Am J Transl Res 2021;13(4):3794-3799
www.ajtr.org /ISSN:1943-8141/AJTR0124465

Original Article

Analysis of the clinical effect of noninvasive mechanical ventilation in AIDS patients complicated with pneumonia

Changming Liu[1], Yan He[3], Gang Xiao[2], Hui Ouyang[4], Chan Zhang[4]

[1]The Third Department of Infection, [2]Department of AIDS, The First Hospital of Changsha, Changsha, Hu'nan Province, China; [3]Department of Infection, The Second Xiangya Hospital of Central South University, Changsha, Hu'nan Province, China; [4]Department of Respiratory Medicine, The Fourth Hospital of Changsha, Changsha, Hu'nan Province, China

Received October 19, 2020; Accepted November 27, 2020; Epub April 15, 2021; Published April 30, 2021

Abstract: Objective: To explore the clinical application effect of noninvasive mechanical ventilation for patients with acquired immune deficiency syndrome (AIDS) complicated with pneumonia. Methods: A prospective study was conducted on 86 patients with AIDS complicated with pneumocystis pneumonia. The patients were randomly divided into a control group and an experimental group, both of which were treated with conventional drugs. The control group was supplemented with oxygen via a mask, and the experimental group was additionally treated with noninvasive ventilator ventilation. The changes of arterial oxygen partial pressure, oxygenation index, respiratory frequency, pulse rate, serum albumin and other indicators between the two groups before and after treatment were observed. The patient's hospitalization time, overall improvement and mortality rate were compared. Results: Compared with those before treatment, the arterial oxygen partial pressure, oxygenation index, respiratory frequency, and pulse rate of the two groups of patients were significantly improved after treatment ($P<0.05$). The improvement of the experimental group after treatment was more significant than that of the control group, and the difference was statistically significant ($P<0.001$). After treatment, the proportion of recovery rate of serum albumin in the experimental group was 81.40%, which was significantly higher than that in the control group (53.49%), and the difference was statistically significant ($P<0.05$). Compared with the control group, hospitalization time, treatment improvement and mortality rate in the experimental group had significant advantages and statistical significance ($P<0.05$). Conclusion: For AIDS patients complicated with pneumonia, noninvasive mechanical ventilation had obvious treatment effects, which could significantly improve respiratory function, reduce mortality rate, and increase recovery rate. It can be considered as a therapeutic method to be included in routine treatment protocols.

Keywords: Acquired immune deficiency syndrome, pneumonia, patients with comorbidities, noninvasive mechanical ventilation treatment, clinical effect

Introduction

Acquired immunodeficiency syndrome (AIDS) is caused by human immunodeficiency virus (HIV) infection. It is highly infectious and has a high mortality rate, which seriously endangers people's lives and health [1, 2]. Although the AIDS epidemic situation has been relieved to some extent, it is still on the rise, and it is necessary to continuously strengthen the treatment and control of patients. AIDS patients are often prone to infections such as fungi, bacteria, and viruses due to the continued decline in immune levels. They are also prone to multiple complications, with pulmonary infections being one of the most common complications and pneumocystis pneumonia having the highest incidence [3, 4].

At present, the clinical treatment of patients with AIDS complicated with pneumonia mainly uses antibiotics and hormone therapy [5, 6]. For those with severe respiratory failure, masks are used to inhale oxygen but they deliver unsatisfactory clinical results [7]. Therefore, it is particularly important and urgent to explore a new type of ventilation therapy. Bi-level positive pressure ventilation (BiPAP) equipment is a new type of mechanical ventilation equipment that has been developed in recent years. It has the

advantages of noninvasive positive pressure ventilation, no intubation, no sedatives, high comfort, and easy acceptance by patients [8-10]. This article retrospectively studied 86 patients with AIDS complicated with pneumocystis pneumonia who were treated in The First Hospital of Changsha from June 2018 to June 2020 to explore the clinical application effects of noninvasive mechanical ventilation treatment, with a view to providing more research data on the clinical application of noninvasive ventilation with BiPAP.

Materials and methods

Clinical data

In this prospective study, 86 patients with AIDS and pneumocystis pneumonia who were treated in The First Hospital of Changsha from June 2018 to June 2020 were selected as clinical subjects. The patients were divided into a control group and an experimental group by a random number table, each with 43 patients. Both groups were treated with conventional drugs. The control group was supplemented with mask oxygen, and the experimental group was additionally treated with noninvasive ventilator ventilation. The study was approved by the Ethics Committee of The First Hospital of Changsha, and all patients signed the informed consent.

Inclusion and exclusion criteria

Patients included all met the AIDS diagnostic criteria issued by the WHO [11]. Pneumonia was caused by pneumocystis, which was detected in lung parenchyma or lower respiratory tract secretions, and the respiratory failure was grade I (PaO_2<60 mmHg, $PaCO_2$ normal or decreased). The fingertip blood oxygen concentration of these patients was greater than 90% after oxygen was given through the mask. The included patients did not have obvious heart disease or chronic obstructive pulmonary disease and they could communicate normally and were conscious.

The patients who were excluded: patients who suffered from severe respiratory failure and noninvasive oxygen did not guarantee normal breathing; patients who were comatose or unable to communicate normally; patients who were accompanied by severe organ and systemic diseases.

Methods

After admission, both groups of patients were treated with HAART (Zhongyan II combined antiviral therapy) and symptomatic antibacterial therapy, while maintaining the water-electrolyte balance, acid-base balance and the necessary nutritional support [12]. On this basis, the control group used a mask to inhale oxygen, and the oxygen flow was controlled at 6.0 L/min. The experimental group used a bi-level ventilator (American Kangwei Company, BiPAP Focus model) for noninvasive mechanical ventilation treatment. The inspiratory pressure started from 8 cmH_2O and gradually rose to 24 cmH_2O. The expiratory pressure started from 4 cmH_2O and rose to 8 cmH_2O. We maintained patient's blood oxygen saturation above 90% and controlled oxygen supply at 5-6 L/min with reference to patient's fingertip blood oxygen saturation. The device had an automatic air leakage compensation function. Medical staff tracked and closely monitored the changes in the arterial oxygen partial pressure, respiratory frequency, pulse rate and other indicators of the two groups of patients.

Outcome measures

Main observation indicators: In this study, we observed and recorded changes in the arterial oxygen partial pressure, oxygenation index, respiratory frequency, pulse rate, serum albumin and other indicators of the two groups of patients before and after treatment. Serum albumin was measured from the patient's venous serum, detected by the immunoturbidimetric method kit (Ningbo Preble Biotechnology Co., Ltd., Ningbo, China, Zhejiang Food and Drug Administration (Quasi) No. 2400428, 2013), and the recovery rate of serum albumin was recorded (normal reference value is 40-55 g/L) [9]. Respiration-related indicators were observed and recorded using a ventilator (Kangwei, USA, model BiPAP Focus), and pulse and heart rate were monitored using a pulse and heart rate monitor (Shenzhen Coman Medical Equipment Co., Ltd., China, Coman STAR8000E).

Secondary observation indicators: The patient's hospitalization time, treatment improvement and mortality rate were compared [13]. The treatment improvement included observation of time to improved breathing and the need for invasive ventilation therapy.

Table 1. Comparison of clinical data between the two groups

Group	Control group (n=43)	Experimental group (n=43)	$t/\chi^2/Z$	P
Male/Female	27/16	29/14	0.205	0.651
Age range (years)	26-59	22-61	-	-
Average age (years)	45.2±11.3	41.7±9.7	1.541	0.127
Weight (kg)	56.24±8.13	57.46±7.94	0.704	0.483
$CD4^+$ (pcs/μL)/$CD8^+$ (%) expressed	270±98/29.81±4.22	283±102/27.69±3.94	0.631/1.692	0.548/0.094
Comorbidities (cases) Anemia/Genital herpes	27/33	24/38	-0.701	0.483

Table 2. Comparison of arterial oxygen partial pressure and oxygenation index between the two groups

Groups	PaO_2 (mmHg)		PaO_2/FiO_2 (mmHg)	
	Before treatment	After treatment	Before treatment	After treatment
Control group (n=43)	48.47±4.66	77.33±5.15*	224.16±20.16	274.43±22.11*
Experimental group (n=43)	47.51±3.89	87.11±4.37*	216.52±22.67	304.12±24.38*
t	1.037	9.495	1.651	5.915
P	0.303	<0.001	0.102	<0.001

Note: Compared with the same group before treatment, *P<0.05.

Data analysis

All data were processed by the statistical software SPSS 17.0. The count data were expressed as a percentage and analyzed by the chi-square test. Measurement data conforming to a normal distribution were expressed as mean ± standard deviation ($\bar{x}$ ± sd), and non-conformity was determined by non-parametric tests, with independent t-tests for comparisons between groups and paired t-tests for comparisons within groups. P<0.05 indicated that the difference was statistically significant.

Results

Comparison of clinical data

The general clinical data of patients in the control group and the experimental group, such as age range, average age, weight, immune status, comorbidities, etc., were not statistically different between the groups (P>0.05), and they were comparable, as shown in **Table 1**.

Comparison of arterial oxygen partial pressure and oxygenation index

Compared with before treatment, as seen from **Table 2**, the arterial oxygen partial pressure and oxygenation index of the two groups of patients were significantly improved after treatment (P<0.05). After treatment, the improvement status of the experimental group was more significant than that of the control group, and the difference was statistically significant (P<0.001).

Comparison of respiratory rate and pulse rate

Compared with those before treatment, the respiratory rate and pulse rate of the two groups of patients were significantly improved after treatment (P<0.05). After treatment, the improvement status of the experimental group was more significant than that of the control group, and the difference was statistically significant (P<0.001), as shown in **Table 3**.

Serum albumin comparison

After treatment, the serum albumin content of the experimental group was significantly higher than that of the control group, and the difference was statistically significant (P<0.001). The proportion of recovery rate of serum albumin in the experimental group was 81.40%, which was significantly higher than that in the control group (53.49%) and the difference was significant (P=0.006<0.01), as shown in **Table 4**.

Comparison of hospitalization time and treatment improvement

Patients in the experimental group, as observed in **Table 5**, that used noninvasive mechanical ventilation were significantly better than those

Table 3. Comparison of respiratory rate and pulse rate between the two groups

Group	Respiratory rate (times/min)		Pulse rate (times/min)	
	Before treatment	After treatment	Before treatment	After treatment
Control group (n=43)	30.43±4.53	27.36±2.15*	99.26±4.46	78.12±4.55*
Experimental group (n=43)	31.62±3.84	23.99±3.01*	100.45±4.07	69.72±3.91*
t	1.314	5.974	1.292	9.182
P	0.192	<0.001	0.199	<0.001

Note: Compared with the same group before treatment, *P<0.05.

Table 4. Comparison of serum albumin content between the two groups

Group	Before treatment (g/L)	After treatment (g/L)	Recovery rate (%)
Control group (n=43)	32.46±4.21	40.29±3.13	53.49%
Experimental group (n=43)	31.88±3.92	44.29±5.41	81.40%
t/χ^2	0.661	4.197	7.626
P	0.510	<0.001	0.006

Table 5. Comparison of hospitalization time and treatment improvement between the two groups

Group	Hospitalization time (d)	Breathing improvement time (d)	Use rate of invasive ventilator (%)
Control group (n=43)	19.3±3.5	5.82±1.02	9 (20.93%)
Experimental group (n=43)	13.9±2.0	4.11±0.73	2 (4.65%)
t/χ^2	8.784	8.940	5.108
P	<0.001	<0.001	0.024

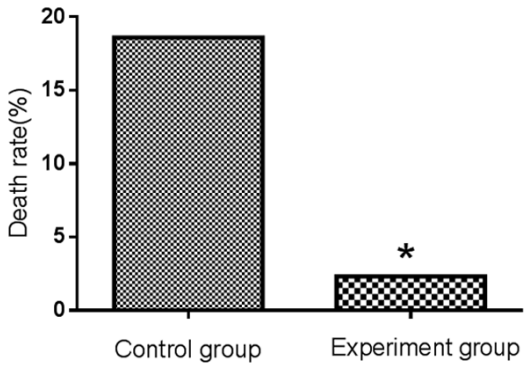

Figure 1. Comparison of mortality after treatment between the two groups. Compared with control group, *P<0.05.

in the control group in terms of hospitalization time, breathing improvement time, and final use of invasive ventilators, and the difference was statistically significant (respectively P< 0.001, P<0.001, P=0.024<0.05).

Comparison of mortality

Among the two groups of patients, the final mortality rate of the control group was 18.60% (8/43), and the experimental group was 2.33% (1/43); the difference was statistically significant (P= 0.035, t=4.468), as shown in **Figure 1**.

Discussion

AIDS patients are prone to a variety of complications due to immunodeficiency. Pneumonia is common and is one of the main causes of death in AIDS patients [14]. The initial manifestations of AIDS patients with pneumonia are similar to those of colds, such as low fever, anorexia, diarrhea, etc., and most of the patients have insufficient nutritional supply [15]. At the same time, due to the severe impairment of the patient's immune function, spores in the pulmonary system multiply rapidly, affecting the oxygen exchange efficiency of the patient's lungs, thickening the interstitial fluid, aggravating respiratory difficulties, and eventually leading to respiratory failure. Therefore, for AIDS patients complicated with pneumonia, in addition to antibacterial, anti-infective, hormone therapy and nutritional support, effective auxiliary ventilation support is also needed. It has been reported that auxiliary ventilation therapy has important clinical significance for patients with AIDS complicated with pneumonia, which can improve patient's ventilation ability, prolong the survival duration, and improve prognosis [16, 17].

The BiPAP ventilator is a new piece of auxiliary ventilation equipment that is different from traditional mask respiration. It can perform noninvasive positive pressure ventilation, with stable airway pressure and it has a convenient operation, and it can complete the synchronous treatment of ventilation. It has been reported that noninvasive mechanical ventilation has a significant effect on the treatment of patients with early respiratory dysfunction, which can reduce the rate of tracheal intubation and reduce the occurrence of malignant respiratory failure [18]. In this article, we used BiPAP noninvasive mechanical ventilation ventilators to assist patients with AIDS complicated with pneumonia. The patient's arterial oxygen partial pressure and oxygenation index were significantly improved, suggesting that positive pressure ventilation could improve ventilation and airway function, maintain normal breathing, and create more time for further clinical treatment. It can also reduce the patient's breathing rate, effectively improve breathing quality, and relieve the problem of dyspnea. Goel et al. also reported that the use of noninvasive mechanical ventilation treatment could significantly relieve the clinical symptoms of patients with chronic respiratory failure and effectively improve theie prognosis [19]. Ronit et al. reported that serum albumin levels were closely related to the fatality rate of AIDS combined with severe pneumocystis pneumonia [20]. For example, patients with low serum albumin levels had insufficient nutritional supply and metabolic disorders, and the mortality rate was significantly higher than that of normal patients. The results of this study also showed that the improvement rate of serum albumin in the experimental group was higher than that of the control group, and the fatality rate was also lower than that of the control group. This may be due to the use of noninvasive mechanical ventilation to offset the excessive consumption of energy due to respiratory fatigue. This treatment effectively maintains the patient's mental state and appetite, and thereby maintains a relatively normal serum albumin level. It could be seen that the improvement of the patient's respiratory state is of great significance to the overall treatment and prognosis of the patient. The hospitalization time and the breathing improvement in the experimental group were shorter than those in the control group, confirming the direct role of noninvasive mechanical ventilation in improving prognosis and recovery, which may be attributed to improved respiratory function and reduced cardiac strain in patients. If the body is in a steady state and the resistance is restored, the patient can naturally recover faster. This was also consistent with Mas A et al. who reported that effective noninvasive mechanical ventilation can significantly improve patients with severe pneumonia and respiratory failure, and can alleviate dyspnea and reduce mortality [21]. However, this study also had some shortcomings. For example, it was only a single-center study and no immune index detection was performed. It would be further improved and deepened in future investigative periods.

In summary, the use of noninvasive mechanical ventilation adjuvant therapy in AIDS patients complicated with pneumonia is a safe and effective clinical treatment method. It can significantly improve the respiratory function of patients and keep their metabolism relatively stable. At the same time, it can also reduce the treatment rate of invasive ventilation, reduce the mortality rate, and increase the recovery speed of the patient's body. It can be used as a treatment method to be incorporated into conventional treatment in AIDS patients complicated with pneumonia.

Disclosure of conflict of interest

None.

Address correspondence to: Chan Zhang, Department of Respiratory Medicine, The Fourth Hospital of Changsha, No. 70 Lushan Road, Yuelu District, Changsha 410011, Hu'nan Province, China. Tel: +86-0731-88942115; E-mail: zhangchan4hcs@163.com

References

[1] Vangipuram R and Tyring SK. AIDS-associated malignancies. Cancer Treat Res 2019; 177: 1-21.

[2] Hamarsheh O. HIV/AIDS in palestine: a growing concern. Int J Infect Dis 2020; 90: 18-20.

[3] Su JW, Shen XM, Ni Q, Zhao H, Cai JR, Zhu B, Wu WR, Lang GJ, Xu KJ and Sheng JF. Infection of severe acute respiratory syndrome coronavirus 2 in a patient with AIDS. Aids 2020; 34: 1575-1576.

[4] Laila U, Akram M, Shariati MA, Hashmi AM, Akhtar N, Tahir IM, Ghauri AO, Munir N, Riaz M, Akhter N, Shaheen G, Ullah Q, Zahid R and Ah-

mad S. Role of medicinal plants in HIV/AIDS therapy. Clin Exp Pharmacol Physiol 2019; 46: 1063-1073.
[5] Voshavar C. Protease inhibitors for the treatment of HIV/AIDS: recent advances and future challenges. Curr Top Med Chem 2019; 19: 1571-1598.
[6] Korean Society for AIDS. The 2018 clinical guidelines for the diagnosis and treatment of HIV/AIDS in HIV-infected koreans. Infect Chemother 2019; 51: 77-88.
[7] Marcus JL, Leyden WA, Chao CR, Horberg MA, Klein DB, Quesenberry CP Jr, Towner WJ and Silverberg MJ. Immunodeficiency, AIDS-related pneumonia, and risk of lung cancer among HIV-infected individuals. Aids 2017; 31: 989-993.
[8] Akhter N and Rizvi NA. Application of BiPAP through endotracheal tube in comatose patients with COPD exacerbation. Pak J Med Sci 2017; 33: 1444-1448.
[9] Bittencourt HS, Reis HF, Lima MS and Gomes MN. Non-invasive ventilation in patients with heart failure: a systematic review and meta-analysis. Arq Bras Cardiol 2017; 108: 161-168.
[10] Hensel M, Strunden MS, Tank S, Gagelmann N, Wirtz S and Kerner T. Prehospital non-invasive ventilation in acute respiratory failure is justified even if the distance to hospital is short. Am J Emerg Med 2019; 37: 651-656.
[11] Ranganathan K and Umadevi KMR. Common oral opportunistic infections in human immunodeficiency virus infection/acquired immunodeficiency syndrome: changing epidemiology; diagnostic criteria and methods; management protocols. Periodontol 2000 2019; 80: 177-188.
[12] Salzer HJF, Schäfer G, Hoenigl M, Günther G, Hoffmann C, Kalsdorf B, Alanio A and Lange C. Clinical, diagnostic, and treatment disparities between HIV-infected and non-HIV-infected immunocompromised patients with pneumocystis jirovecii pneumonia. Respiration 2018; 96: 52-65.
[13] Kendrick KR, Baxi SC and Smith RM. Usefulness of the modified 0-10 borg scale in assessing the degree of dyspnea in patients with COPD and asthma. J Emerg Nurs 2000; 26: 216-222.
[14] Zajac V. Evolutionary view of the AIDS process. J Int Med Res 2018; 46: 4032-4038.
[15] Di Pasquale MF, Sotgiu G, Gramegna A, Radovanovic D, Terraneo S, Reyes LF, Rupp J, González Del Castillo J, Blasi F, Aliberti S and Restrepo MI. Prevalence and etiology of community-acquired pneumonia in immunocompromised patients. Clin Infect Dis 2019; 68: 1482-1493.
[16] Confalonieri M, Calderini E, Terraciano S, Chidini G, Celeste E, Puccio G, Gregoretti C and Meduri GU. Noninvasive ventilation for treating acute respiratory failure in AIDS patients with pneumocystis carinii pneumonia. Intensive Care Med 2002; 28: 1233-1238.
[17] Esquinas Rodríguez AM, Cazaux A, Langer M and Cambursano H. Acute hypoxemic respiratory failure in acquired immune deficiency syndrome: effects of noninvasive ventilation: the highest PEEP may not be best. Respir Care 2012; 57: 1699-1700.
[18] Coudroy R, Frat JP, Boissier F, Contou D, Robert R and Thille AW. Early identification of acute respiratory distress syndrome in the absence of positive pressure ventilation: implications for revision of the berlin criteria for acute respiratory distress syndrome. Crit Care Med 2018; 46: 540-546.
[19] Goel NN, Owyang C, Ranginwala S, Loo GT, Richardson LD and Mathews KS. Noninvasive ventilation for critically ill subjects with acute respiratory failure in the emergency department. Respir Care 2020; 65: 82-90.
[20] Ronit A, Hatleberg CI, Ryom L, Bonnet F, El-Sadr W, Reiss P, Weber R, Pradier C, De Wit S, Law M, d'Arminio Monforte A, Lundgren J, Mocroft A, Phillips AN and Sabin CA. Associations between serum albumin and serious non-AIDS events among people living with HIV. Aids 2018; 32: 1837-1848.
[21] Mas A and Masip J. Noninvasive ventilation in acute respiratory failure. Int J Chron Obstruct Pulmon Dis 2014; 9: 837-852.