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Original Research Article

Effect of acetylcysteine solution combined with fiberoptic bronchoscopy alveolar lavage in elderly patients with severe ventilator-associated pneumonia

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Abstract

Purpose: *To explore the effect of acetylcysteine solution combined with fiberoptic bronchoscopy alveolar lavage in elderly patients with severe ventilator-associated pneumonia (VAP).*
Methods: *A total of 120 elderly patients with severe VAP admitted to Department of Critical Care Medicine, the First Affiliated Hospital of Xinjiang Medical University in the past two years were selected for this study. They were randomized into groups A and B. Group B underwent fiberoptic bronchoscopy alveolar lavage for 7 days, group A received acetylcysteine solution plus. Clinical pulmonary infection score (CPIS), respiratory mechanics changes, blood gas levels, inflammatory factor levels, antibiotic use time and mechanical ventilation time were compared.*
Results: *Compared to group B, group A witnessed a lower CPIS, an evidently superior dynamic lung compliance (Cdyn), and worse for other respiratory mechanics indices ($p < 0.001$). After treatment, the partial pressure of blood oxygen (PaO_2) and oxygenation index (PaO_2/FiO_2) saw a surge; the partial pressure of carbon dioxide ($PaCO_2$) tapered off, and the levels of inflammatory factors witnessed a slump in group A than compared with those for group B ($p < 0.001$). A shorter antibiotic use time and mechanical ventilation time was observed in group A compared with group B ($p < 0.001$).*
Conclusion: *Acetylcysteine solution combined with fiberoptic bronchoscopy alveolar lavage yields a promising outcome in notably ameliorating CPIS, respiratory mechanics indicators and blood gas levels, driving down the level of inflammatory factors and diminishing treatment time in elderly patients with severe VAP.*

Keywords: *Acetylcysteine, Fibrobronchoscope, Alveolar lavage, Pneumonia*

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INTRODUCTION

Ventilator-associated pneumonia (VAP), usually caused by mechanical ventilation and with a high morbidity in the elderly population, not only leads to weaning failure, but also strikingly increases the mortality of the patients, which inflicts damage on patients' quality of life [1-3]. At present, the primary purpose of VAP treatment in clinical practice is to bring down the infection

degree of patients and optimize their respiratory function. Antibiotics, the long appreciated and most preferred drugs for VAP notwithstanding, are drastically undermined by multidrug-resistant bacteria. Consequently, indispensable as it is, the exploration of additional treatments requires further in-depth research in the field. To date, bronchofiberscope alveolar lavage has been widely used in the treatment of VAP, which can effectively suck out the pulmonary secretions of patients and improve the late application effect of antibiotics [4-6]. In addition, acetylcysteine solution can fully liquefy sputum and make it easier to be discharged, which theoretically confirms a good auxiliary effect on bronchoalveolar lavage. However, there were few experiments to study the combination of acetylcysteine solution and bronchoalveolar lavage. Based on this, 120 patients with related diseases treated in recent two years were selected as research samples to explore the application effect of the combination of acetylcysteine solution and bronchoalveolar lavage in elderly patients with severe VAP.

METHODS

Patient profile

A total of 120 elderly patients with severe VAP admitted to Department of Critical Care Medicine, the First Affiliated Hospital of Xinjiang Medical University in recent two years were selected and randomized to group A and group B. The general data were comparable ($p > 0.05$), as displayed in Table 1. The study followed International Compilation of Human Research Standards [7] and was approved by Medical Ethics Committee of the First Affiliated Hospital of Xinjiang Medical University, China (approval no. 20181215-01).

Inclusion criteria

(1) Patients with VAP; (2) Patients with mechanical ventilation ≥ 48 h; (3) Patients with abnormal signs and the trachea accompanied by secretions; (4) Patients or their families had full knowledge of the research process and signed the informed consent.

Exclusion criteria

(1) Patients with other organ diseases or lung diseases; (2) Patients with mental problems.

Treatments

All patients were treated with routine VAP, including bronchoalveolar lavage with fiberoptic bronchoscope. The steps were as follows: ① In the pine position, patients were given local anesthesia with lidocaine (Tongfang Pharmaceutical Group Co., Ltd., Guo Yao Zhun Zi H20063466). ② The fiberoptic bronchoscope (Shanghai Hongmai Medical Equipment Co., Ltd., Hu Xie Zhu Zhun 2016220684) was used to suck out secretions, which were then sent for inspection and culture; ③ Normal saline was used to irrigate the diseased parts of patients repeatedly, and was stopped after the aspirate was clarified [8-11]. Bronchoscopic alveolar lavage was performed once a day for 1 week.

Patients in group A were treated with acetylcysteine solution (ZAMBON ITALIA S.R.L, H20150548) by atomization inhalation, each time with 2 ml, twice a day, for 1 week continuously [12-15].

Table 1: General patient profile

Group	Number of cases (n=120)	Group A (n=60)	Group B (n=60)	t/χ^2	*P*-value
Gender				0.031	0.861
Male	65	32	33		
Female	55	28	27		
Age (years old)	120			0.142	0.887
Range		60-84	61-84		
Mean age		65.1±7.8	65.3±6.9		
Category				0.044	0.833
Early onset	45	22	23		
Late onset	75	38	37		
APACHE Ⅱ	120	20.0±3.0	20.1±2.9	0.178	0.859
Medical history				0.222	0.637
Diabetes	36	17	19		
Hypertension	68	33	35		

Evaluation criteria for curative effect

The evaluation criteria of curative effect in this study included CPIS, respiratory mechanics change, blood gas level, inflammatory factor level, antibiotic use time and mechanical ventilation time: ① CPIS: the data were recorded before treatment, 1 day, 3 days and 7 days postoperatively. The lower the score, the better the patient's condition. ② Respiratory mechanics changes: the plateau pressure (Pplat), Cdyn, airway resistance (RAW) and work of breathing (WOB); ③ Blood gas level: PaO_2, $PaCO_2$ and PaO_2/FiO_2; ④ Levels of inflammatory factors: IL-8, CRP and PCT; ⑤ Antibiotic use time and mechanical ventilation time: day was taken as the unit, and the data of two groups were compared.

Statistical analysis

SPSS20.0 was used for the data processing. Graphs were built using GraphPad Prism 7 (San Diego, USA). X^2 test and *t* test were performed.

RESULTS

CPIS

The CPIS for patients in group A were 9.2 ± 1.6, 7.2 ± 1.5, 5.1 ± 1.2 and 4.3 ± 1.2 days 0, 1, 3 and 7, respectively, while for patients in group B CPIS was 9.3 ± 1.5, 8.5 ± 1.4, 7.9 ± 1.1 and 6.8 ± 1.0 on days 0, 1, 3 and 7, respectively ($p < 0.001$). After treatment, group A showed lower CPIS values than group B ($p < 0.001$), as shown in Figure 1.

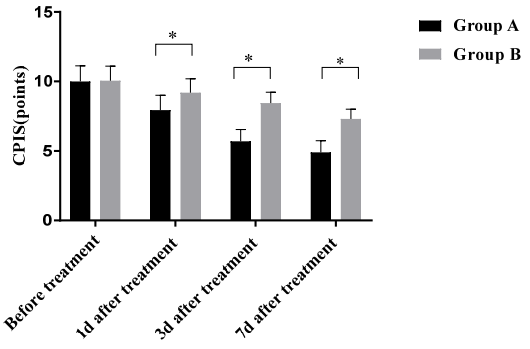

Figure 1: CPIS in patients (mean ± SD) on days 0, 1, 3 and 7

Respiratory mechanics

After treatment, the two groups both yielded favorable results in terms of the respiratory mechanics indexes ($p < 0.001$). In comparison with group B, the higher results of Cdyn but lower of other indexes in group A were obtained ($p < 0.001$), as shown in Table 2.

Blood gas level

By contrast to group B, group A garnered a rosy outcome with better PaO_2, lower $PaCO_2$ level and higher PaO_2/FiO_2 ($p < 0.001$), as shown in Figure 2. PaO_2 and $PaCO_2$ in group A after treatment were 90.3 ± 3.4 and 36.3 ± 2.7 mmHg, while for group B after treatment while the indices were 82.1 ± 3.0 and 45.1 ± 3.1) mmHg, respectively ($p < 0.001$).

Table 2: Changes in respiratory dynamics of patients (mean ± SD)

Group	Time	Group A	Group B	t	*P*-value
Pplat	Before treatment	28.0±4.2	27.9±4.1	0.126	0.900
(cmH₂O)	After treatment	11.0±2.1	13.4±2.3	5.715	0.000
	t	26.849	22.875		
	P-value	0.000	0.000		
Cdyn	Before treatment	28.1±4.9	28.2±4.7	0.109	0.913
(mL/ cmH₂O)	After treatment	46.7±5.0	40.1±4.5	7.276	0.000
	t	19.704	13.563		
	P-value	0.000	0.000		
RAW	Before treatment	16.9±3.0	16.8±3.1	0.172	0.864
(cmH₂O·L⁻¹·s⁻¹)	After treatment	10.1±2.1	13.5±2.3	8.096	0.000
	t	13.771	6.340		
	P-value	0.000	0.000		
WOB	Before treatment	0.9±0.2	0.9±0.1	0.000	1.000
(J/L)	After treatment	0.4±0.1	0.6±0.2	6.633	0.000
	t	16.583	9.950		
	P-value	0.000	0.000		

Table 3: Inflammatory factors in patients (mean ± SD)

Group	Time	Group A	Group B	t	*P*-value
IL-8	Before treatment	149.0±11.6	148.9±11.5	0.045	0.964
(pg/ml)	After treatment	100.5±8.5	140.6±10.8	21.638	0.000
	t	25.011	3.902		
		0.000	0.000		
CRP	Before treatment	78.5±9.3	79.0±8.6	0.293	0.770
(mg/L)	After treatment	37.1±6.0	67.2±8.2	21.970	0.000
	t	27.742	7.365		
	P-value	0.000	0.000		
PCT	Before treatment	27.1±4.1	27.2±4.0	0.129	0.897
(ng/L)	After treatment	15.3±2.4	21.8±3.1	12.296	0.000
	t	18.420	7.914		
	P-value	0.000	0.000		

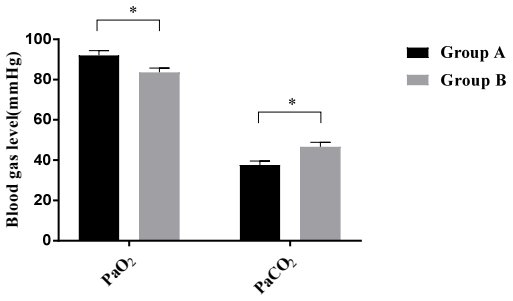

Figure 2: Blood gas levels of patients (mean ± SD). ***Note:*** Partial pressure of oxygen = PaO_2 and partial pressure of carbon dioxide = $PaCO_2$

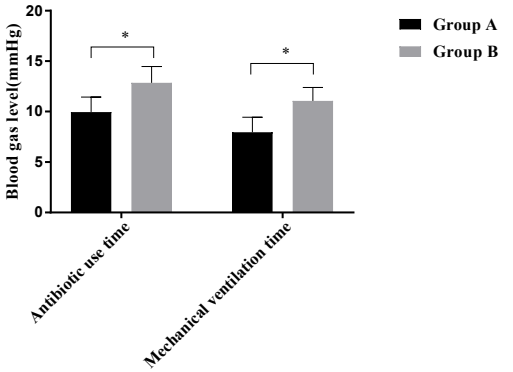

Figure 3: Comparison of antibiotic use time and mechanical ventilation time of patients (mean ± SD)

Inflammatory factor level

After treatment, strong evidence of lower levels of inflammatory factors in group A when compared with group B was observed in Table 3 ($p < 0.001$).

Antibiotic use time and mechanical ventilation time

Compared to group B, patients in group A enjoyed a shorter antibiotic use time and mechanical ventilation time ($p < 0.001$), as shown in Figure 3. Antibiotic use time and mechanical ventilation time in group A were 8.9 ± 2.1 and 6.9 ± 2.1 days, while for group B the corresponding values were 11.7 ± 2.3 and 10.1 ± 1.9 days, respectively; $^*p < 0.001$.

DISCUSSION

As one of the serious complications caused by mechanical ventilation, VAP is extremely unfavorable to the prognosis of patients with a mortality up to 60%, which requires effective treatment measures to ensure the safety of patients [16-19]. Antibiotics, as a class of anti-infective drugs, are often used in the treatment of VAP, but their therapeutic effects are subject to many factors, and there are certain limitations in the treatment of VAP. Based on this, it is necessary to combine antibiotics with other therapeutic measures to improve the therapeutic effects for VAP patients. Nowadays, bronchoalveolar lavage with fiberoptic bronchoscope has been widely used in clinical practice, which can effectively suck out the respiratory secretions of patients for sputum culture, thus laying a theoretical foundation for the follow-up antibiotic treatment. In addition, acetylcysteine solution can fully liquefy the thick secretion, optimize the output rate of alveolar active substances in patients, and facilitate the discharge of sputum, which exhibits a positive auxiliary effect on the treatment of VAP patients.

CPIS is a comprehensive indicator used to judge the curative effect and prognosis of VAP patients, which possesses a high clinical guiding significance for the treatment of VAP patients. In this study, group A obtained lower CPIS scores than group B ($P<0.001$), which proved that patients in group A given combined therapy garnered better curative effect and prognosis. Accordingly, the acetylcysteine solution combined with fiberoptic bronchoscopy alveolar lavage is effective in the treatment of VAP

patients. After treatment, group A enjoyed better respiratory mechanics indexes than group B (P<0.001), which indicated a significantly reduced that pulmonary resistance of patients after the sputum was sucked out, a higher level of mechanical ventilation, and a markedly elevated pulmonary condition in group A. In comparison with group B, PaO_2 and PaO_2/FiO_2 were strikingly higher but $PaCO_2$ lower in group A than those in group B (P<0.001), which indicated that acetylcysteine solution fully diluted the sputum in patients' lungs to facilitate the suction conducted by fiberoptic bronchoscope, thus substantially relieving the bronchial obstruction immediately. After treatment, group A yielded lower levels of inflammatory factors than group B (P<0.001), which was attributed to the fact that the secretion of patients was greatly diluted after combined treatment, and sensitive antibiotics played a corresponding role randomly, which weakened the inflammatory state of patients. In addition, patients in group A enjoyed a shorter antibiotic use time and a mechanical ventilation time than group B (P<0.001), which indicated proved a promising result by the combined treatment. British scholar Lina Bale compared the clinical indexes of patients treated with conventional VAP and patients treated with acetylcysteine solution combined with bronchoalveolar lavage, and concluded that the level of inflammatory factors was lower in patients treated with combined therapy, with IL-8 of (101.2±10.2) pg/ml/ml, CRP of (37.2±6.1) mg/L/L and PCT of (15.3±2.4) ng/L/L. This confirmed that combined therapy had positive significance for VAP treatment [20], which was consistent with the research results obtained in this paper.

Limitations of the study

The following limitations were identified in this study. It is a monocentric study with a small number of participants and short follow-up. A randomized controlled, multicenter, double-blind study with a large sample is needed to confirm the conclusion reached.

CONCLUSION

Acetylcysteine solution combined with fiberoptic bronchoscopy alveolar lavage is a reliable method to improve CPIS, respiratory mechanics indicators and blood gas levels in elderly patients with severe VAP; This strategy greatly reduces the level of inflammatory factors in patients; and shortens the relevant treatment time. Further investigations would help to establish a better solution for VAP patients.

DECLARATIONS

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

This work was performed by all authors named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by all of them. The study was conceived and designed by Ju Guo. Ping Wang and Xiaoyu Ma collected and analyzed the data, Ju Guo wrote the manuscript. All authors read and approved the manuscript for publication.

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