Int J Clin Exp Med 2020;13(10):7212-7221
www.ijcem.com /ISSN:1940-5901/IJCEM0111524

Review Article

Concentrated airway care helps improve respiratory function in patients with type 2 respiratory failure and invasive mechanical ventilation

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Received March 27, 2020; Accepted July 7, 2020; Epub October 15, 2020; Published October 30, 2020

Abstract: Objective: Cluster airway nursing helps to improve the respiratory function of patients with type II respiratory failure and invasive mechanical ventilation. Methods: A total of 127 patients with type II respiratory failure in our hospital were selected as the research subjects. Among them, 75 patients received hierarchical nursing during hospitalization and were regarded as the research group, and 52 patients who only received conventional nursing during hospitalization were regarded as the control group. Blood gas, lung function, CT findings, heart rate, blood pressure, VAP incidence and nursing satisfaction of patients in both groups were observed. Results: After nursing, PaO2 and SaO2 in the research group were higher than those in the control group, PaCO2 was lower than that in the control group ($P < 0.05$). FEV1 and FVC in the research group were higher than those in the control group, FVC and TLC were lower than those in the control group ($P < 0.05$). WT and WA% in the research group were higher than those in the control group ($P < 0.05$). TL, TEL and EI were lower than those in the control group ($P < 0.05$). Heart rate and diastolic pressure in the research group were lower than those in the control group ($P < 0.05$). The incidence of VAP in the research group was lower than that in the control group ($P=0.002$). The nursing satisfaction of the research group was higher than that of the control group ($P=0.041$). Conclusion: Cluster nursing can effectively improve the respiratory function and pulmonary function during the process of mechanical ventilation of type II respiratory failure, and can reduce the incidence of VAP, which is worth implementing clinically.

Keywords: Cluster airway nursing, respiratory function, type II respiratory failure

Introduction

Clinically, type II respiratory failure is also called high carbon respiratory failure [1]. It presents as a clinical syndrome with hypercapnia and decreased arterial blood oxygen saturation caused by ventilation or ventilation disturbance [2]. It is also a common complication in acute exacerbation of chronic obstructive pulmonary disease [3]. During the onset period, the patients' lung ventilation and ventilation function decrease, and their symptoms such as dyspnea become severe, causing them to be unable to carry on effective gas exchange, aggravating the symptoms of hypoxia and ischemia, and further leading to a series of clinical syndromes with loss of physiological functions and metabolic disorders [4]. It causes serious threat to the patients' health and daily life. Serious illness can even bring about critical illness and even death. At present, the clinical diagnosis and treatment methods for type II respiratory failure are mainly conventional invasive mechanical ventilation [5]. However, a ventilation time that is too long will easily lead to ventilator-associated pneumonia (VAP) and aggravate the condition of patients [6]. Some data show that effective nursing intervention after invasive mechanical ventilation for patients with type II respiratory failure can reduce complications of patients [7, 8].

In recent years, the concept of cluster airway nursing has gradually been proven clinically [9].

It is a relatively new nursing management method, which can actively and continuously intervene on behalf of patient's health, help to relieve pain, prevent and reduce the risk of other complications, and improve clinical nursing effects [10]. Some studies suggest that cluster airway nursing management uses evidence-based medicine as the main concept and it can obtain practical and effective care during treatment [11]. According to the changes and development of the condition of each patient's, a corresponding and more humanized nursing scheme can be formulated, so as to improve nursing quality and optimize nursing efficacy [12]. Some scholars have already applied cluster airway nursing management to clinical practice for their treatment and research [13]. However, it is not clear whether cluster airway nursing management is helpful to improve respiratory function of patients with type II respiratory failure and invasive mechanical ventilation. Therefore, this study was carried out and the effect of cluster airway nursing management on reducing VAP was also studied, so as to provide effective preventive measures for the future clinical treatment of type II respiratory failure and reduce its complications.

Materials and methods

General information

A total of 127 patients with type II respiratory failure who were admitted to our hospital from May 2015 to May 2018 were selected as the research subjects. Among them, 75 who received hi cluster airway nursing during hospitalization were considered as the research group (RG) and the other 52 patients received only conventional nursing during hospitalization were treated as the control group (CG). This experiment was approved by the Ethics Committee of the Central Hospital of Wuhan, and all the above research subjects signed an informed consent form.

Inclusion and exclusion criteria

Inclusion criteria: All patients met the diagnostic criteria for COPD complicated with type II respiratory failure in the Guidelines for Diagnosis and Treatment of Chronic Obstructive Pulmonary Disease (2013 Revision) [14]; they met all indications of mechanical ventilation; they did not have any serious medical diseases, tumor metastasis and had complete case data. All patients or their immediate family members signed an informed consent.

Exclusion criteria were as follows: patients with other malignancies; patients with severe liver and kidney dysfunction; patients with mental disorders; patients who refused or conflicted with medical investigators; patients with respiratory failure caused by other diseases; patients with contraindications to surgery; patients with drug allergy; patients with other cardiovascular and cerebrovascular diseases; patients with other autoimmune diseases; patients with other infectious diseases; patients with physical disabilities who were unable to take care of themselves; patients who transferred from another hospital.

Methods

The CG received conventional nursing; to maintain an open airway, and were given sputum aspiration and monitoring of vital signs. The RG received cluster nursing in addition to treatment of the CG. Cluster nursing: 1. The training and professional knowledge of the nursing staff was strengthened. The head nurse set up a working group to discuss and analyze the nursing content every week, correct any improper nursing, and carry out relevant knowledge training for nurses with insufficient professional knowledge. 2. We reasonably arranged the duty schedule of the medical staff, changed the mode of "one person, one post" to a shift system, increased rest time and shortened working time and intensity. 3. Medical personnel were required to be active, and we communicated with patients actively and explained relevant knowledge and precautions of diseases to them. 4. Nursing staff were strictly required to follow the principle of sterile operations, and the ward was disinfected 3 times a day through ultraviolet ray. 5. We instructed patients and their families to eat a high protein diet with high vitamin containing foods and pay attention to meat and vegetable co-consumption. 6. We assisted patients to complete simple rehabilitation training.

Fasting arterial blood was extracted from patients before and after nursing, blood gas analysis was carried out, and pulmonary function examination was performed on patients

Table 1. Clinical data table

	Research group (RG) (n=75)	Control group (CG) (n=52)	t or x^2	P
Age (years)	48.2±5.1	49.8±6.0	1.616	0.109
BMI (kg/cm^2)	21.84±3.54	22.04±3.64	0.310	0.758
Gender			0.058	0.810
Male	42 (56.00)	28 (53.85)		
Female	33 (44.00)	24 (46.15)		
Living environment			0.302	0.583
Cities and towns	58 (77.33)	38 (73.08)		
Countryside	17 (22.67)	14 (26.92)		
Family history			0.037	0.848
Yes	8 (10.67)	5 (9.62)		
No	67 (89.33)	47 (90.38)		
Nationality			0.804	0.370
Han	70 (96.00)	48 (92.31)		
Ethnic minorities	3 (4.00)	4 (7.69)		
Smoking			0.476	0.490
Yes	45 (60.00)	28 (53.85)		
No	30 (40.00)	24 (46.15)		
Drinking			0.169	0.681
Yes	46 (61.33)	30 (57.69)		
No	29 (38.67)	22 (42.31)		

with pulmonary function instruments. After nursing, multi-slice spiral CT was used to examine the lung condition of patients. We also used our hospital's nursing satisfaction score to investigate the patient's satisfaction with a full score of 100: A score of more than 90 was very satisfied; 70-90 points was satisfied; 50-70 points meant needing improvement; a score of less than 50 was unsatisfied. Calculated nursing satisfaction = (very satisfied + satisfied)/ total × 100%.

Outcome measures

Main outcome measures: Blood gas examination of patients in both groups was observed, including pH, PaCO2, PaO2 and SaO2. Pulmonary function was recorded, including forced expiratory volume in 1s (FEV1), forced vital capacity (FVC), residual volume (RV), and total lung capacity (TLC). CT examination results include bronchial lumen inner diameter (LD), tube wall thickness (WT), percentage between airway wall area and total airway cross sectional area (WA%), and tube wall thickness/ accompanying pulmonary artery diameter (WT/ PA).

Secondary outcome measures were as follows: heart rate, blood pressure, VAP incidence and nursing satisfaction of patients in both groups.

Statistical methods

The data from the results were statistically analyzed via SPSS 22.0, and the graphs were illustrated with Graphpad8. The counting data were expressed by (rate), and the comparison between groups was analyzed by Chi-square test. The measurement data were expressed as (mean ± standard deviation), and the comparison between groups was performed with a t test. A *p* value lower than 0.05 was statistically significant.

Results

Clinical data of patients

The clinical data of patients in the two groups collected by us revealed that there was no statistical difference between the RG and CG in gender, age, BMI, nationality, place of residence, smoking and drinking history (P > 0.05) (**Table 1**).

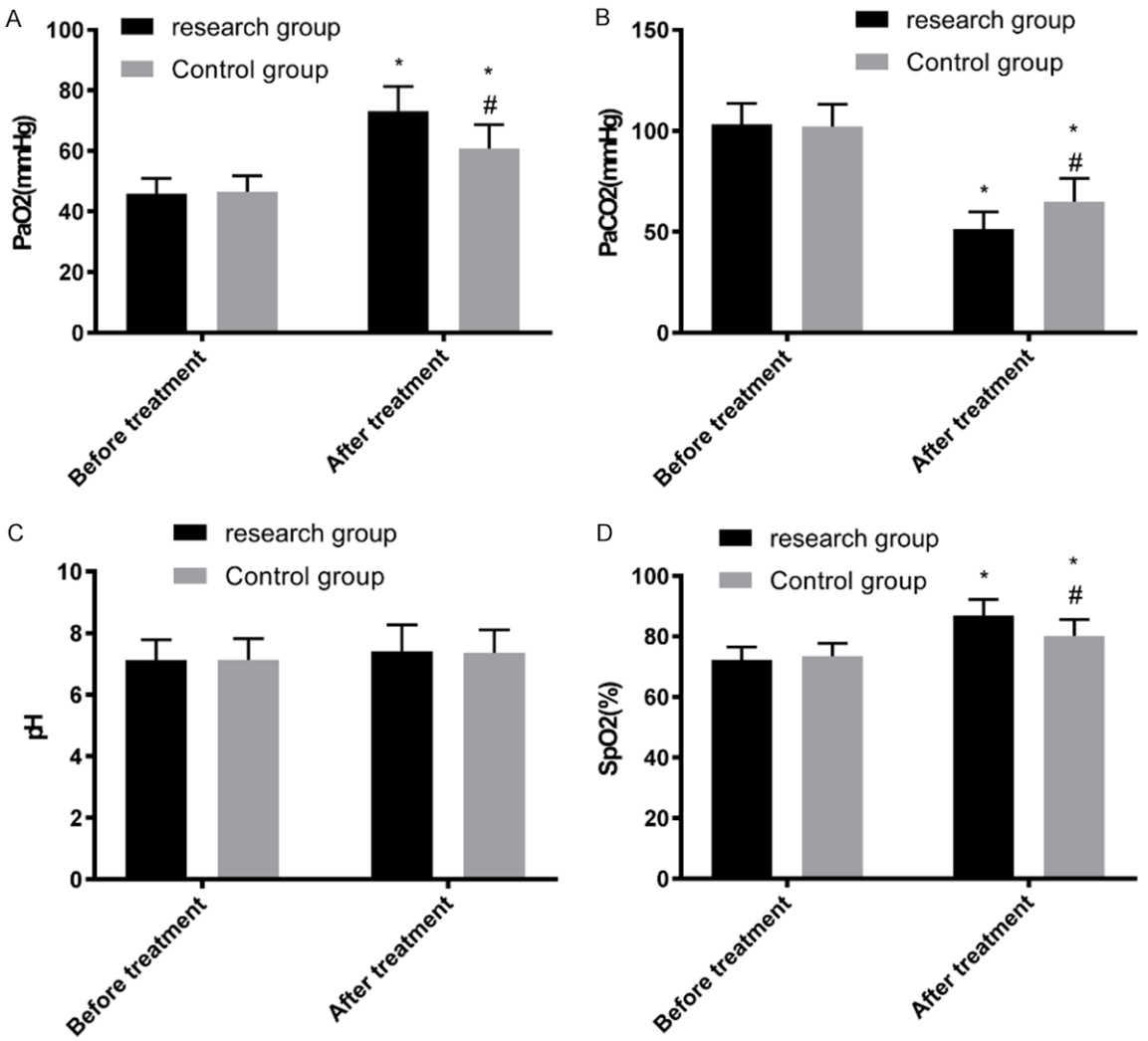

Figure 1. Comparison of blood gas function between the two groups. A. PaO2 comparison between the two groups. B. PaCO2 comparison between the two groups. C. pH comparison between the two groups. D. SaO2 comparison between the two groups. * indicates the comparison with the same group before nursing ($P < 0.05$); # indicates the comparison with the RG after nursing ($P < 0.05$).

Blood gas examination of patients in the two groups

Blood gas functional tests signified that there was no difference in pH, PaCO2, PaO2 and SaO2 between both groups before nursing ($P > 0.05$), but PaO2 and SaO2 increased and PaCO2 decreased after nursing ($P < 0.05$). After nursing, PaO2 and SaO2 in the RG were higher than those in the CG, and PaCO2 was lower than those in the CG ($P < 0.05$) (**Figure 1**).

Pulmonary function examination of patients in the two groups

Pulmonary function examination revealed that there was no difference in FEV1, FVC, FVC and TLC between both groups before nursing ($P > 0.05$), while FEV1, FVC increased and FVC, TLC decreased after nursing ($P < 0.05$). After nursing, FEV1 and FVC in the RG were higher than those in the CG, while FVC and TLC were lower than those in the CG ($P < 0.05$) (**Figure 2**).

CT examination

CT examination signified that there was no marked difference in LD between both groups ($P > 0.05$), while WT and WA% in the RG were higher than those in the CG ($P < 0.05$), and TL, TEL and EI were lower than those in the CG ($P < 0.05$) (**Figure 3**).

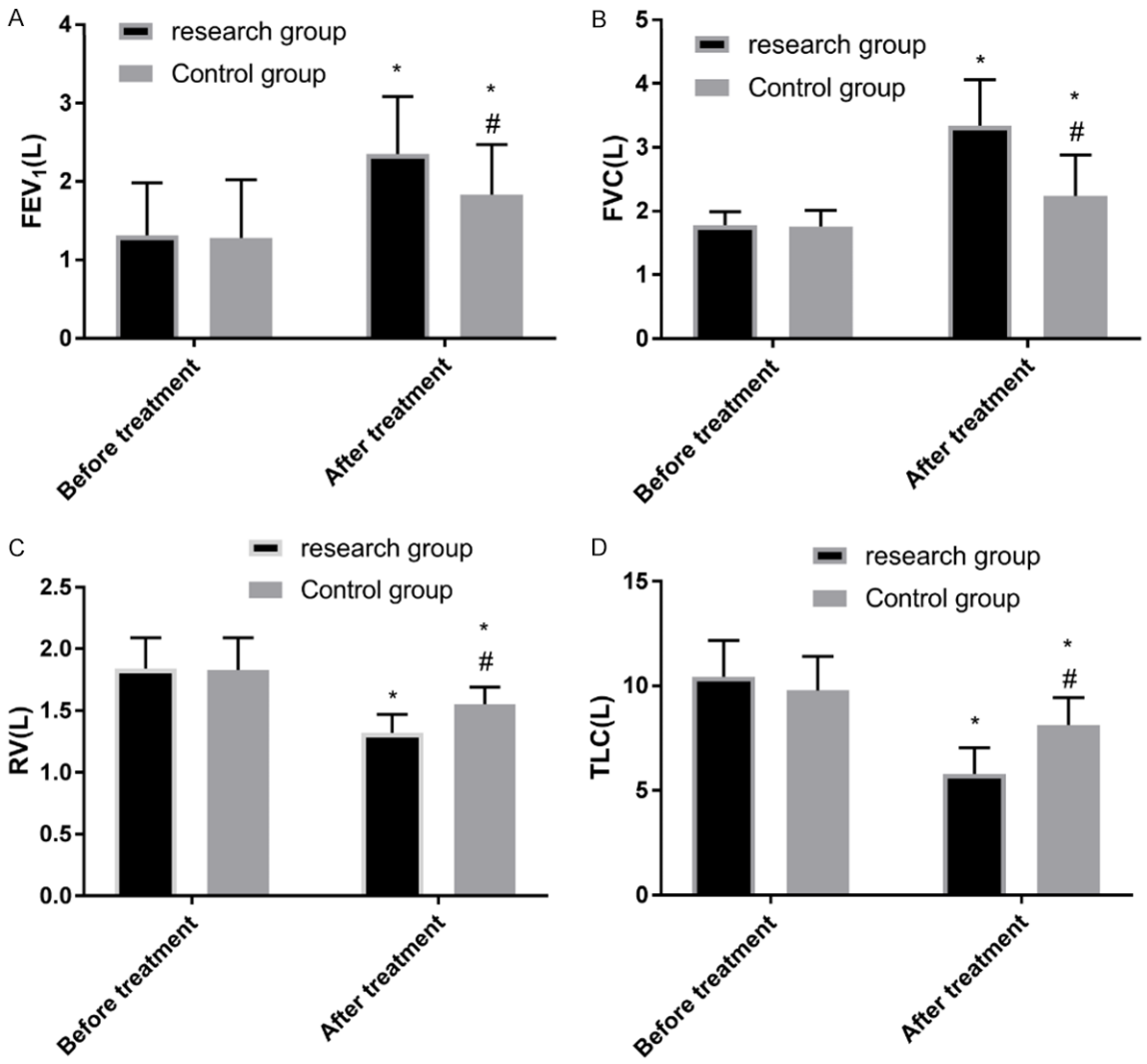

Figure 2. Comparison of lung function examination results between the two groups. A. FEV1 comparison between the two groups. B. FVC comparison between the two groups. C. FVC comparison between the two groups. D. TLC comparison between the two groups. * indicates the comparison with the same group before nursing ($P < 0.05$); # indicates the comparison with the RG after nursing ($P < 0.05$).

Comparison of clinical indicators

Heart rate and diastolic pressure in the RG were lower than those in the CG ($P < 0.05$), while systolic pressure had no difference ($P > 0.05$) (**Figure 4**).

VAP incidence

The incidence of VAP in the RG was 16.67%, which was clearly lower than that in the CG (42.31%) (P=0.002) (**Table 2**).

Nursing satisfaction

After investigation, the nursing satisfaction of the RG was 86.11%, significantly higher than 71.15% of the CG (P=0.041) (**Table 3**).

Discussion

Type II respiratory failure is a respiratory dysfunction syndrome that presently easily occurs in the process of mechanical ventilation in clinical practice [15]. Once a patient suffers from type II respiratory failure, it will cause a series of physiological dysfunction and metabolic disorders, which has a great negative impact on treatment [16]. In order to prevent the occurrence of type II respiratory failure, clinical efforts have been made to explore and find effective intervention programs [17]. Recently, with the deepening of research, more and more research has pointed out that the occurrence of type II respiratory failure can be effectively avoided through nursing intervention [18].

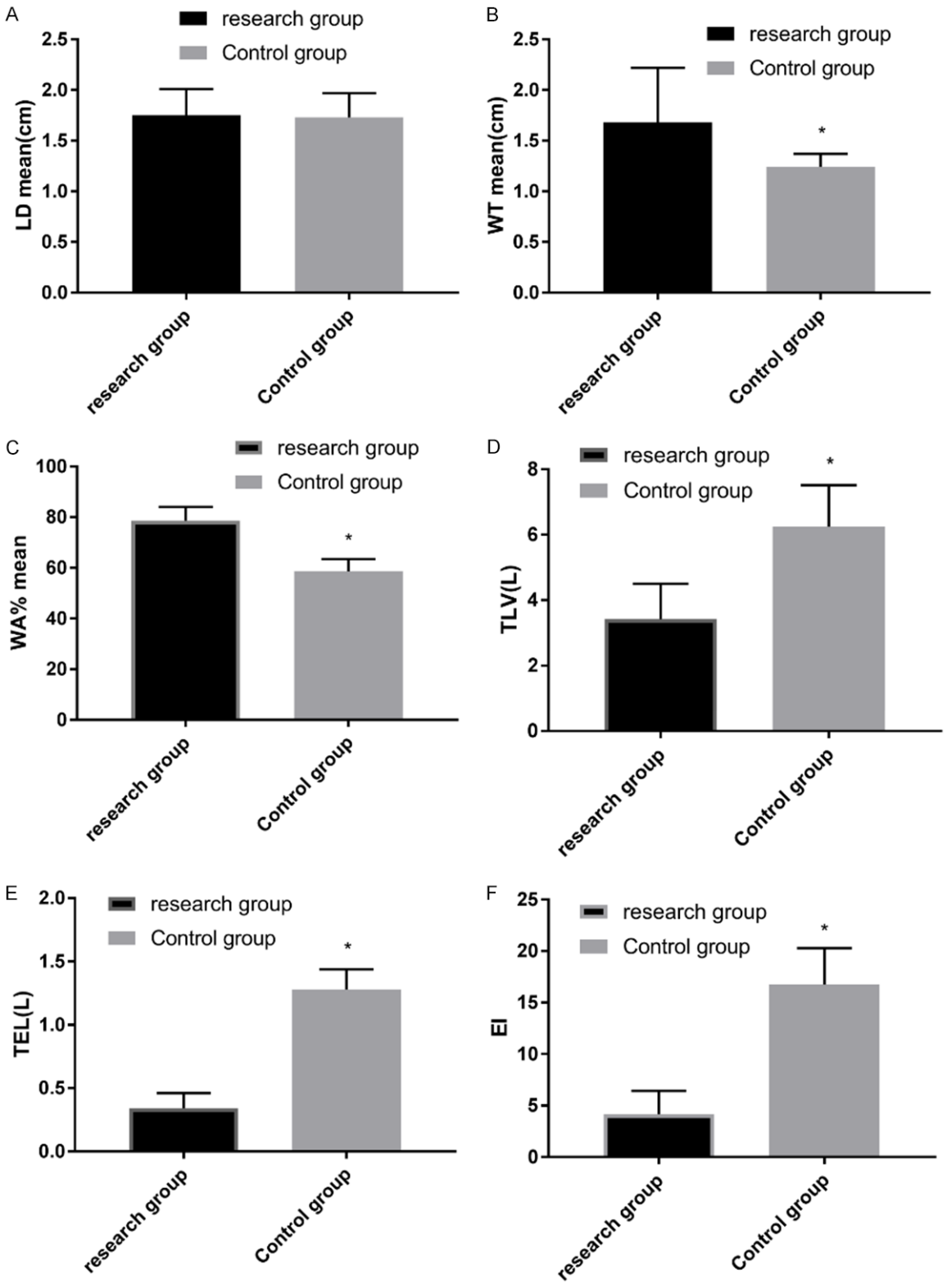

Figure 3. Comparison of CT examination results between the two groups. A. LD comparison in the two groups. B. WT comparison between the two groups (*P < 0.05). C. WA% comparison between the two groups (*P < 0.05). D. TL comparison between the two groups (*P < 0.05). E. TEL comparison between the two groups (*P < 0.05). F. EI comparison between the two groups (*P < 0.05).

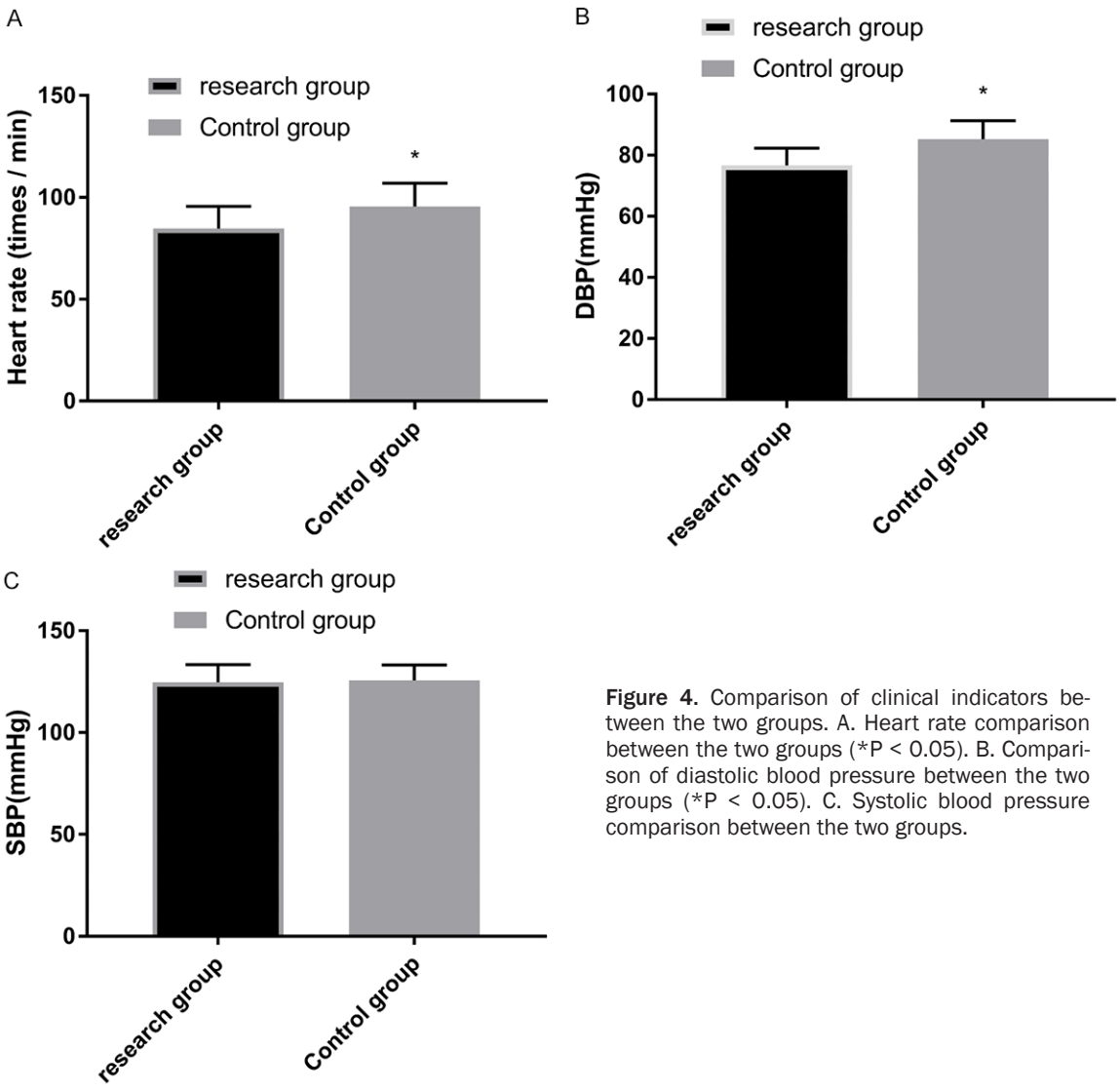

Figure 4. Comparison of clinical indicators between the two groups. A. Heart rate comparison between the two groups (*P < 0.05). B. Comparison of diastolic blood pressure between the two groups (*P < 0.05). C. Systolic blood pressure comparison between the two groups.

Cluster nursing is a new nursing model which integrates treatment, nursing and operations, and aims at improving clinical efficacy. It can not only effectively improve patient treatment management quality, but also accelerate the rehabilitation process of patients [19]. This experiment explores the application of cluster nursing in type II respiratory failure, which is quite remarkable to the future clinical treatment.

The results of this experiment showed that the blood gas function and lung function of patients in the RG using cluster nursing were better than those in the CG using conventional nursing after nursing, suggesting that the using cluster nursing had marked improvement effect on lung function of those with type II respiratory failure. Sinclair C and others [20] explored the impact of cluster nursing on patients with severe lung diseases, which was also consistent with the results of this experiment and could support our results. Blood gas analysis is mainly aimed at determining whether the blood in the body is anoxic and if carbon dioxide is excessive. In addition, it can help to determine whether the anoxia caused by respiratory dysfunction is able to assist in the understanding of the patients unique condition, differential diagnosis, measure the efficacy and estimate the prognosis. In other words, through blood gas analysis, we can have a comprehensive understanding of the patients' ventilatory function, ventilation function (mainly hypoxia and

Table 2. VAP incidence comparison [n (%)]

	Research group (RG) (n=75)	Control group (CG) (n=52)	x^2	P
Happened	12 (16.67)	22 (42.31)	9.975	0.002
Not happened	60 (83.33)	30 (57.69)		

Table 3. Comparison of nursing satisfaction [n (%)]

	Research group (RG) (n=75)	Control group (CG) (n=52)	x^2	P
Very satisfied	42 (58.33)	16 (30.77)		
Satisfied	20 (27.78)	21 (40.38)		
Need improvement	7 (9.72)	10 (19.23)		
Dissatisfied	3 (4.17)	5 (9.62)		
Satisfaction (%)	86.11	71.15	4.196	0.041

carbon dioxide retention), and the body's acid-base state and electrolyte disturbance [21]. The examination of lung function is one of the necessary examinations of respiratory system diseases. It can detect the patency of the respiratory tract and the size of lung volume, which is quite significant to the assessment and severity of diseases [22]. After nursing, PaO2 and SaO2 in the RG were higher than those in the CG, PaCO2 was lower than those in the CG, FEV1 and FVC in the RG were higher than those in the CG, FVC and TLC were lower than those in the CG; all of which showed the advantages of using cluster nursing and further promoted the recovery of patients. In order to further confirm the practicality of cluster nursing, we found that WT and WA% of patients in the RG were higher than those in the CG, and TL, TEL and EI were lower than those in the CG. CT examination is a more advanced medical imaging examination technology: the CT beam is used to scan a certain thickness of the human body, with high density resolution, which can directly show organs and lesions that cannot be shown by X-ray examination, and is very helpful to judge respiratory function [23], and the results can show the significance of cluster nursing for patients with type II respiratory failure. We speculate that the difference between the two groups may be caused by the following points: 1. Cluster nursing requires professional training of nursing staff, which can effectively improve the overall nursing quality for patients with different levels of technology and experience in clinical practice, and plays a crucial part in improving the rehabilitation of patients and reducing the occurrence of adverse reactions [24]. 2. Through reasonable work arrangements, blindness in routine nursing can be avoided and unnecessary labor damage can be reduced. Not only can nursing staff have more reasonable work and rest arrangements in the work process, but also the working enthusiasm of nursing staff can be improved. The passive and rigid work arrangements can be changed into active and enthusiastic participation, which can fundamentally improve the working status and attitude of nursing staff and also improve the nursing efficiency for patients [25]. 3. Cluster nursing requires nursing staff to communicate with patients actively and explain successful cases of treatment and relevant knowledge of diseases to them. In this process, they not only have a certain preliminary understanding of their own diseases, but also know how to seek benefits and avoid harm on their own, thus reducing secondary damage of diseases caused by ignorance. In the process of doctor-patient communication, the relationship between patients and medical staff is narrowed; therefore fear, resistance and rebellious psychology of patients are reduced, and their confidence in successful treatment and the treatment compliance are improved, resulting in the effects of their rehabilitation being greatly enhanced [26]. 4. Cluster nursing requires nursing staff to abide by the principle of aseptic operations and do a good job in disinfection of rooms, thus effectively avoiding the possibility of nosocomial infection during invasive and traumatic operations, creating an excellent environment for mechanical intubation ventilation of patients and reducing VAP occurrence. By comparing the incidence of VAP between the two groups, we found that the incidence of VAP in the RG was dramatically lower than that in

the CG, which could support our conjecture [27]. 5. Cluster nursing provides dietary nutrition support to patients. By evaluating the nutritional status of patients and giving corresponding nutritional guidance to them, it can better coordinate the process of the body rehabilitation, enhance the body's resistance and prevent the occurrence of infection [28]. Additionally, by comparing the nursing satisfaction of patients in the two groups, we also found that the nursing satisfaction of those in the RG was dramatically better than that in the CG, which indicated the application value of cluster nursing in clinical practice and that it has a remarkable effect on improving the quality of clinical nursing.

This experiment explores the application value of cluster nursing for type II respiratory failure, but there are still some limitations due to limited experimental conditions, such as short examination period, being unable to evaluate the impact of cluster nursing on long-term prognosis of patients with type II respiratory failure, and unable to carry out statistical analysis of big data due to the small base of research subjects. In addition, because there are all kinds of different nursing methods clinically and only conventional nursing is taken as the control, it is not excluded that the application effect of cluster nursing is not as clear as compared with other nursing modes. We will do more in-depth experimental research according to the above limitations as quickly as possible to obtain more comprehensive experimental results for clinical reference.

In summary, cluster nursing can effectively improve respiratory and lung function during mechanical ventilation of type II respiratory failure, and can reduce VAP incidence, which is worthy of promotion and use in clinical practice.

Disclosure of conflict of interest

None.

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