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Clinical observation of noninvasive positive pressure ventilation in the treatment of elderly patients with severe pneumonia and respiratory failure.

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Abstract

Objective: To investigate the clinical efficacy of noninvasive positive pressure ventilation in the treatment of elderly patients with severe pneumonia and respiratory failure.

Methods: A total of 85 elderly patients with severe pneumonia and respiratory failure treated in our hospital from November 2016 to June 2017 were divided according to different treatment methods as control group including 35 cases treated by routine treatment and experimental group including 50 cases treated by noninvasive positive pressure ventilation, the curative effect and resulting influence were compared between the two groups.

Results: Before treatment, no significant difference was found between the two groups in blood gas indexes of PaO_2 and $PaCO_2$ ($P>0.05$); while after treatment, the level of PaO_2 was significantly higher ($P<0.05$) and the level of $PaCO_2$ significantly lower in the experimental group compared with the control group ($P<0.05$). Before treatment, there was no significant difference between the two groups in indexes of HR, RR and SaO_2 ($P>0.05$); while after treatment, the indexes of HR as well as RR were significantly lower ($P<0.05$) and the SaO_2 index was significantly higher in the experimental group compared with the control group ($P<0.05$), the positive pressure ventilation time and hospitalization time of the experimental group were significantly shorter than those of the control group of statistical significance, ($P<0.05$).

Conclusion: In treatment of elderly patients with severe pneumonia and respiratory failure, noninvasive positive pressure ventilation is effective in improving blood gas indexes, ECG monitoring signs and clinical indicators in patients, thus worthy of clinical popularization and application.

Keywords: Elderly, Positive pressure ventilation, Severe pneumonia, Respiratory failure.

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Introduction

Severe pneumonia is a common respiratory disease in clinical practices, which can seriously endanger human health. The main causes of the disease include infection, immune damage, drug stimulation and allergy [1]. Respiratory failure is a common complication in patients with severe pneumonia and it is confirmed when the level of PaO_2 in severe pneumonia patients is lower than 60 mmHg and the level of $PaCO_2$ is higher than 50 mmHg [2]. Clinical studies have shown that [3] once the severe pneumonia patients suffer from respiratory failure, they will subject to significantly increased mortality rate. In recent years, the incidence of severe pneumonia complicated with respiratory failure in elderly patients is increasing and due to such factors as underlying diseases, low body resistance as well as poor nutritional status, there is a high possibility of respiratory failure after the onset of the disease, thus posing a serious threat to the life safety of the elderly patients. Noninvasive positive pressure mechanical ventilate technique is a new type of ventilation treatment. It can simulate people's normal respiratory function, increase the ventilatory capacity of alveolar pulmonis by means of positive pressure and promote pulmonary ventilation so as to effectively improve blood oxygen saturation and the symptoms of dyspnea in patients [4,5]. Because noninvasive positive pressure mechanical ventilators allows patients to spontaneously breathe with two continuous positive airway pressure levels, it, with combined characteristics of spontaneous breathing and controlled respiration, enhances synchrony of patient-ventilator with mechanical ventilation and reduces volume damages as well as the influence on hemodynamics. It also decreases work of breathing and oxygen consumption, increases alveolar ventilation, revives collapsed lungs and improves ventilation perfusion ratio, serving as a treatment method easy to be accepted by patients and attracting increasing attention in clinical practices. However, some scholars point out that noninvasive positive pressure ventilation is not able to provide high-level respiratory support and fails to take effective airway management. The key to treating elderly patients with severe pneumonia and respiratory failure is to effectively remove secretions and correct hypoxia as well as dyspnea. At present, there is insufficient report on the effect of noninvasive positive pressure ventilation on severe pneumonia associated with respiratory failure in the elderly. In this study we selected from in our hospital 85 elderly patients to make clear the application value of noninvasive positive pressure ventilation in the treatment of severe pneumonia complicated with respiratory failure as follows:

Data and Methods

General information

A total of 85 elderly patients with severe pneumonia and respiratory failure treated in our hospital from November 2016 to June 2017 were divided according to different treatment methods as control group including 35 cases and experimental group including 50 cases. In the control group there were 22 males and 13 females aged 60-75 with a mean age of (67.5 ± 2.1) years, including 10 cases of type I respiratory failure and 25 of type II respiratory failure. In the experimental group there were 30 males and 20 females aged 61-76 with a mean age of (68.5 ± 1.4) years old, 20 cases of type I respiratory failure and 30 of type II respiratory failure. There was no significant difference between the two groups in the basic data of no statistical significance (P>0.05).

Methods

The control group received conventional treatment, including oxygen inhalation through nasal catheter, vasodilator adoption, antibiotic medication and correction of acid-base balance as well as nutrition. The experimental group were given noninvasive positive pressure ventilation (NPPV) besides the treatment in the control group by using BIPAPVi-sion ventilator (Respironics Inc) with appropriate mask for patients in which ventilatory modes of pressure support mode as well as synchronization/time (S/T) mode were selected with the expiratory pressure of 4-8 cm H_2O, inspiratory pressure of 10-25 cm H_2O and ventilation frequency of 12 times/min. Ventilator parameters were adjusted with arterial partial pressure of oxygen (PaO_2) over 60 mmHg. When the disease was improved, respiratory conditions and inspired oxygen fraction (FiO_2) were lowered in time.

Observation index

The observation indexes in the two groups included the blood gas indexes of arterial oxygen partial pressure (PaO_2) and carbon dioxide partial pressure ($PaCO_2$) before and after treatment, the vital signs before and after treatment, the heart rate (HR), respiratory rate (RR) as well as blood oxygen saturation (SaO_2) revealed by ECG monitor, the positive pressure ventilation time and hospitalization time.

Statistical processing

Data were analyzed by SPSS21.0 software in which the measurement data were described as "$\overline{x} \pm s$" and assessed by t test, P<0.05 suggested that there was difference of statistical significance.

Results

Comparison of blood gas indexes between the two groups

Before treatment, no significant difference was found between the two groups in blood gas indexes of PaO_2 and $PaCO_2$ (P>0.05); while after treatment, the level of PaO_2 was significantly higher (P<0.05) and the level of $PaCO_2$ significantly lower in the experimental group compared with the control group (P<0.05) shown as Table 1.

Table 1. Comparison of blood gas indexes between the two groups (x ± s, mmHg).

Group	Case (n)	PaO_2		$PaCO_2$	
		Before Treatment	After Treatment	Before Treatment	After Treatment
Control group	35	54.8 ± 2.5	65.2 ± 2.7	65.7 ± 2.5	37.1 ± 1.3
Experimental group	50	54.6 ± 2.3	78.5 ± 3.4	66.3 ± 2.1	52.9 ± 1.6
t		0.347	6.792	0.226	7.945
p		>0.05	<0.05	>0.05	<0.05

Comparison of ECG monitoring vital signs between the two groups

Before treatment, there was no significant difference between the two groups in indexes of HR, RR and SaO_2 (P>0.05); while after treatment, the indexes of HR as well as RR were significantly lower (P<0.05) and the SaO_2 index was significantly higher in the experimental group compared with the control group (P<0.05) shown as Table 2.

Table 2. Comparison of ECG monitoring vital signs between the two groups (x ± s).

Group	Case (n)	HR time/min		RR time/min		SaO_2 (%)	
		Before Treatment	After Treatment	Before Treatment	After Treatment	Before Treatment	After Treatment
Control group	35	126.4 ± 4.7	109.2 ± 2.2	36.7 ± 3.1	28.8 ± 1.0	72.5 ± 3.1	88.2 ± 3.0
Experimental group	50	127.2 ± 5.8	90.3 ± 0.8	36.9 ± 2.7	20.0 ± 0.8	72.8 ± 2.6	97.0 ± 5.0
t		0.172	6.862	0.195	7.784	0.236	7.903
p		>0.05	<0.05	>0.05	<0.05	>0.05	<0.05

Comparison of positive pressure ventilation time and hospitalization time between the two groups

The positive pressure ventilation time and hospitalization time of the experimental group were significantly shorter than those of the control group of statistical significance, ($P<0.05$) shown as Table 3.

Table 3. *Comparison of positive pressure ventilation time and hospitalization time between the two groups (x ± s).*

Group	Case (n)	Positive pressure ventilation time (h)	Hospitalization time (d)
Control group	35	10.2 ± 2.2	28.8 ± 1.0
Experimental group	50	5.3 ± 0.8	15.0 ± 0.8
t		9.021	8.636
P		<0.05	<0.05

Discussion

Severe pneumonia is a critical disease in the respiratory system with main pathological features of inflammatory bleeding, lung tissue edema and alveolar consolidation [6]. The essence of severe pneumonia is acute pulmonary inflammation. It is one of common urgent and severe cases in respiratory system, often caused by bacteria, viruses as well as mycoplasma and easy to give rise to respiratory failure with high mortality rate [7-9]. During the treatment, the patient should be firstly ensured to breathe easy and then according to symptoms of the disease undergo ventilation therapy at appropriate time combined with anti-infection treatment to prevent damages of multiple organs. Elderly patients with severe pneumonia combined with respiratory failure should be given mechanical ventilation treatment. The invasive mechanical ventilation, however, has longer duration as well as high incidence of complications and in patients treated with tracheotomy, artificial airway has long service time with high probability of infection and the patients are routinely inserted with the nasal-gastric tubes, giving rise to a risk of gastroesophageal reflux [10-12]. Therefore, in our hospital we used non-invasive positive pressure ventilation to reduce ventilation time so as to reduce the risks in patients. The results of this study showed that before treatment, no significant difference was found between the two groups in blood gas indexes of PaO_2 and $PaCO_2$ ($P>0.05$); while after treatment, the level of PaO_2 was significantly higher ($P<0.05$) and the level of $PaCO_2$ significantly lower in the experimental group compared with the control group ($P<0.05$), suggesting that NPPV effectively relieved two blood gas indicators in patients. It can effectively reduce or suppress the production of inflammatory markers in tracheal cells to cause decreased respiratory permeability and alleviate edema of tracheal mucosa, expansion as well as relaxation of bronchial smooth muscle, that is to say, it manages to improve the blood gas indexes by alleviating pulmonary ventilation and dysfunction.

The results also showed that before treatment, there was no significant difference between the two groups in indexes of HR, RR and SaO_2 ($P>0.05$); while after treatment, the indexes of HR as well as RR were significantly lower ($P<0.05$) and the SaO_2 index was significantly higher in the experimental group compared with the control group ($P<0.05$),indicating that NPPV can effectively improve the ECG monitoring signs of HR, RR and SaO_2 perhaps because it can inhibit the production of phosphodiesterase in tracheal smooth muscle cells so as to lower intracellular concentration of Ca^2, activate protease A and G, promote activity of smooth muscle cells and enhance relaxation of the muscle with anti-inflammatory effect, thus making the patients' vital capacity increased with airway maintained patent [13,14]. On the other hand, it can improve heart rate and abnormal function of automatic nerve in patients by reducing the working time of sympathetic and parasympathetic nerve [15].

It was also shown in this study that: the positive pressure ventilation time of the control group (10.2 ± 2.2) h, significantly longer than that of the experimental group given non-invasive positive pressure ventilation, that was (5.3 ± 0.8) h; the hospitalization time of the control group was (28.8 ± 1) d, significantly longer than that of the experimental group, that was (15 ± 0.8) d, suggesting that NPPV treatment is effective in reducing the positive pressure ventilation duration and hospitalization time. In the course of NPPV treatment, patients can be helped while breathing in to overcome airway resistance as well as flexibility and improve alveolar ventilation, which facilitates to exchange gas and eventually improves the function of ventilation as well as oxygenation so as to correspondingly shorten positive pressure ventilation time and hospitalization stay. Limited by external environment, time and number of cases, the adverse effects of noninvasive positive pressure ventilation on elderly patients with severe pneumonia and respiratory failure are required to be further analyzed and supplemented in future researches.

To sum up, the treatment of NPPV is effective in promoting the blood gas indexes of PaO_2 and $PaCO_2$, gradually improving the ECG signs of HR and RR and SaO_2 and shortening the positive pressure ventilation duration as well as hospitalization stay in elderly patients with severe pneumonia and respiratory failure.

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