

Report

Impact of ambroxol combined with systematic nursing care on ventilatory function and blood gas parameters in elderly patients with severe respiratory failure

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Abstract: Severe respiratory failure (RF) refers to external respiratory air dysfunction, characterised by carbon dioxide retention, hypoxia, agitation, dyspnea and cyanosis. Although basic care plays a role in nursing, treatment with ambroxol improves prognosis. We aim to investigate the effects of ambroxol combined with institutionalised guardianship care on ventilatory function and blood gas indexes in elderly patients with severe RF. One hundred elderly patients with severe RF were divided into experimental and control groups with 50 patients in each. The adopted control group was provided with basic care while the experimental group was provided with institutionalised guardianship care. Both groups were compared based on ventilatory function, clinical indicators, blood gas indicators and complications. After 14 days of care, forced expiratory volume in one second (FEV₁), peak expiratory flow rate (PEF), oxygen saturation and arterial partial pressure of oxygen in both groups was compared. After institutionalised guardianship care, the combined complication rate was 4.00% while it was 16.00% after basic care ($P < 0.05$). In the current study of care of elderly critically ill RF patients treated with ambroxol, the institutionalised guardianship care was effective, helping to improve the patients' ventilatory function and reduce the risk of complications.

Keywords: severe respiratory failure, ambroxol, institutionalised guardianship care, blood gas indicators

INTRODUCTION

Severe respiratory failure (RF) refers to severe external respiratory air dysfunction, characterised by carbon dioxide retention and hypoxia. It mostly affects middle-aged and elderly

people, with the main symptoms being agitation, dyspnoea and cyanosis [1, 2]. Up to 16% of patients with RF are elderly and RF is a frequent cause of death in the elderly population [3]. Clinical treatment with western drugs such as ambroxol, a new injectable expectorant that inhibits inflammation, helps to improve the synthesis of active substances on the lung surface and enhances the ability of macrophages to destroy bacteria and, supplemented by mechanical ventilation, can significantly reduce the inflammatory response in elderly patients with severe RF [4]. The dangerous nature of advanced RF can have life-threatening consequences if not treated promptly with scientific care [5, 6]. Therefore, additional interventions need to be supplemented for older adults with severe RF [4, 7].

Although basic care plays a role in nursing, the use of this model of care alone tends to be of poor quality due to its lack of a comprehensive intervention plan [8]. Several nursing methods have been put forward to promote the rehabilitation of patients with respiratory failure, including systematic nursing care, early rehabilitation nursing and intensive care unit [9, 10]. As a relatively new intervention strategy, institutionalised guardianship care [10] is based on the principles of detail, rigour, precision and accuracy. The scientific and standardised management combined with systematic interventions ensures the safety of care and improves the treatment effect and prognosis [11]. However, the improvement of blood gas indexes in elderly patients with severe RF by institutionalised guardianship care still needs to be further investigated. Based on this situation, the present study employed 100 elderly patients with severe RF and treated with ambroxol to investigate the value of institutionalised guardianship care and provide clinical clues to optimising the severe RF intervention.

MATERIALS AND METHODS

General Data

One hundred elderly patients with severe RF admitted to Lixin County People's Hospital from December 2021 to December 2022 were selected and divided into an experimental group (50 patients) and a control group (50 patients) according to the envelope randomisation method. The experimental group received ambroxol treatment and institutionalised guardianship care while the control group received only basic care. The control group consisted of 23 females and 27 males, age 61-88 years (mean 71.40 ± 6.56 years). Systemic complications were: 22 cases of diabetes mellitus, 10 cases of coronary heart disease and 6 cases of chronic renal insufficiency at early stage. The experimental group consisted of 22 females and 28 males, age 62-89 years (mean 71.58 ± 6.41 years). Systemic complications were: 21 cases of diabetes mellitus, 9 cases of coronary heart disease and 5 cases of chronic renal insufficiency at early stage. The baseline data of both groups were compared, with significant difference ($P > 0.05$) between the two groups.

Inclusion criteria: 1) The subjects who met relevant diagnostic criteria for severe RF ($\text{PaO}_2 < 8\text{kPa}/60\text{mmHg}$ and/or $\text{PaCO}_2 > 6.0\text{kPa}/45\text{mmHg}$) in advanced age [12]; 2) Patients who could communicate normally; 3) All were first-time patients. **Exclusion criteria:** 1) The subjects having serious complications such as hemoptysis and coma; 2) Presence of other systemic infections or organ infections; 3) Patients with impaired liver and kidney functions; 4) Patients not willing to participate in the study.

The research study was approved by the Ethics Committee of Lixin County People's Hospital (Approval No. LCH202101010).

Methods

Treatment method: Patients in the experimental group were treated with Mucosolvan (trade name of ambroxol) (2 ml; 15 mg, Shanghai Boehringer Ingelheim Pharmaceutical Co.), 15 mg mixed in 20 ml saline for nebulised inhalation, administered daily for 7 days. The control group received only basic care without Mucosolvan.

Nursing method: The control group received basic nursing care and a variety of indexes were checked, changes in their condition and vital signs were monitored, and if they had difficulty in expelling sputum, they were tapped on the back and given health education and instructions to maintain good living habits. The experimental group received institutionalised guardianship care. The care team consisted of the deputy director, the nurse-in-charge of the respiratory department, a dietician and a clinical nurse. Institutionalised guardianship care differs from basic care as it involves a structured approach with a multidisciplinary team trained in intensive respiratory care management. The team members receive standardised training in the basics of intensive RF treatment, mechanical ventilation, respiratory system management, intensive care nursing, and other professional knowledge to ensure a smooth nursing process. The care measures are developed based on the need to monitor severe RF patients, with input from respiratory medicine experts. Detailed explanations of the indications and assessment requirements for non-invasive mechanical ventilation, potential adverse effects of ambroxol administration and preventive measures are provided. The implementation is monitored using a three-tier quality checklist, with regular special inspections by the nursing department.

Nursing programme: The daily check-in system was strictly enforced. The patient's condition was monitored and assessed in real time and the monitoring care plan was adjusted according to the patient's specific situation. Therefore, nurses were asked to enhance communication skills with patients and keep appropriate records in case of need. In addition, apart from making their daily inquiries, nurses also provided timely counselling for patients' psychological conditions. Soothing music was played to reduce patients' negative emotions such as anxiety and frustration. Patients' confidence in treatment was improved by explaining successful cases so that they were willing to happily cooperate with treatment. The patients' suctioning effect was evaluated and back buckling was given and patients were encouraged to get out of bed as soon as possible to reduce complications.

Quality control: A quality control management system was established to monitor the quality of mechanical ventilation and the effect of ambroxol in real time. At the end of each month a workshop on the quality management of mechanical ventilation was held regularly to summarise possible problems with the work and discuss ways of improvement. The team leader was responsible for all aspects of management, including environmental and airway management in the intensive care unit, and team members were asked to evaluate the patient's condition and enhance basic care based on the assessment results.

Observation Indicators

Ventilatory function: The forced expiratory volume in one second (FEV1) of both groups before intervention and 14 days after the intervention was measured by a lung function tester, and the peak expiratory flow rate (PFE) was also measured.

Clinical indicators: The disappearance of breathlessness, the use of a ventilator, the time taken to relieve shortness of breath and the number of days of intensive care unit were recorded in both groups.

Blood gas indexes: The partial pressure of carbon dioxide (PaCO₂) and oxygen saturation were measured before intervention and after 14 days of care in both groups using an ABL9 blood gas analyser (Shanghai Huanxi Medical Equipment Co.), and the partial pressure of oxygen (PaO₂) index was also measured.

Complications: Complications such as ventilatory infection, bedsores and venous thrombosis were recorded in both groups.

Statistical Methods

The measurement data were expressed as $\bar{x} \pm s$, with independent samples t-test for comparison between groups and paired t-test for comparison within groups. The count data were expressed as [n (%)], with χ^2 test for comparison between groups. Data were analysed with SPSS 23.0 software and P<0.05 indicates statistical differences.

RESULTS AND DISCUSSION

Comparison of Ventilatory Function

After 14 days of care the FEV1 and PFE indexes of both groups increase, although the experimental group has higher indexes than the control group (P<0.05) (Table 1), indicating that the care provided to the experimental group is more effective in improving lung function. Severe RF is a serious condition that results in a range of pathological changes, mainly due to impaired pulmonary ventilation and airflow for a variety of reasons. Patients often suffer from symptoms such as dyspnoea, cyanosis and, in some cases, cardiac arrhythmias, resulting in cardiac arrest, which can seriously affect their quality of life [13, 14]. The appropriate nursing interventions for patients during treatment with ambroxol should not be overlooked [15, 16].

Table 1. Comparison of ventilatory function ($\bar{x} \pm s$)

Group	Case	PFE(L/min.)		t-value	P-value	FEV1 (%)		t-value	P-value
		Before	After			Before	After		
Experimental group	50	235.55 ±22.44	301.54 ±28.27	15.326	0.001	45.28 ±4.39	70.50 ±7.22	17.745	0.001
Control group	50	234.52 ±22.42	279.02 ±25.30	11.425	0.001	45.26 ±4.38	63.81 ±6.24	14.242	0.001
t-value	-	0.218	3.982	-	-	0.022	4.703	-	-
P-value	-	0.828	0.000	-	-	0.983	0.000	-	-

Comparison of Clinical Indicators

From Table 2 it is evident that the experimental group has fewer days spent on breathlessness, use of ventilators, relief time for shortness of breath, and intensive care unit than the control group (P<0.05), which is consistent with the results of previous study [17]. Apparently institutionalised guardianship care has the potential to improve ventilation and reduce the number of ventilator and

intensive care unit days in elderly patients with severe RF. The reasons for this may be, compared to basic care countermeasures, institutionalised guardianship care is more systematic and comprehensive, focusing on careful observation of the patient's condition in order to detect possible adverse effects during mechanical ventilation and ambroxol administration as early as possible to take appropriate countermeasures, thus improving the efficacy of ambroxol and shortening the time for symptom improvement by using the ventilator and time for relief of shortness of breath.

Table 2. Comparison of clinical indicators ($\bar{x} \pm s$, d)

Group	Case	Time taken for breathlessness to disappear	No. of days on ventilator	Time taken for shortness of breath relief	Time spent in intensive care unit
Experimental group	50	2.51± 0.46	5.43± 1.15	3.48± 1.65	7.48± 1.21
Control group	50	3.38± 0.55	7.27± 1.32	4.24± 0.76	9.24± 1.46
χ^2	-	8.179	7.576	6.554	6.226
<i>P</i>	-	0.000	0.000	0.000	0.000

Comparison of Blood Gas Indicators

After 14 days of care the blood oxygen saturation and arterial PaO₂ increase in both groups, although the experimental group has a higher indicator than the control group (Table 3). On the other hand the arterial PaCO₂ decreases, the experimental group having a lower indicator than the control group (*P*<0.05). This indicates that the experimental group's treatment is more effective in improving oxygenation and reducing carbon dioxide levels in the blood.

Table 3. Comparison of blood gas indicators ($\bar{x} \pm s$)

Group	Case	Arterial PaCO ₂ (mmHg)		t- val ue	P- val ue	Oxygen saturation (%)		t- val ue	P- val ue	Arterial PaO ₂ (mmHg)		t- value	P- value
		Before	After			Before	After			Before	After		
Experimental group	50	62.56±6.58	34.39±3.57	22.365	0.001	64.25±6.65	85.71±8.25	17.541	0.001	53.39±5.39	76.27±7.31	18.476	0.001
Control group	50	62.64±6.51	43.34±3.87	18.362	0.001	64.37±6.58	78.70±7.25	15.242	0.001	53.48±5.10	68.48±6.40	16.315	0.001
t-value	-	0.058	10.12	-	-	0.086	9.256	-	-	0.081	6.069	-	-
P-value	-	0.954	0.000	-	-	0.932	0.000	-	-	0.935	0.000	-	-

Comparison of Complications

After institutionalised guardianship care the combined complication rate of ventilatory infection, decubitus ulcers and venous thrombosis is 4.00% in the experimental group, which is lower than the control group (16.00%) after basic care (*P*<0.05) (Table 4). This suggests that the use of institutionalised guardianship care for elderly severe RF patients treated with ambroxol significantly reduces the risk of complications compared to basic care. The reason for this may be

that the standardised training of team members' expertise during institutionalised guardianship care helps to improve ventilator operating skills. The observation of the patient's condition also seems to enable a timely and accurate understanding of the changes in the condition of the elderly severe RF patients, thus preventing adverse conditions.

Table 4. Comparison of complications (n (%))

Group	Case	Ventilator infection	Bed sore	Venous thrombosis	Total aggregated rate
Experimental group	50	1 (2.00)	0 (0.00)	1 (2.00)	2 (4.00)
Control group	50	3 (6.00)	1 (2.00)	4 (8.00)	8 (16.00)
χ^2	-	-	-	-	4.000
<i>P</i>	-	-	-	-	0.046

CONCLUSIONS

The experimental group, which receives institutionalised guardianship care combined with ambroxol treatment, seems to show significant improvements in ventilatory function, days spent on breathlessness, use of ventilators, relief time for shortness of breath, intensive care unit days, blood oxygen saturation, arterial PaO₂, and arterial PaCO₂ reduction. It also leads to lower combined complication rates of ventilatory infection, decubitus ulcers and venous thrombosis in elderly patients with severe RF. In contrast, the control group, which receives only basic care, does not seem to exhibit comparable results. These findings suggest that institutionalised guardianship care as a systematic and professional nursing model combined with ambroxol treatment tends to provides better clinical outcomes for severe RF patients and should be promoted in clinical practice.

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