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Original Article

Cluster care improves the efficacy of sequential invasive-noninvasive mechanical ventilation for AECOPD accompanied with type II severe respiratory failure

Ning Zhang[1], Xue Li[2], Ranran Zheng[3], Runhua Bu[4], Guanjun Li[5]

[1]Intensive Care Unit, [5]Department of Anesthesiology, Shandong Provincial Third Hospital, Jinan, Shandong, China; Departments of [2]Science and Education, [3]Control Hospital Infection, [4]Cardiology, Liaocheng Third People's Hospital, Liaocheng, Shandong, China

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Abstract: Objective: The aim of this study was to examine the effects of cluster nursing on AECOPD (acute exacerbation of chronic obstructive pulmonary disease) complicated with type II severe respiratory failure treated by the sequential invasive-noninvasive mechanical ventilation. Methods: Medical records of 92 patients with AECOPD accompanied with type II severe respiratory failure were retrospectively analyzed. Selected patients were given sequential invasive-noninvasive mechanical ventilation. Of these, 37 patients received routine care (sham group), while the other 55 patients received cluster care based on routine care (observation group). Total mechanical ventilation times, incidence of ventilator associated pneumonia, tracheal intubation times, success rates of ventilator weaning, reintubation rates, hospital stays, times of hospitalizations, and quality of life scores (by Seattle Obstructive Lung Disease Questionnaire), as well as nursing satisfaction, were compared. Results: Total mechanical ventilation times and tracheal intubation times of the observation group were shorter than those of the sham group ($P<0.05$). Incidence of ventilator associated pneumonia and reintubation rates of the observation group were lower than those in the sham group ($P<0.05$). The success rate of ventilator weaning in the observation group was higher than that of the sham group ($P<0.05$). Hospital stays in the observation group were shorter than those in the sham group ($P<0.05$). Quality of life and nursing satisfaction scores in the observation group were higher than those in the sham group after treatment ($P<0.05$). Conclusion: Cluster nursing care based on routine nursing care will improve nursing effects in patients with AECOPD and type II respiratory failure treated with sequential invasive-non-invasive mechanical ventilation. It will shorten total mechanical ventilation times, decrease incidence of ventilator-associated pneumonia, upgrade the quality of life of patients, and elevate nursing satisfaction scores.

Keywords: Cluster care, sequential invasive-non-invasive mechanical ventilation, AECOPD, respiratory failure

Introduction

Chronic obstructive pulmonary disease (COPD) is a chronic respiratory disease. It has the features of completely irreversible airflow obstruction and progressive deterioration of lung function. Exact causes of the disease remain unclear. Various adverse reactions always occur because of alveolar abnormalities and airway dysfunction, as well as the impact of harmful particles inhaled from the air [1, 2]. Pathological surveys have shown that COPD mainly occurs in middle-aged and elderly people (older than 40 years old), with an incidence rate of 9% to 10% [3]. In Asian countries, especially in China, the population dying from COPD annually has exceeded 1 million. Those that are disabled due to the disease account for up to 5 million [4]. Statistics indicate that worldwide COPD deaths reached 3 million in 2016, accounting for 5.2% of total deaths. The death toll continues to increase gradually year by year [5]. COPD, especially AECOPD, seriously threats the life and health of patients, causing great social and economic burden due to its high mortality rate and high disability rate. By 2020, COPD is expected to rank fifth in the world, with the heaviest disease and economic burden [6].

Clinical application of mechanical ventilation in acute and severe respiratory diseases indicates great progress made in modern medicine. It

effectively improves the therapeutic efficacy and quality of life of AECOPD patients. However, increased risks of complications, including invasive and respiratory-related pneumonia, have seriously impacted the application of mechanical ventilation, even resulting in therapy failure [7]. Therefore, "sequential" mechanical ventilation was generated. It effectively solves the difficulty of ventilator weaning, reduces re-intubation rates. It is unanimously recognized by experts, domestic and abroad [8]. Clustered nursing care was first put forward by the American Medical Improvement Center in 2004. This nursing mode has been proven to integrate the latest nursing methods. It aims to effectively improve therapeutic efficacy on the basis of the evidence-based medicine and to prevent and reduce occurrence of complications [9]. In recent years, it has been reported that cluster nursing care will prevent and reduce occurrence of ventilator-associated pneumonia [10, 11]. However, reports concerning the application of cluster nursing in patients with AECOPD and severe type II respiratory failure treated with sequential invasive-non-invasive mechanical ventilation have been rare.

Therefore, the current study analyzed the application value of cluster nursing, retrospectively examining medical records of 92 patients with AECOPD and type II severe respiratory failure.

Materials and methods

Subjects

Medical records of patients with AECOPD and type II severe respiratory failure were retrospectively analyzed in the current study. All patients were given sequential invasive-non-invasive mechanical ventilation. Of these, 37 patients were given routine nursing care in the Intensive Care Unit (sham group), while the other 55 patients were given cluster nursing care based on routine nursing care (observation group). Inclusion criteria: 1) Patients satisfying the guidelines for diagnosis and treatment of chronic obstructive pulmonary disease (revised in 2013), drafted by the Chronic Obstructive Pulmonary Diseases Group of Chinese Thoracic Society; 2) Partial pressure of carbon dioxide in arterial blood of the patients was greater than 50 mmHg and the partial pressure of oxygen in arterial blood of the patients was less than 60mmHg; 3) Patients did not suffer from consciousness disorders; and 4) Patients were not older than 75. Exclusion criteria: Patients with hemodynamic abnormalities, organ dysfunction, such as heart and liver dysfunction, severe pulmonary dysfunction, allergic asthma, lung cancer, osteoarthrosis diseases impacting movement, severe malnutrition, mental disorders, learning dysfunction, and incomplete medical data were excluded. This study was approved by the Ethics Committee. All patients and family members provided informed consent.

Treatment methods

All patients received routine treatment for AECOPD accompanied by type II severe respiratory failure. Antispasmodic and anti-infective treatments were given via invasive ventilation through the establishment of artificial airways and tracheal intubation. The ventilation mode was synchronous intermittent mandatory ventilation combined with pressure support. When the pulmonary infection control window was reached, tracheal intubation was removed for non-invasive ventilation. The ventilator was BiPAP in type and purchased from Philips. Patients in the sham group were given routine nursing care, including artificial airway management, ventilator pipeline cleaning, oral cavity care, infection prevention, and psychological care. Patients in the observation group were given cluster care based on routine nursing care, including elevating the head of the bed by 30°-45°, excluding patients with position contraindications, preventing vomiting and aspiration, providing nursing for routine airway secretion for patients with ventilation times more than 72 hours, exercising respiratory function, and gastrointestinal care. All hands were cleaned and disinfected before the operation, strictly following aseptic operation requirements.

Measurement outcomes

Total mechanical ventilation times, incidence of ventilator-associated pneumonia, tracheal intubation times, success rates of ventilator weaning, reintubation rates, hospital stays, times of hospitalizations, quality of life scores (by Seattle Obstructive Lung Disease Questionnaire), and nursing satisfaction scores (total score is 100 and higher scores indicate higher the nursing satisfaction) were measured.

Diagnostic criteria of ventilator-associated pneumonia: Pulmonary inflammation occurs with

the symptom of a fever when the ventilator has been applied for longer than 48 hours; Body temperature is higher than 37.5°C; Secretion of the respiratory tract is purulent; Secretion contains new pathogenic bacterial by bacterial culture; Blood routine examination results show that white blood cell count exceeds $10*10^9$/L; Imaging results show infiltrative shadow enlargement or new infiltrations in the lungs.

Criteria of ventilator weaning success: No adverse reactions observed 24 hours after ventilator weaning and oxygenation is given with the nasal catheter; No recanalization or mechanical ventilation are given within 5 days of ventilator weaning; Imaging results suggest reduced infiltrative shadows in the lungs; Respiratory infections are effectively controlled; Respiratory frequency does not exceed 28 times/minute, according to pulmonary function testing; Oxygen saturation of the arterial blood exceeds 90%; Partial pressure of the carbon dioxide in arterial blood does not exceed 60 mmHg.

Statistical analysis

SPSS 19.0 (Asia Analytics Formerly SPSS China) was adopted for data analysis. Count data are expressed with [n (%)] and rates were compared with χ^2 test. Measurement data are expressed with $\bar{x} \pm$ sd and comparisons between the two groups were performed by t-test. $P<0.05$ implies statistical significance.

Results

General information

A total of 37 patients were selected for the sham group, including 18 males and 19 females. Of these, 14 patients were younger than 65 years and 23 patients were older than 65 years old. A total of 55 patients were selected for the observation group, including 26 male patients and 29 female patients. Of these, 24 patients were younger than 65 years and 34 patients were older than 65 years old. There were no significant differences in gender and age between the two groups ($P>0.05$). Other basic data, such as body weight, height, white blood cell count, neutrophil ratio, PH, partial pressure of oxygen in arterial blood, and partial pressure of carbon dioxide in arterial blood, were not statistically different between the two groups ($P>0.05$) (**Table 1**).

Cluster care shortens total mechanical ventilation times

Total mechanical ventilation times of the sham group and observation group were, respectively, (9.74±1.22) days and (9.01±1.37) days, suggesting that total mechanical ventilation times between the two groups were statistically different. Total ventilation times of the observation group were shorter than those of the sham group ($P<0.05$) (**Figure 1**).

Cluster care reduces incidence of ventilator-associated pneumonia

Rates of ventilator-associated pneumonia in the sham group and observation group were, respectively, 27.03% (10 cases) and 9.09% (5 cases), suggesting that incidence of ventilator-associated pneumonia was statistically different between the two groups. Incidence of ventilator-associated pneumonia in the observation group was lower than that in the sham group ($P<0.05$) (**Figure 2**).

Cluster care shortens tracheal intubation times

Tracheal intubation times of the sham group and observation group were, respectively, (5.96±0.24) days and (5.43±0.32) days, suggesting that tracheal intubation times were statistically different between the two groups. Tracheal intubation times of the observation group were shorter than those of the sham group ($P<0.05$) (**Figure 3**).

Cluster care increases success rates of ventilator weaning

Success rates of ventilator weaning in the sham group and observation group were, respectively, 81.08% (30 cases) and 94.55% (52 cases), suggesting that success rates of ventilator weaning were statistically different between the two groups. Success rates of ventilator weaning in the observation group were higher than those in the sham group ($P<0.05$) (**Figure 4**).

Cluster care lowers reintubation rates

Reintubation rates of the sham group and observation group were, respectively, 13.51% (5 cases) and 1.82% (1 case), suggesting that reintubation rates were statistically different between the two groups. Reintubation rates in

Table 1. General information

	Sham group (n=37)	Observation group (n=55)	χ^2/t	*P* value
Gender [n (%)]			0.017	0.897
Male	18 (48.65)	26 (47.27)		
Female	19 (51.35)	29 (52.73)		
Age [n (%)]			0.001	0.973
≤65 years old	14 (37.84)	21 (38.18)		
>65 years old	23 (62.16)	34 (61.82)		
Body weight [n (%)]			0.088	0.767
≤60 kg	20 (54.05)	28 (50.91)		
>60 kg	17 (45.95)	27 (49.09)		
Height [n (%)]			0.002	0.967
≤165 cm	19 (51.35)	28 (50.91)		
>165 cm	18 (48.65)	27 (49.09)		
White blood cell count (10^9/L)	11.72±2.65	11.34±2.47	0.703	0.484
Neutrophil ratio (%)	87.67±7.94	86.85±7.15	0.516	0.607
PH	7.19±0.05	7.18±0.04	1.062	0.291
Partial pressure of oxygen in arterial blood (mmHg)	53.17±1.92	53.25±2.12	0.184	0.854
Partial pressure of carbon dioxide in arterial blood (mmHg)	87.85±6.83	86.73±7.11	0.753	0.454
Heart rate (times/minutes)	110.26±8.41	109.53±7.88	0.424	0.673
Mean arterial pressure (mmHg)	98.41±8.25	99.78±9.01	0.739	0.462
Smoking history [n (%)]			0.204	0.651
Yes	26 (70.27)	41 (74.55)		
No	11 (29.73)	14 (25.45)		
With other diseases [n (%)]			0.845	0.358
Yes	20 (54.05)	35 (63.64)		
No	17 (45.95)	20 (36.36)		

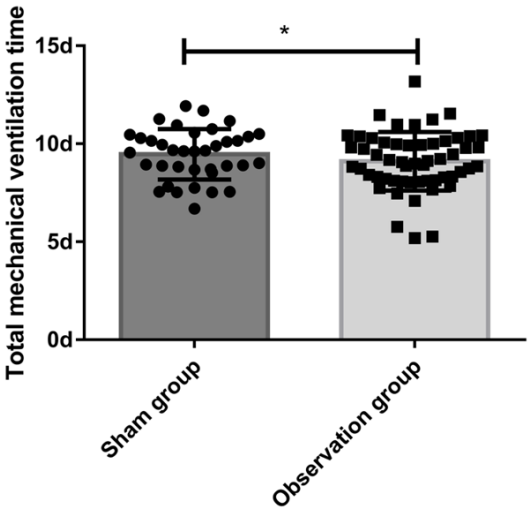

Figure 1. Analysis of total mechanical ventilation times in the two groups. The total ventilation time of the observation group was significantly shorter than that of the sham group *: P<0.05.

the observation group were lower than those in the sham group (P<0.05) (**Figure 5**).

Cluster care shortens hospital stays and times of hospitalization

Hospital stays of the sham group and observation group were, respectively, (90.62±25.38) days and (65.47±18.26). Times of hospitalization in the sham group and observation group were, respectively, (5.33±2.14) and (2.62±1.25), suggesting that hospital stays and times of hospitalization between the observation group and sham group were statistically different. Hospital stays and hospitalization times in the observation group were shorter than those in the sham group (P<0.001) (**Table 2**).

Cluster care improves quality of life

Quality of life scores of the sham group and observation group, before treatment, were (62.33±8.75) and (63.14±8.63), suggesting that quality of life scores between the two groups were not statistically different (P>0.05). Quality of life scores, after treatment, were (70.56±7.45) and (79.52±7.24) in the sham

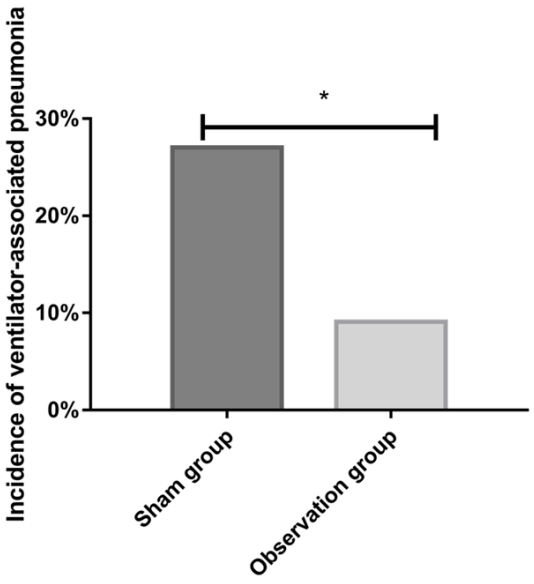

Figure 2. Incidence of ventilator-associated pneumonia in the two groups. Incidence of ventilator-associated pneumonia in the observation group was lower than that in the sham group *: P<0.05.

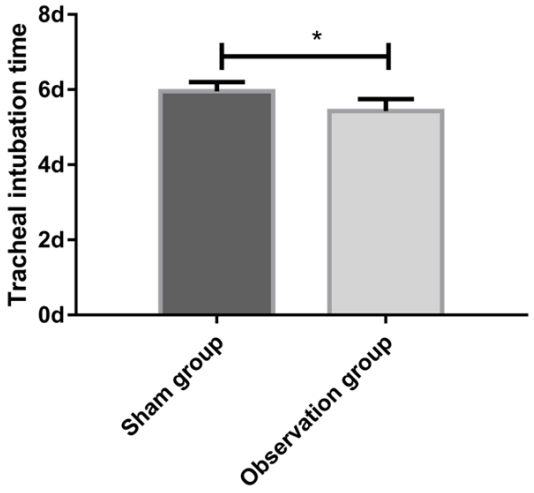

Figure 3. Tracheal intubation times of the two groups of patients. The tracheal intubation time of the observation group was shorter than that of the sham group *: P<0.05.

group and observation group, suggesting that quality of life scores between the two groups were statistically different. Quality of life scores in the observation group were higher than those in the sham group (P<0.05) (**Figure 6**).

Cluster care improves nursing satisfaction

Nursing satisfaction scores of the sham group and observation group were, respectively,

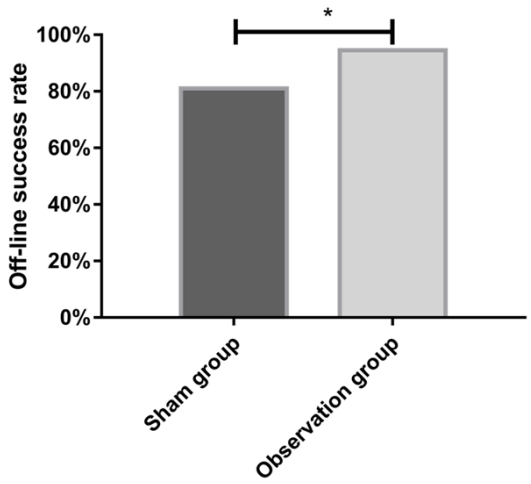

Figure 4. Success rates of ventilator weaning the two groups of patients. The success rate of ventilator weaning in the observation group was higher than that in the sham group *: P<0.05.

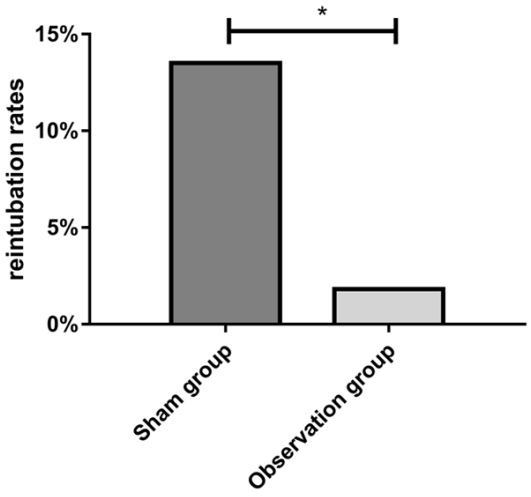

Figure 5. Reintubation rates of the two groups of patients. The reintubation rate in the observation group was lower than that in the sham group *: P<0.05.

(78.69±7.42) and (87.55±6.93), suggesting that nursing satisfaction between the two groups was statistically different. Nursing satisfaction in the observation group was higher than that of the sham group (P<0.05) (**Figure 7**).

Discussion

COPD is a multi-gene systemic respiratory disease characterized by airflow limitation. Surveys and statistics, in recent years, have displayed that the population suffering from COPD in the United States has exceeded 16 million.

Table 2. Hospital stays and times of hospitalization

	Sham group (n=37)	Observation group (n=55)	t	*P* value
Hospital stay	90.62±25.38	65.47±18.26	5.509	<0.001
Times of hospitalization	5.33±2.14	2.62±1.25	7.659	<0.001

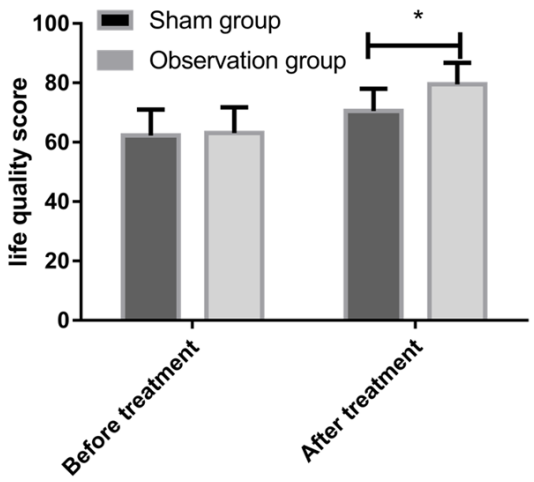

Figure 6. Quality of life scores in both groups. The quality of life score in the observation group was higher than that in the sham group *: P<0.05.

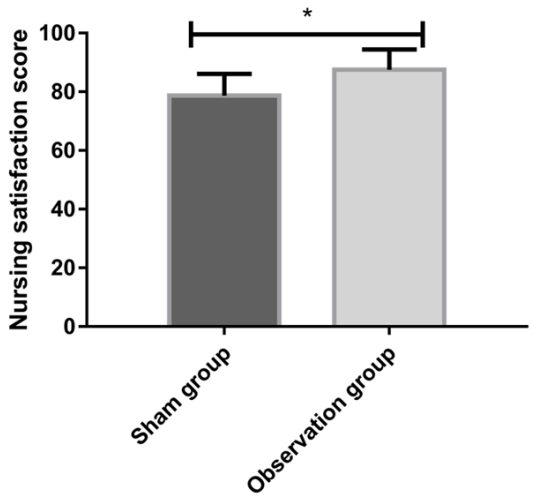

Figure 7. Nursing satisfaction scores of both groups. Nursing satisfaction in the observation group was higher than that of the sham group *: P<0.05.

COPD has become the fourth highest killer of US people [12]. Incidence of COPD in Chinese people older than 40 years old is as high as 8.2%, seriously affecting the quality of life of patients [13]. In addition, many COPD patients are accompanied by respiratory failure, which further boosts the mortality of COPD patients. However, no specific drugs have been indicated for the disease. Sequential invasive-non-invasive mechanical ventilation is an effective method of treating AECOPD with respiratory failure. However, the therapeutic efficacy of this method is adversely affected by various complications, such as ventilator-associated pneumonia. Nursing care is always one of the most effective adjuvants for clinical treatment [14, 15]. Therefore, the current study analyzed the application value of cluster nursing intervention by retrospectively examining nursing records of patients with AECOPD and type II respiratory failure.

This study included the medical records of 92 patients with AECOPD and type II respiratory failure, strictly following inclusion and exclusion criteria. Basic data, including age and gender, was not statistically different between the two groups, indicating that the two groups were comparable and results are reliable. Due to bronchial-pulmonary infections, patients with COPD will have more concentrated secretions. This aggravates the edema of the respiratory tract and increases airway resistance and respiratory internal friction. In addition, patients are generally physically weak. Malnutrition and serious disorders concerning water and electrolytes are typically found. The above causes lead to respiratory failure [16, 17]. Sequential invasive-noninvasive mechanical ventilation will effectively alleviate airway spasms, increase airway and alveolar pressure, decrease airway resistance, and improve ventilation function. However, long-term mechanical ventilation will still induce the risks of ventilator-associated pneumonia and failure of ventilator weaning [18, 19]. Therefore, effective nursing care is necessary to improve the effectiveness of sequential invasive-non-invasive mechanical ventilation therapy. Current routine nursing for intensive care units gradually fail to satisfy the increasing demands, as application is extended. Cluster nursing, based on literature references and evidence-based medicine validation, aims to improve the nursing care quality in the hospital, providing a comprehensive intervention strategy and satisfying the treatment needs of patients during hospitalization [20, 21]. Results of this study show that, compared

with patients only receiving routine nursing in the sham group, patients receiving cluster nursing had shorter total mechanical ventilation times, tracheal intubation times, hospital stays, and shorter hospitalization times. Furthermore, reintubation rates and ventilator weaning success rates in the observation group were higher than those in the sham group. Incidence of ventilator-associated pneumonia in the observation group was lower than that in the sham group. Present results indicate the positive application significance of clustering nursing in patients with AECOPD and type II respiratory failure. With an increase of mechanical ventilation times, the risks of ventilator-associated pneumonia tend to increase, seriously affecting therapeutic effects. Furthermore, long-term lasting and recurrence of AECOPD with type II respiratory failure also increases hospital stays, exerts great pressure on the patients and their families concerning economy and spirit, and seriously impacts quality of life [22, 23]. The above factors reflect the positive significance of clustering care in clinical treatment. Some studies have reported that providing cluster nursing simultaneously with invasive-non-invasive sequential mechanical ventilation will reduce incidence of adverse reactions, shorten times for ventilator weaning, and improve the effectiveness of mechanical ventilation [24]. During the application process of clustering care, it is very important to elevate the bed head by 30°-45° and disinfect the hands strictly. These will effectively prevent ventilator-associated pneumonia [25, 26]. However, attention must be paid to education and training of nursing providers. Associated nursing operations must be implemented to improve the nursing satisfaction of patients and upgrade nursing effects. There were some limitations to the current study, however. Performance of nursing in the two groups was not evaluated and samples were limited. Therefore, future research should expand the samples used, aiming to improve study results.

In summary, clustered nursing will effectively improve the effects of routine nursing in patients with AECOPD and type II respiratory failure treated with sequential invasive-non-invasive mechanical ventilation. This method will cut down total mechanical ventilation times, reduce incidence of pneumonia, improve quality of life, and enhance the nursing satisfaction of patients.

Disclosure of conflict of interest

None.

Address correspondence to: Guanjun Li, Department of Anesthesiology, Shandong Provincial Third Hospital, No.12 Wuyingshan Middle Road, Tianqiao District, Jinan 250000, Shandong, China. Tel: 86-0531-85953277; E-mail: xiaoicu@163.com

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