison to the conventional mode (synchronized intermittent mandatory ventilation with pressure support).

Design: Forty patients with acute exacerbation of COPD and acute chronic respiratory failure, who were mechanically ventilated and met the criteria to proceed in a weaning attempt, but had failed a spontaneous breathing T piece trial were included in the study and randomized into two

Abbreviations: ABG, arterial blood gases; A/C, assisted control ventilation; CMV, controlled mandatory ventilation; COPD, chronic obstructive pulmonary disease; ETT, endotracheal tube; FIO₂, fraction of inspired oxygen; GCS, glasgow coma scale; I/E ratio, inspiration/expiration ratio; IMV, invasive mechanical ventilation; MV, mechanical ventilation; NIPPV, non invasive positive pressure ventilation; NIV, non invasive ventilation; PS, pressure support; PSV, pressure support ventilation; RSBI, rapid shallow breathing index; SBT, spontaneous breathing T piece trial; SIMV-PS, synchronized intermittent mandatory ventilation with pressure support; VAP, ventilator associated pneumonia

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groups. Group I included twenty patients who were extubated and received non-invasive ventilation. Group II included twenty patients who were reconnected to the ventilator and continued weaning with synchronized intermittent mandatory ventilation with pressure support.

**Results:** The duration of weaning was significantly short in group I compared to group II (35 ± 1.63 versus 47 ± 2.25 hours) \((p = 0.044)\), duration of ICU stay was significantly shorter in group I compared to group II (9.50 ± 3.2 versus 11.4 ± 2.70 days) \((p = 0.049)\). While the number of deaths in ICU was significantly higher (5; 25%) in group II compared to (3; 15%) group I \((p = 0.031)\) and the number of deaths at 30 days was significantly higher (9; 45%) in group II compared to (5; 25%) group I \((p = 0.008)\).

**Conclusions:** Noninvasive positive pressure ventilation permits earlier removal of the endotracheal tube, reduces weaning time, stay in the intensive care unit, decreases the incidence of nosocomial pneumonia and improves 30 day survival rates.

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**Introduction**

Chronic obstructive pulmonary disease (COPD) is a disease with an increasing prevalence and mortality worldwide [1]. Mechanical ventilation (MV) is often life-saving when patients with COPD experience acute respiratory compromise [2,3]. Invasive ventilation is associated with numerous complications including airway injury, higher risk for gastrointestinal bleeding, thromboembolism, barotrauma, and ventilator-associated pneumonia [4].

Weaning has been defined as the process whereby mechanical ventilation is gradually withdrawn and the patient resumes spontaneous breathing [5].

Synchronized intermittent mandatory ventilation is the first alternative to T-tube trials, is now a frequently used mode to wean patients off the ventilator. It involves a gradual reduction in the amount of support being provided by the ventilator, there is no disconnection from the ventilator [6]. One of the most important advantages of synchronized intermittent mandatory ventilation with pressure support (SIMV-PS) is the reduction in the need for sedation during the weaning process [7].

The combination of early extubation and non invasive positive pressure ventilation (NIPPV) is a good alternative for ventilation in a group of heterogeneous patients who initially failed weaning [5].

**Aim of the work**

The aim of the present study was to evaluate the effectiveness of non invasive ventilation as a weaning method in COPD patients on mechanical ventilation in comparison to conventional mode SIMV with pressure support (SIMV-PS).

**Patients and methods**

This study was conducted in the ICU ward in the Chest and Anesthesiology Departments, Tanta University Hospital on 40 mechanically ventilated patients having COPD with acute exacerbation and respiratory failure from June 2011 to January 2012. This study was approved by the research ethics committee; Quality Assurance Unit, Faculty of Medicine, Tanta University.

**Inclusion criteria**

Mechanically ventilated COPD patients who meet the criteria to proceed with a weaning attempt. Those patients who failed at 30 min [5] to 2 h [8] of spontaneous breathing T piece trial (SBT) were included in this study.

**Exclusion criteria**

Patients with any contraindication for non invasive positive pressure ventilation (NIPPV) were excluded from the study: fascial or cranial trauma or surgery, recent gastric or esophageal surgery, active upper gastrointestinal bleeding, and excessive amount of respiratory secretions.

**The following was done to all patients**

All patients were initially ventilated with control/assist control mode, intubation was done through the orotracheal route. Muscle relaxants and sedation were used as required. Standard ventilator settings for COPD i.e., respiratory rate of 12/min, tidal volume 8–10 mL/kg, FIO\(_2\) to obtain a saturation of 90%, and an I:E ratio of 1:4 were initiated. With the endotracheal tube in place, T-piece weaning trial was given to the patients who had the following criteria:

1. Improvement of the cause of acute respiratory failure that led to use of mechanical ventilation.
2. Correction of arterial hypoxemia (PaO\(_2\) > 60 mm Hg).
3. Fraction of inspired oxygen (FIO\(_2\)) ≤ 40%.
4. No fever (\(\geq 38 \degree C\)) or hypothermia (\(< 35 \degree C\)).
5. No need for vasoactive drugs.
6. Normal consciousness (Glasgow coma score ≥ 13) with no need for sedative agents.

**Criteria of SBT trial failure**

Spontaneous breathing trial (SBT) failure was considered when the patient had any of the following:

1. Respiratory frequency (\(f\)) > 35/min.
2. Rapid shallow breathing index (RSBI) > 105 breaths/liter/min.
3. Peripheral O₂ saturation (SpO₂) measured by pulse-oximetry of less than 90%.
4. Heart rate > 140 or < 50/min.
5. Systolic blood pressure > 180 or < 70 mm Hg.
6. Decreased consciousness, agitation or diaphoresis.

Immediately after T-piece failure patients were put back on CMV/ACV mode until previous ABG values were reached (before spontaneous breathing trial) and then considered for the respective modality of weaning.

If signs of spontaneous breathing trial failure appeared, patients were divided into two groups according to the type of weaning.

Group I (NIV group): Twenty patients were extubated and received NIV (non-invasive ventilation) using a BiPAP ventilatory support system (RESMED, Sullivan-VPAP ST-II). Patients received NIV via an oronasal mask continuously except during meals and for expectoration. A particular level of IPAP (inspiratory positive airway pressure) according to patient tolerance (10–20 cm H₂O) and EPAP (expiratory positive airway pressure) (5 cm H₂O) that achieved satisfactory blood gases and a respiratory rate < 30/min were used. Once that was achieved, the pressure support was decreased by 2 cm H₂O every 4 h with a good tolerance and with close monitoring for any change in oxygen saturation and respiratory rate.

As soon as we could reduce the IPAP and EPAP levels to 8 and 4 cm H₂O respectively, with a satisfactory ABG of PH ≥ 7.35, SaO₂ ≥ 90%, FiO₂ ≤ 40% and RR < 30/min, patients were allowed to breathe spontaneously; when NIV failed, reintubation was done.

Group II (SIMV-PS group): Twenty patients were reconnected to the ventilator and continued weaning with conventional-weaning mode (SIMV-PS) using mechanical ventilator (Galleio and RAPHAEL Hamilton medical AG, Switzerland). They received SIMV with a respiratory rate of 14/min, starting with pressure support of 20 cm H₂O and tidal volume 8–10 mL/kg. Once satisfactory blood gases were achieved, an RR < 30/min the pressure support was decreased by 2 cm H₂O every 4 h alternatively with a reduction of respiratory rate by 2 cycles/min with a good tolerance and with close monitoring for any change in oxygen saturation and respiratory rate.

All patients were assessed by

(1) **Arterial blood gas analysis**: ABG was performed at presentation and at 1, 4, 8 h during the weaning process.
Arterial blood samples were collected from each patient by the use of disposable sterilized plastic syringe
(2) **Glasgow coma Scale (GCS)**: It was assessed before spontaneous breathing trial as a weaning parameter.
(3) **Rapid shallow breathing index (RSBI)**: The RSBI was determined before weaning, (immediately when patients breathed room air spontaneously through the T piece). The rapid shallow breathing index (RSBI) is a weaning parameter usually measured at the start of spontaneous breathing trial (SBT) [10].
(4) **Duration of weaning in hours**: After randomization in group I after extubation and receiving NIV while in group II after reconnection to the ventilator and continued weaning with conventional-weaning mode (SIMV-PS).
(5) **Duration of ICU stay**: From the day of admission to the day of discharge from ICU.
(6) **Mortality at discharge from ICU (number of deaths in the ICU)** and after 30 days.
(7) **Incidence of nosocomial pneumonia and ventilator associated pneumonia (VAP)**: defined as the presence of new and persistent (> 48 h) lung infiltrates on chest radiography combined with fever, total leukocyte count (TLC) > 10,000 after 48 h on ventilator.
(8) **Complications related to mode of ventilation**.

Success of weaning: was assessed after 2 h of spontaneous breathing when the patient maintained arterial oxygen saturation ≥ 90% on FiO₂ less than 40%, PH > 7.35, respiratory rate less than 30/min with no dyspnea and intact cognition. Absence of even one of these criteria was considered as weaning failure. Weaning failure was also considered if the patient could not be taken off the ventilator after 30 days or needed reintubation within 72 h of disconnection from the ventilator, or if death related to mechanical ventilation occurred [8].

**Statistical analysis**

Statistical presentation and analysis of the present study were conducted, using the mean, standard deviation and Kaplan–Meier analysis, univariate analysis, multivariate analysis by SPSS V.16.

**Results**

There was no significant statistical difference between the two groups regarding criteria of fitness for spontaneous breathing trial Figs. 1 and 2 Table 1 (Table 2).

**Parameters of the studied groups during spontaneous breathing trial failure (Table 3)**

Twelve patients of group I and 13 of group II were able to complete the test within 30 min and failed in the next 30 min, whereas 8 patients of group I and 7 of group II failed before 30 min. No significant statistical difference was found between the 2 groups.
Serial arterial ABG at 0, 1, 2, 4, and 8 h from the start of weaning in the two treatment groups was done and revealed that there was no significant statistical difference between the two studied groups.

**Weaning outcome variables in the two studied groups**

Table 4 shows weaning outcome variables which revealed that the duration of weaning was significantly short in group I compared to group II (35 ± 1.63 versus 47 ± 2.25) hours (p = 0.044), duration of ICU stay was significantly short in
group I compared to group II (9.50 ± 3.2 versus 11.4 ± 2.70) days ($p = 0.049$). While the number of deaths in ICU was significantly higher (5; 25%) in group II compared to (3; 15%) group I ($p = 0.031$) and the number of deaths at 30 days was significantly higher (9; 45%) in group II compared to (5; 25%) group I ($p = 0.008$).

Causes of death within 30 days after entry in the study

The causes that led to death within 30 days after entry in the study included refractory hypoxemia in one patient (5%), cardiac arrest in one patient (5%) and pulmonary embolism in one patient (5%) of group I, while in group II septic shock due to nosocomial pneumonia in two patients (10%), refractory hypoxemia in two patients (10%), cardiac arrest led to death in three patients (15%) and pulmonary embolism in two patients (10%).

Analysis of survival

Cumulative mortality in the ICU after study entry in the two groups (Fig. 3)

Most of ICU deaths occurred between 20 and 24 days after study entry, almost 27% of group II died between days 4 and 6 after randomization, compared with only 10% of group I.

Univariate analyses and multivariate analyses of intensive care unit and 30 days survival (Table 5 and 6)

Independent risk factors that significantly correlated with decreased ICU survival and also decreased 30 day survival were conventional weaning approach ($p = 0.041$) and advanced age ($\geq 65$ years) (i.e. the number of death in the ICU was more in patients weaned by conventional mode and those aged $\geq 65$ years), the number of patients aged $\geq 65$ years was 7 (35%) in group I versus 10 (50%) in group II ($p = 0.033$).

Complications during weaning in the two studied groups

The incidence of nosocomial pneumonia was significantly higher in group II compared to group I. The chest X-rays in group I show no infiltrates while in group II they show bilateral infiltrates in 7 (35%) patients ($p = 0.004$), the total leukocytic count (TLC) cell/mm$^3$ was significantly higher in group II compared to group I (11,390 ± 1386.1) versus (6878 ± 7587) ($p = 0.003$). Other complications such as bed sores, urinary tract infection, GIT bleeding and pneumothorax were higher in group II compared to group I ($p < 0.05$).

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Baseline characteristic of patients during mechanical ventilation.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group I (mean ± SD)</td>
</tr>
<tr>
<td>Age (years)</td>
<td>64.7 ± 3.6</td>
</tr>
<tr>
<td>Smoking index (Pack/year)</td>
<td>40 ± 3.25</td>
</tr>
<tr>
<td>Heart Rate (Beat/min)</td>
<td>130 ± 7.25</td>
</tr>
<tr>
<td>R.R (cycle/min)</td>
<td>31.15 ± 10.03</td>
</tr>
<tr>
<td>Temperature (°C)</td>
<td>36.8 ± 0.39</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>122.5 ± 11.04</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>75 ± 18.4</td>
</tr>
</tbody>
</table>
Non invasive ventilation is an effective tool for facilitating weaning in patients with acute or chronic respiratory failure, mainly patients with COPD [11]. One study has reported a decrease in the use of SIMV, especially alone without PS [12]. Although the use of SIMV as a weaning mode may be decreasing, it remains a commonly used mode for ventilatory support in recent study [13]. One recent study which was carried out in 55 ICUs in Australia and New Zealand revealed that SIMV, with or without PS, is the mode preferred by specialists in that region. However, their survey did not clarify the reasons for the popularity of this ventilator mode [14].

In the present study, the mean value of duration of weaning in hours was significantly lower in group I compared to group II (35 ± 1.63 versus 47 ± 2.25) (p = 0.044).

Some studies [15–17] stated that weaning with NIV was associated with a shorter duration of weaning than the invasive group. Burns et al. 2006 [18] also found that compared to invasive weaning, NIV was associated with shorter mechanical ventilation (by 7.33 days). Some authors [19] concluded that NIV reduces the duration of mechanical ventilation and the incidence of complications associated with prolonged mechanical ventilation, these results are in agreement with the present study.

Two studies [20,21] showed that SIMV was associated with significant increase in weaning duration compared with daily T-piece trials or gradual reductions in pressure support.

On the other hand, Shiva et al. 2009 [8] reported that there was no significant difference in the time spent on mechanical ventilation between NIV and pressure support ventilation. Table 2 criteria of fitness for spontaneous breathing trial (SBT).

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Group I (mean ± SD)</th>
<th>Group II (mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PaO2 (mm Hg)</td>
<td>61.7 ± 2.09</td>
<td>62.75 ± 2.09</td>
<td>0.999</td>
</tr>
<tr>
<td>O2 sat%</td>
<td>91 ± 2.17</td>
<td>92 ± 2.17</td>
<td>0.999</td>
</tr>
<tr>
<td>FIO2 (%)</td>
<td>35% ± 5%</td>
<td>34% ± 5%</td>
<td>0.909</td>
</tr>
<tr>
<td>Temperature(°C)</td>
<td>36.94 ± 0.29</td>
<td>36.80 ± 0.29</td>
<td>0.999</td>
</tr>
<tr>
<td>Glasgow coma score</td>
<td>13.95 ± 0.78</td>
<td>13.90 ± 0.71</td>
<td>0.832</td>
</tr>
</tbody>
</table>

Table 3 Parameters of the studied groups during spontaneous breathing trial failure.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Group I (mean ± SD)</th>
<th>Group II (mean ± SD)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>R.R (cycle/min)</td>
<td>42 ± 2.05</td>
<td>41.2 ± 1.8</td>
<td>0.935</td>
</tr>
<tr>
<td>Tidal volume (L)</td>
<td>0.480 ± 0.133</td>
<td>0.490 ± 0.131</td>
<td>0.756</td>
</tr>
<tr>
<td>RSBI (Breaths/min/liter)</td>
<td>110 ± 10.52</td>
<td>115 ± 10.68</td>
<td>0.587</td>
</tr>
<tr>
<td>Heart rate (beat/min)</td>
<td>122.5 ± 8.50</td>
<td>129.25 ± 12.06</td>
<td>0.048</td>
</tr>
<tr>
<td>Systolic blood pressure (mm Hg)</td>
<td>112.5 ± 13.32</td>
<td>116 ± 12.7</td>
<td>0.223</td>
</tr>
<tr>
<td>Diastolic blood pressure (mm Hg)</td>
<td>75 ± 5.12</td>
<td>75.5 ± 5.10</td>
<td>0.428</td>
</tr>
<tr>
<td>SpO2 (%)</td>
<td>88.25 ± 1.55</td>
<td>86.5 ± 2.1</td>
<td>0.635</td>
</tr>
<tr>
<td>Disturbed Conscious level</td>
<td>12(60%)</td>
<td>17(85%)</td>
<td>0.063</td>
</tr>
<tr>
<td>Agitation</td>
<td>20(100%)</td>
<td>20(100%)</td>
<td>0.999</td>
</tr>
<tr>
<td>Diaphoresis</td>
<td>20(100%)</td>
<td>20(100%)</td>
<td>0.999</td>
</tr>
<tr>
<td>Thoracic abdominal paradoxical movement</td>
<td>20(100%)</td>
<td>20(100%)</td>
<td>0.999</td>
</tr>
</tbody>
</table>

Table 4 Weaning outcome variables in the two studied groups.

<table>
<thead>
<tr>
<th>Table 4</th>
<th>Group I</th>
<th>Group II</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration of weaning in hours mean ± SD</td>
<td>35 ± 1.63</td>
<td>47 ± 2.25</td>
<td>0.044*</td>
</tr>
<tr>
<td>Duration of ICU stay (in days) mean ± SD</td>
<td>9.50 ± 3.2</td>
<td>11.4 ± 2.70</td>
<td>0.049*</td>
</tr>
<tr>
<td>Number of deaths in ICU n (%)</td>
<td>3 (15%)</td>
<td>5 (25%)</td>
<td>0.031*</td>
</tr>
<tr>
<td>Number of deaths at 30 days n (%)</td>
<td>5 (25%)</td>
<td>9 (45%)</td>
<td>0.008**</td>
</tr>
</tbody>
</table>

* P < 0.05: significant.
** P < 0.01: highly significant.

Discussion

Non invasive ventilation is an effective tool for facilitating weaning in patients with acute or chronic respiratory failure, mainly patients with COPD [11]. One study has reported a decrease in the use of SIMV, especially alone without PS [12].

Figure 3 Cumulative mortality in the ICU after study entry in the two studied groups.
group (PSV). This may be explained by the difference between the two studies as in the present study, NIV is in comparison to SIMV with pressure support not pressure support alone. Girault et al. 2011 [22] randomized 208 patients with chronic hypercapnic respiratory failure intubated for acute respiratory failure (ARF) who failed the first spontaneous breathing trial into three groups: conventional invasive weaning group (69 patients), NIV (69 patients) or extubation followed by standard oxygen therapy (70 patients). They reported that NIV was associated with a longer weaning time than in the invasive group (2.5 versus 1.5 days; \( P = 0.033 \)).

In the present study the mean value of duration of ICU stay in days was significantly lower in group I (9.50 ± 3.2) compared to group II (11.4 ± 2.70) \( (p = 0.049) \). Recent studies [17,18,23] stated that NIV was associated with significant reductions in the duration of stay in the ICU; this is in agreement with this study.

On the other hand, some studies [24,25] revealed that no difference was detected in the duration of ICU stay between NIV and conventional weaning with pressure support.

In the present study the number of deaths in the ICU days was significantly lower (3; 15%) in group I compared to (5; 25%) group II \( (p = 0.031) \). In accordance with the present study, Nava et al. 2005 [26] randomized patients with COPD with recurrent spontaneous breathing T piece (SBT) trial failure, concluded that the use of NIV post extubation was associated with lower ICU mortality. Also, some studies [27–29] reported that weaning using NIV significantly reduced mortality and nosocomial pneumonia.

Recently, Ortiz et al. 2010 [30] observed that patients ventilated continually with SIMV with PS had a lower mortality than patients initially ventilated with SIMV with PS and later switched to assisted control ventilation (A/C), or those ventilated continually with A/C.

### Table 5  Univariate analyses of intensive care unit and 30 days survival.

<table>
<thead>
<tr>
<th>Decreased ICU survival Univariate analysis</th>
<th>Adjusted odds ratio</th>
<th>95% CI</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional-weaning approach</td>
<td>6.4</td>
<td>1.2–35.6</td>
<td>0.041*</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>5.9</td>
<td>1.3–30.4</td>
<td>0.033*</td>
</tr>
<tr>
<td>Gender</td>
<td>1.20</td>
<td>1.07–1.32</td>
<td>0.055</td>
</tr>
<tr>
<td>GCS</td>
<td>14.2</td>
<td>13.8–15.2</td>
<td>0.088</td>
</tr>
<tr>
<td>RSBI(breaths/L/min)</td>
<td>19.5</td>
<td>18.62–22.9</td>
<td>0.092</td>
</tr>
<tr>
<td>FIO2</td>
<td>11.1</td>
<td>10.2–12.5</td>
<td>0.142</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decreased 30-days survival Univariate analysis</th>
<th>Adjusted odds ratio</th>
<th>95% CI</th>
<th>( p ) value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional-weaning approach</td>
<td>–</td>
<td>–</td>
<td>0.042*</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>–</td>
<td>–</td>
<td>0.049*</td>
</tr>
<tr>
<td>Gender</td>
<td>1.23</td>
<td>1.17–1.30</td>
<td>0.093</td>
</tr>
<tr>
<td>GCS</td>
<td>14.9</td>
<td>13.3–15.8</td>
<td>0.091</td>
</tr>
<tr>
<td>RSBI(breaths/L/min)</td>
<td>20.4</td>
<td>18.74–22.5</td>
<td>0.090</td>
</tr>
<tr>
<td>FIO2</td>
<td>11.5</td>
<td>10.1–12.2</td>
<td>0.140</td>
</tr>
</tbody>
</table>

CI: confidence interval.

* \( P < 0.05 \): significant.

### Table 6  Multivariate analyses of intensive care unit and 30 day survival.

<table>
<thead>
<tr>
<th>Decreased ICU survival Multivariate analysis</th>
<th>Adjusted odds ratio</th>
<th>95% CI</th>
<th>( p ) Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional-weaning approach</td>
<td>6.3</td>
<td>1.2–35.6</td>
<td>0.04*</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>4.8</td>
<td>1.4–14.3</td>
<td>0.014*</td>
</tr>
<tr>
<td>GCS</td>
<td>14.9</td>
<td>14.8–17.2</td>
<td>0.068</td>
</tr>
<tr>
<td>RSBI(breaths/L/min)</td>
<td>19.5</td>
<td>17.62–22.2</td>
<td>0.091</td>
</tr>
<tr>
<td>FIO2</td>
<td>11.8</td>
<td>11.2–12.2</td>
<td>0.199</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Decreased 30-days survival</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Conventional-weaning approach</td>
<td>3.11</td>
<td>1.2–8.7</td>
<td>0.019*</td>
</tr>
<tr>
<td>Age &gt; 65 years</td>
<td>4.9</td>
<td>1.4–14.3</td>
<td>0.014*</td>
</tr>
<tr>
<td>GCS</td>
<td>14.9</td>
<td>14.8–17.2</td>
<td>0.9</td>
</tr>
<tr>
<td>RSBI (breaths/L/min)</td>
<td>19.5</td>
<td>16.60–24.2</td>
<td>0.079</td>
</tr>
<tr>
<td>FIO2</td>
<td>11.6</td>
<td>11.11–13.17</td>
<td>0.138</td>
</tr>
</tbody>
</table>

CI: confidence interval.

* \( P < 0.05 \): significant.
In contrast, one study [22] stated that there were no differences in complications, ICU or hospital stay between NIV and conventional weaning groups.

In the present study, there was a significant reduction in the number of deaths at 30 days in the group I (5; 25%) compared to (9; 45%) in group II.

Unlike the results of this study, Ferrer et al. 2006 [27] stated that there was no significant difference in 90 days mortality between NIV and the invasive weaning. Also, Shiva et al. 2009 [8] documented that there were no significant statistical difference in the number of deaths at 30 days between patients weaned by NIV and PSV (pressure support ventilation).

In the present study, there was significant reduction in the number of complications in the ICU in group I in comparison to group II, in group II seven patients (35%) had nosocomial pneumonia, four patients (20%) developed pneumothorax and five (20%) had GIT bleeding, these complications were not reported in group I.

Complications are more common when mechanical ventilation is prolonged which usually occurs when using the invasive mode of weaning [4]. With noninvasive ventilator technique, the risk for aspiration of colonized or infected oropharyngeal secretions is probably smaller, because there is no tracheal prosthesis. The patient can expectorate freely and the vocal cords are not kept open, while with invasive ventilation, an endotracheal tube can predispose to the development of pneumonia by impairing cough and mucociliary clearance [31].

Some studies [5,18] stated that patients weaned by NIV had less incidence of nosocomial pneumonia compared to those weaned by the conventional weaning method. Another study [25] stated that the percentage of complications in the NPPV group was lower (28.6% versus 75.7%), with a lower incidence of pneumonia (3.6% versus 45.9%) than in the invasive ventilation group. These results led the authors to conclude that early extubation and NPPV is a valid alternative for ventilation in a group of heterogeneous patients that initially failed in weaning.

In addition Hess et al. 2007 [32] concluded that the use of NPPV is strongly recommended to allow early extubation in patients with COPD who failed a spontaneous breathing trial. Some studies [33,34] reported that NIV decreased the risk of infection (ventilator associated pneumonia) and the need for sedation, which are factors that increase the duration of mechanical ventilation.

On the other hand, Girault et al. 2003 [24] reported that there were no differences in weaning failure or complications between NIV and the conventional weaning group.

In the present study, the causes that led to death within 30 days after entry in the study included, in group I refractory hypoxemia, cardiac arrest, and pulmonary embolism, while in group II septic shock due to nosocomial pneumonia, refractory hypoxemia, cardiac arrest and pulmonary embolism. This is in accordance with the results obtained by Ferrer et al. 2003 [17] who reported that the causes of death within 90 days after entry in the study were septic shock/multiple organ failure in one patient in the NIV group and 9 in the conventional group, refractory hypoxemia in one patient in the NIV group and 2 in the conventional group, cardiac arrest in two patients in the NIV group and one in the conventional group, pneumothorax in one patient in the conventional group and pulmonary embolism in one patient in the conventional group.

In the present study, Independent risk factors significantly correlated with decreased ICU and 30 day survival were conventional weaning approach (p = 0.041) and advanced age (≥ 65 years) (p = 0.033).

Some authors [18] stated that the conventional weaning approach was an independent risk factor of decreased ICU (p = 0.035) and 90 day survival (p = 0.018). They also stated that the conventional weaning approach (p = 0.018) together with advanced age (≥ 70 years) and hypercapnia (PaCO2 ≥ 45 mm Hg) were independent factors significantly associated with decreased 90 day survival (p = 0.003). These results are consistent with the results of the current study, despite doing univariate and multivariate analyses for decreased 90 day survival, while in this study only 30 day survival was seen.

On the other hand, a single recent study [22] documented that no significant difference was found in hospital survival between NIV and conventional ventilation as weaning modes.

In the present study weaning was successful in 17 (85%) and 15 (75%) patients in group I and II respectively. It was significantly higher in group I compared to group II (p = 0.049). On the other hand, Burns et al. 2006 [18] reported that there was no difference in weaning success between NIV and conventional weaning.

The success of NIV is probably related to its ability to reverse the underlying pathophysiology of ARF; which is described as an imbalance between respiratory load and capacity. NIV can decrease rapid shallow breathing, improve gas exchange, improve alveolar ventilation, and decrease the work of breathing [35].

In conclusion, weaning of COPD patients with respiratory failure by noninvasive positive pressure ventilation (NIPPV) had a better outcome compared with the conventional weaning method. Noninvasive positive pressure ventilation permits earlier removal of the endotracheal tube, reduces weaning time, stay in the intensive care unit, decreases the incidence of nosocomial pneumonia and improves 30 day survival rates. Therefore, NIV should be the preferred weaning strategy for patients with COPD especially those with difficulty in weaning.

References

[7] J. Rathgeber, B. Schorn, V. Falk, S. Kazmaier, T. Spiegel, H. Buechard, The influence of controlled mandatory ventilation (CMV), intermittent mandatory ventilation (IMV) and biphasic intermittent positive airway pressure (BIPAP) on duration of


