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Analysis of the Effect of Non-Invasive Positive Pressure Ventilation in Emergency Treatment of Severe Bronchial Asthma with Respiratory Failure

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Abstract: *Objective:* This study aims to evaluate the clinical efficacy of non-invasive positive pressure ventilation (NIPPV) in patients with severe bronchial asthma combined with respiratory failure. *Methods:* 90 patients with severe bronchial asthma combined with respiratory failure between September 2022 and December 2023 were selected for the study and randomly divided into the experimental group (NIPPV-assisted treatment) and the control group. The differences between the two groups were compared in terms of total effective rate of treatment, days of clinical symptom disappearance, days of hospitalization, lung function indexes, incidence of adverse reactions, and quality of life. *Results:* Patients in the experimental group had a significantly higher total effective rate of treatment (97.78%) than the control group (75.56%). In terms of pulmonary function indexes, patients in the experimental group showed significant improvement after treatment, especially the increase in forced expiratory volume and forced vital capacity, while these improvements were not as obvious in the control group. In addition, the incidence of adverse reactions was significantly lower in the experimental group than in the control group, suggesting that the application of NIPPV is relatively safe. Quality of life assessment also showed that patients in the experimental group had significantly better quality of life than the control group after treatment. *Conclusion:* This study demonstrated the effectiveness of NIPPV as an adjunctive treatment for severe bronchial asthma combined with respiratory failure. NIPPV can improve lung function, reduce the incidence of adverse effects, increase the overall effectiveness of the treatment, and contribute to the improvement of patients' quality of life. Therefore, NIPPV should be regarded as an effective and safe treatment in clinical management, especially in patients with severe bronchial asthma combined with respiratory failure, where its application has potential clinical significance.

Keywords: Non-invasive positive pressure ventilation; Adjunctive therapy; Respiratory failure; Severe bronchial asthma combined with respiratory failure; Outcome assessment

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1. Introduction

Severe bronchial asthma is a common respiratory disease characterized by reversible airway narrowing due to airway hyperresponsiveness [1]. Acute exacerbations of this condition may lead to severe dyspnea and even respirato-

ry failure, posing a significant threat to the patient's health [2]. Respiratory failure is a serious clinical condition that occurs when the patient is unable to maintain normal gas exchange, resulting in decreased oxygen saturation and carbon dioxide accumulation. Therefore, effective management in the acute phase is essential to improve the clinical prognosis of patients. Non-invasive positive pressure ventilation (NIPPV), as an adjunctive respiratory support technique, has shown potential value in recent years in the treatment of respiratory failure, especially due to severe bronchial asthma. NIPPV is able to improve ventilation and oxygenation, reduce airway resistance [3], and promote airway opening in patients through mechanical force. Compared with traditional invasive mechanical ventilation, NIPPV has the advantages of less trauma, lower risk of complications, and higher patient comfort, and is increasingly used in clinical practice [4]. Understanding the clinical effects of NIPPV in this patient population not only helps to optimize the treatment plan but may also provide a reference for the treatment of other related diseases [4]. Therefore, exploring the value of NIPPV in the treatment of severe bronchial asthma combined with respiratory failure is of great significance in improving the therapeutic outcome and quality of life of patients.

2. Clinical data and methods

2.1. Clinical data

In the present study, 90 patients with severe bronchial asthma combined with respiratory failure between September 2022 and December 2023 were selected and divided into a control group (n = 45) and an experimental group (n = 45). The experimental group had 16 females and 29 males; the age range was from 46 to 73 years, with a mean of 68.79 ± 1.19 years; the control group had 17 females and 28 males; the age range was from 45 to 74 years, with a mean of 68.82 ± 1.22 years. After clinical statistics review and confirmation, the basic data of this study can be entered into the database for comparison ($P > 0.05$).

Inclusion criteria: the basic data of all patients in this study were registered completely; patients received relevant health education before accepting the test and had a complete understanding of the test experiment; patients signed the informed consent independently, and patients who could not take care of themselves were signed by their family members who agreed to sign on their behalf.

Exclusion criteria: patients with primary organic diseases; patients who received relevant treatment within three months before this study; patients who participated in other studies within three months before this study; patients with abnormal cognitive function or family members strongly opposed to this experiment.

2.2. Treatment methods

All patients in this study were treated for one week. Both groups of patients were given routine oxygen inhalation, expectorants, a moderate amount of theophylline, and terbutaline, with nebulized inhalation of a small amount of bronchodilators. Depending on the condition, appropriate antibiotics were selected to control infections, while maintaining clear airways and ensuring acid-base and fluid balance in the body.

In the control group, patients undergoing treatment chose to use budesonide combined with terbutaline. Budesonide was administered by healthcare personnel via inhalation therapy, with patients using the medication 2–6 times daily, adjusted according to individual conditions. Terbutaline was administered via nebulization during treatment, with researchers placing 5 mg of terbutaline in the nebulization device. Patients were instructed to direct the treatment towards their mouth and nose, administering the medication twice daily, with each inhalation session lasting 10 minutes.

During treatment, the experimental group patients received conventional therapy combined with non-invasive positive pressure ventilation. During the treatment process, researchers adjusted the breathing mode to S/T, set the expiratory pressure to 4–8 cm H_2O, oxygen concentration to 45–50%, oxygen saturation above

90%, and oxygen flow rate to 5–8 L/min. All patients in this study received treatment for one week.

2.3. Observation indexes

The total effective rate of treatment, the number of days of clinical symptom disappearance, and the number of days of hospitalization of patients with acute exacerbation of severe bronchial asthma combined with respiratory failure in the two groups were observed and compared. Cured: the respiratory function of the patients after treatment is obviously improved, and after the researchers evaluated the lung function indexes of the patients, the safety of the treatment of the patients is good; Effective: the lung function of the patients after treatment is obviously improved, and the individual condition of the patients is stable after receiving the treatment with no adverse reactions; Ineffective: the lung function indexes of the patients after treatment are not completely improved, and the condition worsens [4]. When evaluating the patient's condition, their respiratory mechanics indicators and lung infection status were recorded.

2.4 Statistical methods

This study used SPSS21.00 for Windows to analyze the basic data of the patients as well as the experimental data and the statistical methods such as *t*-test for measurement data and χ^2 test for counting data were applied, and the level of significance was set at $P < 0.05$.

3. Results

3.1. Comparison of total effective rate of treatment between the two groups

The total effective rate of treatment in the experimental group (97.78%) was not significantly different from that of the patients in the control group (75.56) ($P > 0.05$), as shown in **Table 1**.

Table 1. Clinical comparison of total effective rate between the two groups [n (%)]

Groups	Cured	Effective	Ineffective	Overall effective rate
Experimental group ($n = 45$)	24	20	1	97.78%
Control group ($n = 45$)	16	18	11	75.56%
χ^2 value	-	-	-	9.928
P value	-	-	-	0.002

3.2. Comparison of treatment efficiency between the two groups

The conditions of patients in both groups were improved to a certain extent after the completion of treatment, while the differences in the days of clinical symptom disappearance and the days of hospitalization between patients in the experimental group and the control group were not statistically significant ($P > 0.05$), as presented in **Table 2**.

Table 2. Comparison of treatment efficiency between the two groups [days, mean ± standard deviation (SD)]

Groups	Days of clinical symptom disappearance	Days of hospitalization
Experimental group ($n = 45$)	4.35 ± 0.25	6.35 ± 0.75
Control group ($n = 45$)	4.15 ± 0.55	6.79 ± 1.02
t value	2.124	1.928
P value	0.123	0.126

3.3. Comparison of the incidence of adverse reactions between the two groups

Both groups of patients have different degrees of adverse reactions, and compared with the control group, the incidence of adverse reactions in the experimental group was lower, and the difference was significant ($P < 0.05$), as shown in **Table 3**.

Table 3. Comparison of the incidence of adverse reactions between the two groups

Groups	Skin symptoms	Vertigo	Infection	Total incidence
Experimental group ($n = 45$)	1	0	1	4.44%
Control group ($n = 45$)	3	2	2	15.56%
χ^2 value	-	-	-	9.746
P value	-	-	-	0.000

3.4. Comparison of lung function indexes between the two groups

There was no significant difference between the lung function of the two groups before treatment, $P > 0.05$. After treatment, the lung function of the observation group was significantly better than that of the control group, and the lung function of the experimental group was significantly strengthened, $P < 0.05$ (**Table 4**).

Table 4. Lung function indexes (mean ± SD)

Groups	FEV_1 (L)		FVC (L)		FEV_1/FVC (%)	
	Before treatment	After treatment	Before treatment	After treatment	Before treatment	After treatment
Experimental group ($n = 45$)	0.86 ± 0.22	1.92 ± 0.89	1.76 ± 0.24	2.83 ± 0.26	52.46 ± 2.34	72.61 ± 2.48
Control group ($n = 45$)	0.84 ± 0.18	1.43 ± 0.75	1.74 ± 2.31	2.11 ± 0.34	51.98 ± 2.28	68.97 ± 2.11
t value	0.4163	2.4907	0.0509	9.9518	0.8692	6.6145
P value	0.6785	0.0152	0.9595	0.0000	0.3878	0.0000

FEV: forced expiratory volume; FVC: forced vital capacity

3.5. Comparison of the quality of life between the two groups before and after treatment

The quality of life of patients in the experimental group was significantly better than that of the control group ($P < 0.05$), as shown in **Table 5**.

Table 5. Comparison of the quality of life between the two groups before and after treatment (mean ± SD, points)

Groups	Time	Physical function	Material life	Psychological function	Self-care ability
Experimental group ($n = 45$)	Before treatment	29.80 ± 5.21	29.73 ± 3.62	35.06 ± 3.42	49.02 ± 5.21
	After treatment	47.86 ± 3.44	44.86 ± 3.86	49.80 ± 3.85	47.86 ± 3.40
Control group ($n = 45$)	Before treatment	30.00 ± 5.13	29.86 ± 3.62	35.22 ± 3.32	30.03 ± 5.12
	After treatment	40.11 ± 3.42	39.06 ± 3.84	45.93 ± 3.41	41.93 ± 3.42

4. Discussion

Severe bronchial asthma combined with respiratory failure is a common but serious clinical condition, which not only poses a direct threat to the patient's life and health but also puts a huge pressure on medical resources

[5]. Such patients often exhibit features such as highly reactive airways, airway narrowing, and excessive mucus, which lead to impaired gas exchange and thus respiratory failure. The occurrence of respiratory failure signifies that the patient's lungs are no longer able to exchange gas effectively, resulting in the inability of the body to obtain sufficient oxygen and the inability to expel carbon dioxide from the body, once respiratory failure occurs, the patient's life is hanging by a thread. Therefore, timely and effective therapeutic strategies are essential to improve the clinical prognosis of patients [6].

The results of the present study evaluated the effectiveness of non-invasive positive pressure ventilation therapy, especially its role in improving lung function, shortening the time of clinical symptom disappearance, reducing the number of hospitalization days, decreasing the incidence of adverse effects, and enhancing the quality of life. The results showed that NIPPV treatment significantly increased the overall treatment efficacy rate, improved patients' lung function indexes, reduced the incidence of adverse reactions, and significantly enhanced patients' quality of life. This finding provides strong evidence for the clinical treatment of severe bronchial asthma combined with respiratory failure and proves the effectiveness and safety of NIPPV as an adjunctive treatment.

NIPPV can effectively improve respiratory function in patients with severe bronchial asthma combined with respiratory failure, which is consistent with the mechanism of action of NIPPV to reduce work of breathing, lower airway resistance, and improve gas exchange. NIPPV improves ventilation and oxygenation by providing positive pressure support, helping patients overcome airway resistance, and reducing the burden on respiratory muscles, which is essential for preventing or reversing the development of respiratory failure. During treatment, NIPPV therapy not only improved lung function indices, such as FEV1 and FVC, but also significantly reduced the incidence of adverse events. This demonstrates the advantages that NIPPV has over traditional invasive mechanical ventilation. Since NIPPV avoids the need for endotracheal intubation, it reduces the risk of infection, improves patient comfort, and therefore reduces the incidence of adverse events, a feature that is important for improving treatment acceptance and overall patient satisfaction. This study also found that the quality of life of patients after NIPPV treatment was significantly better than that of the control group, and the results of the current study reflect that NIPPV can effectively improve the quality of life of patients while enhancing their respiratory function. The improvement of quality of life not only includes the improvement of physical health but also covers the improvement of mental health, social function, and daily activity ability, which is of positive significance for the comprehensive rehabilitation of patients.

5. Conclusion

In summary, this study emphasizes the important role of NIPPV in the treatment of severe bronchial asthma combined with respiratory failure. NIPPV is not only effective in increasing the total effective rate of the treatment and improving the lung function indexes but also reduces the incidence of adverse effects and significantly enhances the quality of life of patients. Therefore, NIPPV should be regarded as an effective and safe adjunctive therapy and should be more widely used in the treatment of patients with severe bronchial asthma combined with respiratory failure.

Disclosure statement

The author declares no conflict of interest.

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