Efficacy of non-invasive positive pressure ventilation in the treatment of respiratory failure in patients with COPD at the acute exacerbation stage

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Abstract

Objective: To observe the efficacy of non-invasive positive pressure ventilation (NIPPV) in the treatment of respiratory failure in patients with COPD at the acute exacerbation stage. Methods: A total of 38 COPD patients at the acute exacerbation stage with respiratory failure who were admitted to our hospital from January, 2012 to January, 2013 with complete medical materials were included in the study and divided into the observation group and the control group according to different treatment methods. On admission, the patients in the two groups were given oxygen inhalation, positive infection control, and drugs that could improve the respiratory function. On the basis, the patients in the observation group were given additional NIPPV. The improvement of blood gas indicators 4, 24, 72 d after admission, and 5, 30 d after discharge in the two groups was compared. The hospitalization time and the number of second hospitalization within 3 months in the two groups were compared. Results: In the observation group, pH value after 4 h ventilation was significantly elevated, and maintained at a stable state after 24 h ventilation, while in the control group, the change of pH value was not statistically significant, and after 5 d treatment, pH value was yet low. In the observation group, PaCO$_2$ was significantly reduced in a short ventilation time, while in the control group, the descending range was small. The comparison of pH and PaCO$_2$ 4 h, 24 h, 72 h, and 5 d after treatment between the two groups was statistically significant, but PaCO$_2$ in the two groups could not reduce to the normal level. PaO$_2$ after treatment in the two groups was improved, but the improved degree in the observation group was significantly superior to that in the control group. The comparison of blood gas indicators 30 d after discharge between the two groups was not statistically significant. The hospitalization time in the observation group was shortened, and the number of second hospitalization within 3 months was significantly lower than that in the control group. Conclusions: NIPPV can rapidly correct the respiratory failure state in patients with COPD merged with respiratory failure, improve the pulmonary function, and reduce the lung injury, with an accurate efficacy.

1. Introduction

COPD is a common respiratory system disease in the clinic, characterized by incomplete irreversible airway limitation, progressive development, and easy recurrence and attack, and can severely affect the patients' living quality. The pulmonary damage caused by COPD can develop into respiratory failure and pulmonary heart disease in a severe condition, with an extremely high disability rate and mortality rate; therefore, the effective treatment is of great significance in improving the prognosis. Non-invasive positive pressure ventilation (NIPPV) is a kind of ventilation way not through the artificial airway. During the ventilation treatment, the patients are connected with the ventilator through the nasal mask, and the assistant ventilation is performed with the ventilator. Some researches demonstrate that the efficacy of NIPPV in the treatment of COPD merged with respiratory failure is significant. The study is aimed to explore the efficacy of NIPPV in the treatment of respiratory failure in patients with COPD at the acute exacerbation stage.
2. Materials and methods

2.1. General materials

A total of 38 COPD patients at the acute exacerbation stage with respiratory failure who were admitted in our hospital from January, 2012 to January, 2013 with complete medical materials were included in the study, among which 17 were male, and 21 were female; aged from 62 to 79 years old, with an average age of (50.58±7.3) years old; course from 1 to 11 years, with an average course of (5.12±1.73) years. All the patients were in accordance with the related diagnostic criteria in the Diagnosis and Treatment Standard (Draft) of COPD formulated by the Respiratory Branch of Chinese Medical Association. Those who had circulatory dysfunction, conscious disturbance, intestinal tract bleeding, severe heart disease, and contradictions of taking NIPPV were excluded from the study.

2.2. Methods

The included patients were divided into the observation group and the control group with 19 cases in each group according to different treatment methods. On admission, the patients in the two groups were given oxygen inhalation (3 L/min), positive infection control, and drugs that could improve the respiratory function. On the basis, the patients in the observation group were given additional NIPPV. BiPAP Ventilator (produced by Respironics) was used for mechanical ventilation. The patients were connected with the ventilator through the nasal mask, from the initial pressure of 14 cmH₂O to increase to the maximum 21 cmH₂O. Once the condition was stable, the pressure was gradually down regulated to 12-15 cmH₂O. The low pressure was generally maintained at 4-7 cmH₂O.

The initial ventilation time was 12-18 h. After 3 d ventilation, the ventilation time was 6-10 h each day, for 2 weeks. The patients in the control group were only given the routine treatments.

2.3. Observation indicators

The improvement of blood gas indicators 4, 24, 72 d after admission, and 5, 30 d after discharge in the two groups was compared. The hospitalization time and the number of second hospitalization within 3 months in the two groups were compared.

2.4. Statistical analysis

SPSS 12.0 software was used for the statistical analysis. Chi-square test was used for the enumeration data, and t test was used for the measurement data. P<0.05 was regarded as statistically significant.

3. Results

3.1. Comparison of the blood gas indicators at each timing points between the two groups

The comparison of blood gas indicators before treatment between the two groups was not statistically significant (P>0.05). In the observation group, pH value after 4h ventilation was significantly elevated (P<0.05), and maintained at a stable state after 24 h ventilation. In the observation group, pH value after 4 h, 1, 3, 5d treatment was significantly higher than that before treatment and the control group at the same stage (P<0.05). In the observation group, PaCO₂ was significantly reduced in a short ventilation time (P<0.05), while in the control group, the descending range was small. The comparison of pH and PaCO₂ 4 h, 24 h, 72 h, and 5 d after treatment between the two groups was statistically significant (P<0.05), but PaCO₂ in the two groups could not reduce to the normal level. The levels of pH and PaCO₂ 4 h, 24 h, 72 h, and 5 d after treatment in the observation group were significantly different from those before treatment (P<0.05). The levels of pH and PaCO₂ 30 d after discharge were not significantly different from those before treatment (P>0.05) (Table 1).

3.2. Comparison of the hospitalization time and rehospitalization number between the two groups

The average hospitalization time and rehospitalization number within 3 months in the control group were significantly greater than

<table>
<thead>
<tr>
<th>Groups</th>
<th>Time</th>
<th>PaO₂</th>
<th>PaCO₂</th>
<th>pH value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation group</td>
<td>Before ventilation</td>
<td>62.30±13.52</td>
<td>86.32±13.73</td>
<td>7.32±0.05</td>
</tr>
<tr>
<td></td>
<td>4 h after treatment</td>
<td>71.20±16.25</td>
<td>70.20±14.30</td>
<td>7.38±0.05*</td>
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<tr>
<td></td>
<td>24 h after treatment</td>
<td>80.58±12.22</td>
<td>57.83±12.50</td>
<td>7.40±0.05*</td>
</tr>
<tr>
<td></td>
<td>72 h after treatment</td>
<td>82.32±10.68*</td>
<td>53.62±16.30</td>
<td>7.38±0.05*</td>
</tr>
<tr>
<td></td>
<td>5 d after treatment</td>
<td>86.37±10.59*</td>
<td>58.55±11.76*</td>
<td>7.39±0.05*</td>
</tr>
<tr>
<td></td>
<td>30 d after treatment</td>
<td>77.36±15.25*</td>
<td>61.93±13.17</td>
<td>7.33±0.05</td>
</tr>
<tr>
<td>Control group</td>
<td>Before ventilation</td>
<td>61.45±11.82</td>
<td>85.42±12.97</td>
<td>7.23±0.05</td>
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<tr>
<td></td>
<td>4 h after treatment</td>
<td>63.67±13.59</td>
<td>84.65±13.03</td>
<td>7.26±0.06</td>
</tr>
<tr>
<td></td>
<td>24 h after treatment</td>
<td>74.32±13.66</td>
<td>83.83±15.17</td>
<td>7.29±0.47</td>
</tr>
<tr>
<td></td>
<td>72 h after treatment</td>
<td>78.33±12.36</td>
<td>68.67±13.83</td>
<td>7.30±0.22</td>
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<tr>
<td></td>
<td>5 d after treatment</td>
<td>76.32±11.38</td>
<td>62.76±16.32</td>
<td>7.31±0.04</td>
</tr>
<tr>
<td></td>
<td>30 d after treatment</td>
<td>78.47±11.68</td>
<td>66.21±11.35</td>
<td>7.32±0.05</td>
</tr>
</tbody>
</table>

*P<0.05, when compared with the control group.
those in the observation group ($P<0.05$) (Table 2).

<table>
<thead>
<tr>
<th>Groups</th>
<th>n</th>
<th>Average hospitalization time (d)</th>
<th>Rehospitalization number within 3 months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>18</td>
<td>8.2±6.2*</td>
<td>6*</td>
</tr>
<tr>
<td>Control</td>
<td>18</td>
<td>13.3±8.6</td>
<td>14</td>
</tr>
</tbody>
</table>

* $P<0.05$, when compared with the control group.

4. Discussion

COPD is a common respiratory disease, with main pathological change of small airway structural stenosis caused by chronic inflammation, which can then destroy the pulmonary parenchyma, and reduce the pulmonary elastic recoil, resulting in carbon dioxide retention and respiratory failure. Respiratory failure is the most common complication developed in the advanced stage of COPD. The efficacy of the traditional artificial airway method in the treatment of COPD merged with respiratory failure is significant, but it is easy to cause a large amount of complications; therefore, searching for a more effective ventilation treatment method is becoming an urgent task to be resolved in the clinic.

Some researches demonstrate that NIPPV can effectively treat COPD merged with respiratory failure, with a significant efficacy. NIPPV can significantly improve the alveolar oxygenation and ventilation, especially the pulmonary ventilation/perfusion, with a more significant effect in preventing the pulmonary overexpansion and airway pressure elevation. During NIPPV treatment, each inhalation will receive a certain pressure to increase the inhalation power and tidal volume in order to reach an appropriate VC and increase the alveolar ventilation, PaCO₂ is accordingly reduced, and pH is recovered. Meanwhile, NIPPV can improve the respiratory muscle fatigue, and reduce the respiratory consumption. Moreover, the positive end expiratory pressure ventilation can effectively prevent the atelectasis and collapse of alveoli and small airway, and improve the imbalance of ventilation/blood flow and gas distribution. The results in the study showed that the improvement of blood gas indicators after ventilation treatment in the observation group was significantly superior to that in the control group ($P<0.05$), indicating that on the basis of the routine treatments, adding NIPPV can rapidly correct the ventilation state in patients with COPD merged with respiratory failure, and can contribute to the rehabilitation. The advantages of NIPPV are in the following: (1) having no artificial airway and complications; (2) can retain the normal feeding, swallowing, and coughing functions; (3) the occurrence rate of ventilator-associated pneumonia is low. However, a strict selection should be chosen for the severe patients in order to avoid delaying the treatment opportunity. In patients with many respiratory secretions, the artificial airway mechanical ventilation should be performed timely, which can rapidly correct the ventilation disturbance and control the infection, later, the non-invasive ventilation treatment is adopted, i.e. Invasive-non-invasive sequence treatment.

In conclusion, NIPPV can rapidly correct the respiratory failure state in patients with COPD merged with respiratory failure, improve the pulmonary function, and reduce the lung injury, with an accurate efficacy.

References