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*Original Article*

# The clinical effect of a bronchofiberscope in treating severe ventilator-associated pneumonia

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**Abstract:** Objective: To analyze the clinical effect of fiberoptic bronchoscopy in treating severe ventilator-associated pneumonia (VAP). Methods: From September 2018 to October 2019, 100 patients with severe VAP were recruited as the study cohort and randomly divided into two groups, with 50 patients in each group. The control group underwent routine treatment, such as lavage, and the experimental group underwent fiberoptic bronchoscopy. The effectiveness rates, recovery times, and respiratory mechanics indexes of the two groups were compared. Result: The total effective rate of the clinical treatment in the experimental group was significantly higher than it was in the control group ($P < 0.05$), and the recovery time in the experimental group was significantly shorter than it was in the control group ($P < 0.05$). After the treatment, the experimental group was significantly better than the control group ($P < 0.05$). After the treatment, the IL-8, CRP, and PCT levels in the experimental group were significantly lower than they were in the control group ($P < 0.05$). Conclusion: Fiberoptic bronchoscopy can significantly improve the therapeutic effect of VAP, significantly shorten patients' recovery times, significantly improve the respiratory mechanics-related indicators, and improve the therapeutic effect, so it is worthy of promotion.

**Keywords:** Fiber bronchoscope, severe, ventilator-associated pneumonia, respiratory mechanics

## Introduction

Ventilator associated pneumonia (VAP) is a disease that occurs 48 hours after mechanical ventilation and 48 hours after extubation. VAP is the main pathogenesis of hospital-acquired pneumonia and is a serious complication of mechanical ventilation [1]. In the general hospital ICU departments, it is very important to take patients off line smoothly during VAP treatment, and this is also a problem that ICU doctors need to solve urgently. Most of the patients are older, and they have low resistance and long hospitalization times, which s lead to an increase in their probability of becoming infected. Post-VAP patients are very prone to expectoration, dysbacteriosis, and even death in serious cases [2, 3]. The principle of severe VAP clinical treatment is to improve patients' pulmonary infection and respiratory functions. The conventional methods include anti infection, sputum lavage, and so on. However, conventional VAP is labor intensive and requires some degree of subjective interpretation. Therefore, interobserver variability is unavoidable, and the incidences of VAP in different hospitals may vary due to the different diagnostic algorithms that are used [4]. Moreover, this may affect comparisons between different studies and influence our understanding of the epidemiology of VAP.

With the development of medical science and technology, fiberbronchoscope technology plays an important role in the examination and treatment of respiratory system diseases. It can not only remove the patients' lung secretions, it can relieve obstructions of the trachea and other problems, but it also cultivates the corresponding antibiotics in the post-treatment period for the sputum cultures of the secretions, which is of great significance for the treatment of the disease [5-7]. The purpose of this study is to investigate the effect of bronchofiberscopes in the treatment of severe VAP.

## Data and methods

### *General information*

From September 2018 to October 2019, 100 patients with severe VAP were recruited as the

study cohort and randomly divided into two groups, with 50 patients in each group. There were 26 males and 24 females in the control group, and they ranged in age from 42-77 years old and had an average age of (62.38±7.81) years old. There were 27 males and 23 females in the experimental group, and they ranged in age from 43-76 years old and had an average age of (63.72±7.28) years old. The two groups' data were compared (P > 0.05). All the patients were confirmed to suffer from VAP through lung histopathology and microbiology. Inclusion criteria: ① Patients admitted to our hospital. ② Patients whose duration of mechanical ventilation was more than 2 hours. ③ Patients with other major organ function diseases. ④ Patients who needed a ventilator to maintain life. ⑤ Patients whose pneumonia occurred within 48 hours after their tracheal intubation and 48 hours after their extubation. Exclusion criteria: ① Patients with blood system or immune system diseases. ② Patients with mental diseases or serious communication disorders. ③ Patients with heart or kidney dysfunction.

*Methods*

The control group was treated with conventional drugs and with routine therapy, combined with lavage and sputum aspiration and routine drug therapy. The sputum samples from the deeper part of the patient's trachea were cultured for bacteria. Next, a drug sensitivity test was carried out. After routine irrigation, the corresponding antibiotics were given for antibacterial treatment. This study was approved by the Ethics Committee of Zhejiang Hospital. All the study participants provided a written informed consent before participating in the study.

The experimental group was given the same treatment the control group received, but the experimental group was also treated with fiberoptic bronchoscopy. The patient was placed in a supine position, and a fiberbronchoscope was inserted through one side of the unobstructed nasal cavity and extended to the position of the patient's side bronchus to find and determine the pathological location. In the later stage, the sputum from the patient's trachea was taken for bacterial culture until the bacterial colony was successful, and then a drug sensitivity test was administered. After an appropriate concentration of sodium chloride solution was sterilized, 250 ml was taken at room temperature, 120 mg ambroxol hydrochloride was added and injected three times. After withdrawing the fiberscope, antibiotics were injected immediately to prevent infection. During the irrigation operation, the total amount of irrigation was ≤ 30 ml.

*Observation indicators*

The therapeutic effect, recovery times, and respiratory mechanics indexes of the two groups were compared. Among them, ① A comparison of the treatment effectiveness: the total effective rates of the patients after the different treatments. A. significant effect: the patient's disease completely disappeared, the etiology test results were normal, B. effective: the patient's disease significantly improved, the positive indicators in the etiology monitoring included 2 items, C. ineffective: the patient's disease did not improve, or it even worsened, the etiology test indicators did not change significantly compared with before the treatment. ② Recovery time comparison between the two groups of patients. The Patients' pulmonary infection times, recovery times and durations in the ICU. ③ The respiratory mechanics indexes were compared with the changes in the peak airway pressure (PIP), airway resistance, and the respiratory work (WOB) indexes in the two groups. ④ The IL-8, CRP, and PCT changes before and after the treatment were observed in the two groups.

*Statistical analysis*

The data included in the SPSS 22.0 software analysis included ($\bar{x} \pm s$) is measurement data, t-test; (%) for the count data, $X^2$ chi square tests, and P < 0.05 indicated statistical significance. GraphPad Prism 7 was used to analyze the results.

## Results

*Comparison of clinical efficacy between the two groups*

After the bronchofiberscope assisted treatment, 36 cases were effective in the experimental group (n = 50), 10 cases were effective, for a total effective rate of 92.00% (46/50), which was significantly higher than in the control group (n = 50), 68.00% (34/50) (P < 0.05), as shown in **Table 1**.

**Table 1.** The clinical efficacy of the two groups [n (%)]

| Group | Number of cases | Markedly effective | Effective | Invalid | Total effective rate |
|---|---|---|---|---|---|
| Experimental group | 50 | 36 (72.00) | 10 (20.00) | 4 (8.00) | 46 (92.00) |
| Control group | 50 | 23 (46.00) | 11 (22.00) | 16 (32.00) | 34 (68.00) |
| $x^2$ | - | 6.986 | 0.060 | 9.000 | 9.000 |
| P | - | 0.008 | 0.806 | 0.003 | 0.003 |

**Table 2.** A comparison of the postoperative recovery indexes between the two groups ($\bar{x} \pm s$)

| Group | Number of cases | Time of pulmonary infection (d) | Recovery time (d) | Stay in ICU (d) |
|---|---|---|---|---|
| Experimental group | 50 | 6.54±1.23 | 7.95±1.93 | 10.43±2.27 |
| Control group | 50 | 10.77±2.34 | 12.86±2.14 | 14.65±3.31 |
| t | - | 11.3144 | 12.080 | 7.435 |
| P | - | 0.000 | 0.000 | 0.000 |

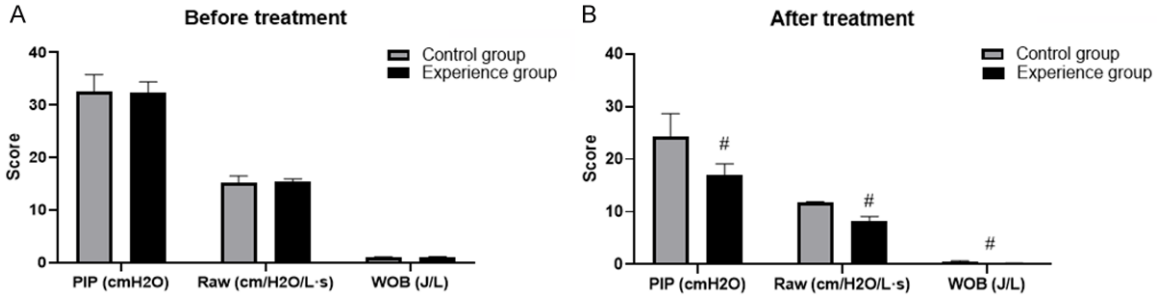


**Figure 1.** A comparison of the respiratory mechanics indexes between the two groups. Our comparison showed that there was no significant difference between the two groups before the intervention (P > 0.05) (A), but the indexes of the patients in the study group were significantly lower than they were in the control group after the intervention (P < 0.05) (B). # means that the difference between the same index in the two groups was statistically significant.

*A comparison of the recovery times in the two groups*

The pulmonary infection recovery times and the durations of the ICU stays in the experimental group were significantly shorter than they were in the control group (P < 0.05), as shown in **Table 2**.

*Comparison of respiratory mechanics indexes between the two groups*

After the treatment, the PIP, raw, and WOB indexes in the experimental group were significantly lower than they were in the control group (P < 0.05), as shown in **Figure 1**.

*Comparison of the serum inflammatory factor level changes between the two groups*

There was no difference in the inflammatory factor levels between the two groups before the treatment (P > 0.05). After the treatment, the IL-8, CRP, and PCT levels in the experimental group were significantly lower than they were in the control group (P < 0.05), as shown in **Figure 2**.

## Discussion

The characteristics of severe VAP are as follows: with the aggravation of the disease, the patient's condition develops rapidly. In a short period of time, it is easy to have multiple serious diseases such as respiratory and organ failure, and Severe VAP can also easily cause a systemic inflammatory reaction in a short period of time. It has a high mortality rate in clinical medicine [8, 9]. Respiratory failure is one of the main conditions that create the need for mechanical ventilation. Mechanical ventilation can help patients maintain normal respiratory function, but staying on it for too long a time will easily lead to VAP, resulting in the aggravation

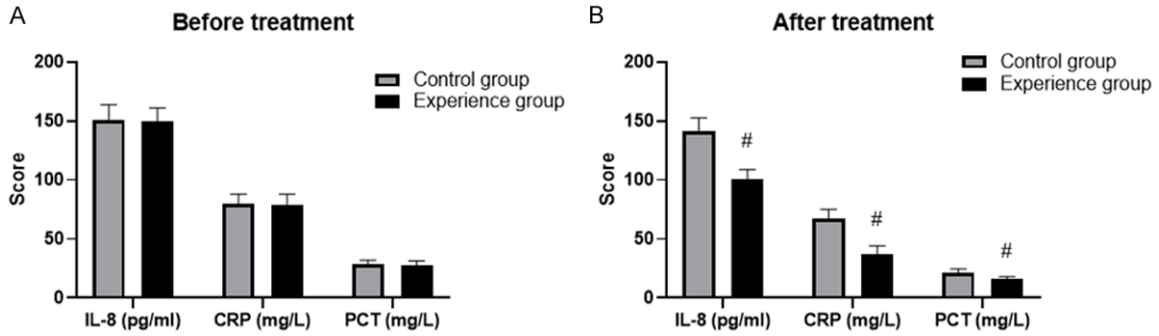


**Figure 2.** A comparison of the changes in the serum inflammatory factor levels between the two groups. Our comparison showed that there were no significant differences between the two groups before the intervention ($P > 0.05$) (A), but the level of each index in the study group was significantly lower than the corresponding index level in the control group after the intervention ($P < 0.05$) (B). # means that the difference between the same index in the two groups was statistically significant.

of the patients' condition. At present, in the treatment of VAP, the patients' respiratory secretions and sputum should be removed first, their pulmonary infections should be strictly controlled, and pulmonary dilatation should be avoided as much as possible [10, 11]. During the routine lavage and sputum suction of VAP, the entire process of sputum suction in patients cannot be observed clearly, and this has a negative impact on the analysis of the patients' symptoms [12]. The antibiotic treatment alone is insufficient, which seriously affects the follow-up implementation and effect of the treatment. Fiberoptic bronchoscopy can effectively shorten the mechanical ventilation time, improve the respiratory function, shorten the recovery time, and improve the quality of life and the recovery speed [13-15].

In this study, 36 cases in the experimental group and 10 cases in the effective group were significantly better than the patients in the control group (92.00%, 68.00%, $P < 0.05$). The patients' recovery times in the experimental group were significantly shorter than they were in the control group ($P < 0.05$). There was no difference in the WOB index levels between the two groups ($P > 0.05$). After the treatment, all the data in the experimental group were significantly lower than the corresponding data in the control group ($P < 0.05$). There was no difference in the content of the inflammatory factors between the two groups before the treatment ($P > 0.05$). After the treatment, the IL-8, CRP, and PCT levels in the experimental group were significantly lower than they were in the control group ($P < 0.05$). This causal analysis shows that the use of fiberbronchoscopes in practical operations is convenient and simple, and they can enable the lung tissue to be explored directly during the treatment, and the bronchi and lungs are washed repeatedly, which ensures that the sputum of the patients' bronchi is cleared more thoroughly, and the accumulation of purulent liquid and secretions in the diseased parts of the lung tissue is eliminated, and this prevents inflammation and multiple infections or the spread of infections. Fiberoptic bronchoscopy technology originated in the 1970s, has become relatively mature, and is widely used in clinical examinations, disease diagnosis, and auxiliary treatment by the medical community [16-18]. This study is similar to Chen Beibei's [19] analysis and discussion, which shows that patients with severe VAP have a significantly improved curative effect and respiratory system related functions after treatment with fiberbronchoscopes, so it has a good clinical effectiveness [20]. Because the purulent secretions of the respiratory tracts of the patients with severe VAP will have a serious negative impact on the oxygenation function of the alveoli, which makes it impossible for the human body to convert the carbon dioxide in the inhaled gas into oxygen, thus hindering the respiratory function [21]. In former routine treatments, patients with VAP were treated with lavage and the cleaning of the respiratory tract alone or with antibiotics, which was ineffective [22]. With the development of science and technology, fiberbronchoscope technology is becoming more and more mature, so it is becoming an important medical means in the examination and treatment of respiratory dis-

eases. This method is characterized by accurate positioning, which can achieve the local irrigation and local removal of the diseased organs of the respiratory system, and it can effectively remove the bad secretions in the respiratory tract. In recent years, the use of fiberoptic bronchoscopy-assisted treatment has enabled severe VAP patients to promptly and effectively remove the body waste that affects the normal operation of the main functions of the respiratory system, in order to ensure the normal operation of the alveolar gas exchange function. If we add antibiotics to the lavage, it can directly affect local pathogens and completely eliminate them [23]. In addition, fiberbronchoscope technology can also effectively absorb the deeper secretions of human body quickly under direct vision irrigation, so it is more helpful to keep the patient's respiratory system unobstructed, further improving the respiratory function, and improving the actual effect of the clinical treatment. Fiberbronchoscopes can enter the body through the nasal cavity of the patient and directly reach the lower respiratory tract, performing deep secretion absorption function. Because of its soft and flexible structure, and its small volume and diameter, it can clear and explore patients' artificial airways and respiratory systems, help retain sputum samples for later culture, help guide the selection of antibiotics and targeted treatment, and improve the treatment effect [24]. In addition, the use of fiberoptic bronchoscopes to clear the focus and the accumulation of secretions in the respiratory system can not only accelerate the recovery of lung ventilation function, but it can also promptly control the development of various related inflammations and promote the recovery of the disease through the use of antibiotics through sputum culture. The respiratory mechanics data, such as pressure, resistance, respiratory work and so on, are commonly used indicators for monitoring mechanical ventilation. The fluctuation ranges of the various parameters are different, and they will play a key role in the development of patients' conditions [25]. Among them, the two treatment methods used in the control group and the experimental group can improve the patients' respiratory functions, and the respiratory mechanics data in the fiberbronchoscope treatment group was significantly better than it was in the control group, which shows that the treatment effect is better, and the effect of clearing the deep secretions of the trachea appears again [26]. In severe VAP patients with severe systemic inflammation, the IL-8, CRP, and PCT levels were significantly increased. The observation results can directly reflect the development of the disease in the treatment. After the treatment, the data showed that the fiberoptic bronchoscopy can improve all the organ injuries caused by systemic inflammation.

The present study has certain limitations. The small size of our study (only 50 patients with VAP were included) is one limitation. Our patients' VAP-causing pathogens might essentially reflect our local ecology. Whether or not the same microorganism distribution would be found in other ICUs remains to be explored. Since we did not compare the bacterial strains genetically, we cannot formally rule out this hypothesis.

To sum up, fiberoptic bronchoscopy assisted treatment can improve the cure efficiency of severe VAP, improve patients' inflammatory states, improve patients' recovery effects, and it has a high clinical effectiveness, so it is worthy of promotion.

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## Disclosure of conflict of interest

None.

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## References

[1] He Y. Clinical efficacy of bronchofiberscope sputum aspiration combined with ambroxol in the treatment of ventilator-associated pneumonia. Journal of Practical Cardio Cerebrovascular Diseases 2016; 24: 352-353.

[2] Song G, Zhang L and Zhou F. Study on the adjuvant treatment of severe ventilator-associated pneumonia with fiberbronchoscope. Hebei Medicine 2016; 38: 2636-2638.

[3] Huang X, Shen G and Yu R. Study on the effect of fiberoptic bronchoscopy on severe VAP patients. Hebei Medicine 2016; 6.
[4] Chang HC, Chen CM, Kung SC, Wang CM, Liu WL and Lai CC. Differences between novel and conventional surveillance paradigms of ventilator-associated pneumonia. Am J Infect Control 2015; 43: 133-6.
[5] Chen H, Zeng G, Tang Z, Mei L, Zeng H and Tang H. The effect of bronchofiberscope alveolar lavage on systemic inflammatory response and respiratory mechanics in patients with severe pneumonia. Chinese Journal of Physicians 2019; 21: 1251-1253.
[6] Walaszek M, Gniadek A, Kolpa M, Wolak Z and Kosiarska A. The effect of subglottic secretion drainage on the incidence of ventilator associated pneumonia. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub 2017; 161: 374-380.
[7] Yang S, Liu X, Dong L and Yang X. Application of bronchofiberscope combined with bronchoalveolar lavage in children with severe pneumonia and atelectasis. Chinese Journal of Coal Industry Medicine 2018; 19: 647-648.
[8] Yagmurdur H, Tezcan AH, Karakurt O and Leblebici F. The efficiency of routine endotracheal aspirate cultures compared to bronchoalveolar lavage cultures in ventilator-associated pneumonia diagnosis. Niger J Clin Pract 2016; 19: 46-51.
[9] Lei Y. Effect analysis of bronchoscopic alveolar lavage in severe pneumonia. Journal of Clinical Emergency 2016; 841-843.
[10] Moiseeva TN, Al-Radi LS, Sharkunov NN, Chernova NG, Klyasova GA, Gracheva AN, Baryakh EA, Maryin DS, Shitareva IV, Julakyan UL, Kostina IE, Sinitsina MN, Galstyan GM and Kravchenko SK. Pneumocystis pneumonia in patients with Hodgkin lymphoma. Ter Arkh 2014; 86: 60-65.
[11] McIntire AM, Harris SA, Whitten JA, Fritschle-Hilliard AC, Foster DR, Sood R and Walroth TA. Outcomes following the use of nebulized heparin for inhalation injury (HIHI Study). J Burn Care Res 2017; 38: 45-52.
[12] Yang X, Chen BB, Zhang MH, Zhao S and Mo BQ. Influence of fiberoptic bronchoscopy on respiratory mechanical parameters of patients with severe ventilator-associated pneumonia. Chinese Journal of Nosocomiology 2015; 1781-1783.
[13] Xin M, Han L and Li J. Analysis of the clinical and fibrobronchoscopic characteristics of severe Staphylococcus aureus pneumonia. Chinese Pediatric Emergency Medicine 2018; 25: 791-793.
[14] Gupta R and Espiritu J. Azathioprine for the rare case of nonspecific interstitial pneumonitis in a patient with psoriasis. Ann Am Thorac Soc 2015; 12: 1248-1251.
[15] Liu Y and Zhu C. The effect of bronchofiberscope alveolar lavage on sputum bacterial clearance and disease progression in children with severe pneumonia. J Pediatr 2019; 25-28.
[16] Yuan Y, Zhang H, Zhang X, Xiao Z, Lu X, Yang M, Zhou X and Liu M. Observation on the therapeutic effect of bronchofiberscope alveolar lavage on children with severe pneumonia with mechanical ventilation. Chinese Pediatric Emergency Medicine 2019; 26: 27-31.
[17] Gupta J, Nagpal VK, Kaur M, Sharma J, Goila AK and Kathor N. Comparison of blind endotracheal aspiration and bronchoscopic brush biopsy sampling methods for bacteriological diagnosis of ventilator-associated pneumonia in intensive care unit. Anesth Essays Res 2018; 12: 695-699.
[18] Wood GC, Jonap BL, Maish GO 3rd, Magnotti LJ, Swanson JM, Boucher BA, Croce MA and Fabian TC. Treatment of achromobacter ventilator-associated pneumonia in critically Ill trauma patients. Ann Pharmacother 2018; 52: 120-125.
[19] Chen C, Yan M, Hu C, Lv X, Zhang H and Chen S. Diagnostic efficacy of serum procalcitonin, C-reactive protein concentration and clinical pulmonary infection score in ventilator-associated pneumonia. Med Sci (Paris) 2018; 34 Focus issue F1: 26-32.
[20] Dennis BM, Betzold RD, Patton D, Hopper HA, Jenkins J, Fonnesbeck C, Drake W and May AK. Bacterial burden in critically injured ventilated patients does not correlate with progression to pneumonia. Surg Infect (Larchmt) 2018; 19: 369-375.
[21] Duarte JC, Cordeiro CR and Ferreira AJ. Role of flexible bronchoscopy in non-resolving community-acquired pneumonia - a retrospective analysis. Rev Port Pneumol (2006) 2017; 23: 168-169.
[22] Slebos DJ, Shah PL, Herth FJF, Pison C, Schumann C, Hübner RH, Bonta PI, Kessler R, Gesierich W, Darwiche K, Lamprecht B, Perez T, Skowasch D, Deslee G, Marceau A, Sciurba FC, Gosens R, Hartman JE, Srikanthan K, Duller M and Valipour A. Safety and adverse events after targeted lung denervation for symptomatic moderate to severe chronic obstructive pulmonary disease (AIRFLOW). A multicenter randomized controlled clinical trial. Am J Respir Crit Care Med 2019; 200: 1477-1486.
[23] Han Q, Chen C, Fu R, Tan L and Xia L. Portable fibrobronchoscopic treatment for non-severe ischemic stroke-associated pneumonia patients with dysphagia: a pilot study. Neurol Res 2019; 41: 216-222.

[24] Cao LJ, Liu JH, Shuai JF, Niu B, Lu SK and Huang KL. Efficacy of early treatment via fiber bronchoscope in children with Mycoplasma pneumoniae pneumonia complicated by airway mucus obstruction. Zhongguo Dang Dai Er Ke Za Zhi 2018; 20: 298-302.

[25] Long TW, Lin JL and Dai JH. Influencing factors for the clinical effect of bronchoalveolar lavage in children with Mycoplasma pneumoniae pneumonia and atelectasis. Zhongguo Dang Dai Er Ke Za Zhi 2020; 22: 984-989.

[26] Oki M, Saka H, Kogure Y, Oka S, Nakahata M, Shigematsu F, Ishida A and Kitagawa C. Feasibility study of ultrasound video bronchoscopy for sampling endobronchial lesions. Clin Respir J 2020; 14: 675-682.