Int J Clin Exp Med 2018;11(8):8593-8600
www.ijcem.com /ISSN:1940-5901/IJCEM0077890

Original Article

Evaluation of cluster nursing for elderly patients during chronic respiratory failure

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Received April 13, 2018; Accepted May 30, 2018; Epub August 15, 2018; Published August 30, 2018

Abstract: Objective: To investigate and evaluate the application effects of cluster nursing to elderly patients with chronic respiratory failure during mechanical ventilation and its role in preventing ventilator-associated pneumonia (VAP) and other complications. Methods: A total of 210 elderly patients receiving mechanical ventilation in the Intensive Care Unit of Houjie Hospital of Dongguan from March 2015 to June 2017 were selected as research objects, who were randomly divided into the research group (n = 105) and the control group (n = 105). Patients in the control group were given conventional nursing, and those in the research group received cluster nursing on the basis of conventional nursing. The duration of mechanical ventilation, length of stay in the intensive care unit, and hospitalization expenses after nursing, incidences of VAP and adverse reactions, blood gas analysis results before and after treatment, clinical total effective rate, evaluation of nursing comfort, and nursing satisfaction rate were compared between the two groups of patients. Results: In the research group, ventilator supporting time and length of stay were remarkably shorter, the hospitalization expenses were lower, and arterial partial pressure of oxygen, arterial partial pressure of carbon dioxide and other indexes after treatment were better than those in the control group. The differences between the two groups were statistically significant (all $P<0.05$). Incidences of VAP and adverse reactions in research group were decreased compared with those in the control group (both $P<0.05$), while the clinical effective rate was increased notably ($P<0.05$). The evaluation of comfort of the patients and satisfaction rate of the patients' families with the nursing services in the research group were superior to those in the control group, and the differences had statistical significance (both $P<0.05$). Conclusion: Applying the cluster nursing mode can effectively ameliorate the respiratory conditions of the elderly patients with chronic respiratory failure, shorten the ventilator supporting time and length of stay, lower the mortality rate, reduce complications, facilitate the patients' rehabilitation, and improve nursing comfort and satisfaction rate of the patients, which plays a very important role.

Keywords: Elderly patients, respiratory failure, ventilator-associated pneumonia, cluster nursing

Introduction

Most chronic respiratory failure in elderly patients is an end stage of diseases developed from gradual exacerbation of bronchio-pulmonary diseases [1]. Its major clinical manifestations are insufficiency of the oxygen supply and retention of carbon dioxide caused by gas exchange that cannot be maintained effectively in patients at a resting state [2]. If the disease is not corrected in time, it will lead to disorders of the metabolic system and dysfunction of multiple organs, increasing the mortality rate. It is generally difficult to correct respiratory failure by virtue of simple oxygen inhalation by nasal catheter, so mechanical ventilation therapy is needs to be performed in time [3].

Ventilator-associated pneumonia (VAP) is one of the common complications in patients who are given mechanical ventilation to ameliorate the symptoms of respiratory failure [4]. According to related statistics, its mortality rate is 20-60%, and the cost of treatment is approximately RMB 100,000 Yuan or above [5, 6]. For elderly patients, because of the older age and

weak body functions, their resistance to germs as well as coughing and expectorating ability declines significantly, and their capability to recover trauma is decreased remarkably. Therefore, reproduction of pathogens is increased constantly with prolonged mechanical ventilation, finally resulting in a notably higher VAP incidence in the elderly than in young adults [7].

Cluster nursing is type of nursing mode proposed on basis of evidence-based medicine [8]. Relevant studies conducted in China and foreign countries have demonstrated that cluster nursing plays crucial roles in standardizing nursing procedures in wards, providing high-quality medical services for patients, lowering the incidence of VAP and improving the enthusiasm of health-care workers [9]. This study aims to assess the effects of the cluster nursing mode on elderly patients complicated with chronic respiratory failure and VAP by virtue of fairly detailed observation indexes. A total of 210 elderly patients with respiratory failure receiving mechanical ventilation in Houjie Hospital of Dongguan were selected and based on conventional nursing mode, cluster nursing methods were further integrated to investigate the effect of cluster nursing in improving the prognosis of elderly patients with respiratory failure.

Materials and methods

Selected objects and grouping

A total of 210 elderly patients treated with mechanical ventilation in Intensive Care Unit (ICU) of Houjie Hospital of Dongguan from March 2015 to June 2017 were selected as research objects, who were randomly divided into the research group (n = 105) and the control group (n = 105). Patients in the control group received conventional nursing, and those in the research group received cluster nursing on basis of the conventional nursing. General information on the research objects included gender, age, type of primary disease, method of establishing artificial airway as well as Acute Physiology and Chronic Health Evaluation II score (APACHE II score), and Glasgow Coma Scale score (GCS score) evaluated through relevant scales.

Inclusion criteria: (1) all the patients' guardians were fully informed of and agreed with the content of this study and signed the informed consent, and this study was reviewed by the Ethics Committee of Houjie Hospital of Dongguan. (2) patients were aged 60-89 years old. (3) all the patients received mechanical ventilation for the first time, underwent artificial airway-assisted respiration within 72 hours after admission to the hospital and had no past history of respiratory diseases, with duration of ventilation >48 hours. (4) patients breathed at a resting state under standard atmospheric pressure, who were diagnosed with type II respiratory failure with partial pressure of oxygen (PaO_2) <60 mmHg and arterial partial pressure of carbon dioxide ($PaCO_2$) >50 mmHg [10].

Exclusion criteria: (1) patients receiving tracheal intubation outside the hospital and treated with mechanical ventilation at the time of admission; (2) patients diagnosed with pulmonary infection at the time of admission; (3) patients having pulmonary infection, weaning and death within 48 h after mechanical ventilation; (4) patients with other organ failures.

Research methods

Conventional nursing methods in ICU were applied in the control group. Following the principle of aseptic operation, standardizing sputum suction was performed for the patients on time. The head of the bed was elevated 30°-45°, so as to prevent aspiration and reflux of gastric contents of the patients. Oral care was conducted for the patients twice a day. In addition to conventional nursing methods in the ICU, cluster nursing protocol was applied in the research group. (1) Ventilator management: The nursing staff operating the ventilator received professional and systematic training. Pipes of the ventilator were replaced and disinfected every week, and condensed water in the ventilator was changed in time, following the principle of aseptic operations. (2) Sputum suction was performed promptly: when the pressure of the ventilator pipes was increased or the blood oxygen saturation of the patients was decreased suddenly, sputum of other patients was aspirated in due time, so as to reduce mechanical stimulation on the patients. The time of sputum suction was generally less than 15 seconds. (3) Aspiration of subglottic secretion was performed for the patients when the duration of mechanical ventilation exceeded 48 hours, so as to maintain a constant negative pressure ranging from 60 mmHg to 80

Table 1. Comparison of general information of two groups of patients

Group	Control group (n = 105)	Research group (n = 105)	t/χ^2	P
Age (year)	72.52±3.81	73.43±3.62	-1.762	0.080
Gender			0.310	0.578
Male	57	48		
Female	61	44		
Types of disease			1.331	0.722
COPD	47	51		
Cerebrovascular disease	23	21		
CHD	25	27		
Traumatism	10	6		
Types of artificial airway			0.308	0.579
Tracheotomy	49	56		
Trachea cannula	45	60		
APACHE II score	16.34±2.12	15.82±2.34	1.623	0.106
GCS score	7.36±1.49	7.43±1.63	-0.464	0.643

Note: COPD, chronic obstructive pulmonary disease; CHD, coronary heart disease; APACHE, acute physiology and chronic health evaluation; GCS, Glasgow coma scale.

mmHg. Corresponding symptomatic treatment was applied to the patients according to the property of aspirated secretion. (4) Cuff pressure was monitored closely, and it was measured accurately using a cuff pressure gauge at the time of nursing shift and airway-related operations on the patients every day. Generally, the pressure was maintained at 25-30 cmH_20. (5) The nursing staff supplemented the sterile water for injection in the humidifier in time, and the heat and moisture exchanger was replaced every 5-7 days. (6) Oral nursing was conducted three times a day, which was decided according to the hydrogen-ion concentration (pH value) in the patients' oral cavity. (7) Enteral nutrition plus proton pump inhibitors were administered to patients undergoing long-term mechanical ventilation to reduce the reproduction of bacteria colonized in the oral cavity. (8) In order to prevent deep vein thrombosis, anticoagulants were utilized in clinic, and physiotherapy for the lower limb was performed using an air pressure wave therapeutic apparatus at the same time. (9) As for patients taking sedatives, the sedatives were stopped and attempt of weaning was made within a specified time every day. (10) In the ward, the bacterial count in the air was maintained at ≤4 colony-forming units, the temperature was kept at 20-22°C, and the relative humidity was sustained at 50%-60%. The time of air purification via a dynamic disinfectant apparatus was set in accordance with the product description, and the wards were ventilated regularly and disinfected on schedule, of which the desktop and ground were wiped with disinfection solution. (11) Attention was paid to the importance of communication between doctors and patients in the ICU. The doctors communicated with the patients' families about changes in disease conditions and the therapeutic methods in time, gaining trust of the patients and their families [11].

Evaluation criteria

Diagnostic criteria for VAP: At 48 hours after use of ventilator, the body temperature was ≥38°C; there were signs of pulmonary consolidation. Moist rales were audible through auscultation, novel or progressive inflammatory lesions in the lung were displayed on the chest X-ray, purulent secretions were visible in the respiratory tract, or new pathogens were obtained by means of sputum bacterial culture and isolation. Relevant laboratory indexes manifested white blood cell count >10 * 10^9/L or <4.0 * 10^9/L [12, 13].

Observation indexes

The observation indexes were as follows. (1) The duration of mechanical ventilation, length of stay in the ICU and hospitalization expenses of the two groups of patients were recorded. (2) The incidence of VAP and adverse reactions, such as airway mucosa injury, sputum obstruction, deep vein thrombosis, and accidental extubation, were compared. (3) The results of blood gas analysis before and after treatment were compared between the two groups of patients. (4) As for evaluation of the clinical total effective rate, judgment was made on basis of the clinical symptom improvement in the patients. 1) Cured: The clinical symptoms of the patients were improved significantly, weaning was feasible, no apparent positive signs were observed in pulmonary examination, and

Table 2. Comparison of relevant clinical indicators in two groups of patients

Group	Duration of mechanical ventilation (day)	Length of ICU stay (day)	Hospitalization expense (Yuan)
Control group (n = 105)	22.62±11.38	25.73±13.62	13,735.24±236.27
Research group (n = 105)	16.21±7.41	19.27±10.29	9,145.93±197.81
t	4.829	3.860	152.612
P	<0.001	<0.001	<0.001

Note: ICU, Intensive Care Unit.

Table 3. Comparison of incidence of VAP and adverse reactions in two groups of patients (n, %)

Group	Incidence of VAP	Incidence of adverse reactions			
		Airway mucosa injury	Sputum obstruction	Deep vein thrombosis	Accidental extubation
Control group (n = 105)	23 (21.90)	26 (24.76)	17 (16.19)	7 (6.67)	5 (4.76)
Research group (n = 105)	8 (7.62)	10 (9.52)	6 (5.71)	1 (0.95)	0
χ^2	8.515	8.582	5.908	4.678	5.122
P	0.004	0.003	0.015	0.031	0.024

Note: VAP, ventilator associated pneumonia.

no pathogenic bacteria were discovered in sputum culture, blood culture and other relevant laboratory tests. 2) Progressed: The clinical symptoms were improved after treatment, positive pulmonary signs disappeared, but none or a small quantity of pathogenic bacteria were discovered in blood and sputum culture, and intermittent weaning was feasible. 3) Ineffective: The clinical symptoms of the patients were still obvious, positive pulmonary signs were present, and treatment with ventilator was needed. Clinical total effective rate = Number of case (cured + progressed)/total number of cases * 100%. (5) Nursing comfort was evaluated, including posture, physiology, psychology, oxygen inhalation, sputum expectoration, and arteriovenous puncture. Each item was divided into 4 grades, namely, comfortable, quite comfortable, slightly uncomfortable, and extremely uncomfortable, which were scored as 3 points, 2 points, 1 point, and 0 point, respectively. (6) Nursing satisfaction rate: According to the conditions of Houjie Hospital of Dongguan, the satisfaction of the patients' families with the overall nursing quality was evaluated by means of questionnaires containing 20 items with a total score of 100 points. Scoring standard: satisfied (≥85 points), basically satisfied (60-85 points) and dissatisfied (<60 points). Satisfaction rate = Number of case (satisfied + basically satisfied)/total number of cases * 100%.

Statistical analysis

SPSS17.0 software, a statistical tool, was utilized to collect and analyze related data. Measurement data are presented as mean ± standard deviation ($\bar{x}$ ± sd), and independent-samples t-test was performed to calculate difference between groups. Enumeration data are expressed by ratio, and X^2 test (exact probability test) was used for difference between groups. P<0.05 suggests that the difference is statistically significant.

Results

General information

There were no statistically significant differences in comparison of general information such as gender, age, type of primary disease, method of establishing artificial airway, APACHE II score, and GCS score between the two groups of patients (all P>0.05) as shown in **Table 1**.

Comparison of relevant clinical indicators

Both duration of mechanical ventilation and length of ICU stay of patients in the research group were remarkably shorter than those in the control group, and the differences were statistically significant (both P<0.05). The average hospitalization expense was RMB (9,145.93± 197.81) Yuan in research group, which was

Table 4. Comparison of indexes of blood gas analysis before and after nursing in two groups of patients (mmHg)

Group	$PaCO_2$		PaO_2	
	Before ventilation	After ventilation	Before ventilation	After ventilation
Control group (n = 105)	66.77±7.29	47.32±5.19	55.43±6.31	72.12±8.34
Research group (n = 105)	65.84±7.34	41.27±4.39	56.02±6.38	88.73±8.91
t	0.891	9.195	-0.685	-13.938
P	0.374	<0.001	0.494	<0.001

Table 5. Comparison of clinical total effective rate in two groups of patients (n, %)

Group	Cured	Progressed	Ineffective	Died	Clinical total effective rate
Control group (n = 105)	50 (47.62)	32 (30.48)	13 (12.38)	10 (9.52)	82 (78.10)
Research group (n = 105)	69 (65.71)	30 (28.58)	5 (4.76)	1 (0.95)	99 (94.29)
χ^2	7.001	0.092	3.889	7.771	11.562
P	0.008	0.762	0.040	0.005	<0.001

lower than that in control group (RMB (13,735.24±236.27) Yuan), with a statistically significant difference (P<0.05) as shown in **Table 2**.

Comparisons of incidence of VAP and adverse reactions

The incidence of VAP in the research group (7.62%) was decreased compared with that in the control group (21.90%), and the difference was statistically significant (χ^2 = 8.515, P = 0.004). In the research group, the incidences of airway mucosa injury, sputum obstruction, deep vein thrombosis and accidental extubation were 9.52%, 5.71%, 0.95% and 0, respectively, while those incidences in the control group were 24.76%, 16.19%, 6.67% and 4.76%, respectively. The differences in the incidence of adverse reactions between the two groups had statistical significance (all P<0.05) as shown in **Table 3**.

Comparisons of indexes of blood gas analysis before and after nursing

The arterial blood of the two groups of patients was extracted for blood gas analysis before nursing of ventilation. There were no statistically significant differences in PaO_2 and $PaCO_2$ between the two groups of patients (both P>0.05). After the nursing, the PaO_2 and $PaCO_2$ levels were compared again between the two groups, and the results manifested statistically significant differences (both P<0.05) as shown in **Table 4**.

Comparison of clinical total effective rate

A total of 10 patients died of aggravated disease in the control group, while 1 patient died in the research group. The research group had a remarkably higher clinical effective rate (94.28%) than the control group (78.10%), with a statistically significant difference (P<0.05) as shown in **Table 5**.

Comparisons of nursing comfort score and nursing satisfaction rate

There was no statistically significant difference in the score of nursing comfort between the research group and the control group before nursing (P>0.05). After nursing, however, the score of nursing comfort in the research group was increased notably compared with that in the control group, and the difference was statistically significant (P<0.05). The nursing satisfaction rates in the research group and the control group were 94.29% and 79.05%, respectively, and the rate in the research group was higher than that in the control group, with a statistically significant difference (P<0.05) a shown in **Table 6**.

Discussion

Elderly patients with respiratory failure become a population with high-risk VAP after mechanical ventilation due to advanced age, complication with underlying diseases in most cases, prolonged hospital stay and significantly declined immunity. In order to effectively improve

Table 6. Comparison of nursing comfort score and nursing satisfaction rate in two groups of patients

Group	Nursing comfort score		Nursing satisfaction rate			
	Before nursing	After nursing	Satisfied	Basically satisfied	Dissatisfied	Satisfaction rate (%)
Control group (n = 105)	6.32±0.37	8.43±0.52	41	42	22	79.05
Research group (n=105)	6.27±0.41	13.61±1.12	59	40	6	94.29
t/χ^2	1.855	-43.151		10.549		
P	0.065	<0.001		0.001		

the prognosis of the elderly patients, the introduction of the cluster nursing philosophy into nursing services is a practice guideline for optimum nursing effects [14]. Cluster nursing is composed of oral nursing, posture nursing, nasal feeding nursing, deep vein nursing and procedural sedation, which are beneficial to comprehensive nursing for patients with severe diseases receiving mechanical ventilation [15].

In this study, there was only 1 death case in the research group, and the analysis on the cause of death indicated that the patients died of advanced age, past history of myocardial infarction, pulmonary infection induced by long-term application of ventilator and heart failure. The incidence of VAP in patients receiving cluster nursing was 7.62%, and the mortality rate was 0.95%, which were remarkably lower than those in conventional nursing group. Additionally, the incidences of various adverse reactions were lowered notably, which is basically consistent with the research by Guthrie et al. [16]. The reason is that the individualized cluster nursing protocols are formulated in accordance with the specific disease conditions of different patients during mechanical ventilation. Posture nursing, oral nursing, clearance of respiratory secretions and disinfection of ventilator pipeline were implemented one by one, strictly complying with the aseptic principles [17]. Related studies have revealed that the incidence of VAP will be increased 1-3% if the duration of mechanical ventilation is extended for one day, and the risk of patients dying from VAP will be as high as 30-50%. Therefore, daily interruption of sedation can contribute to early weaning of patient with the qualification of weaning and extubation, thus shortening the duration of mechanical ventilation. In addition, intervention with cluster nursing can ameliorate retention of carbon dioxide in the patients in an effective manner and accelerate their recovery, which is in line with the findings in this study [18].

The occurrence of VAP may prolong the hospital stay and increase hospitalization expenses, bringing great economic and life pressure to the patients and their families. As for patients in the research group who received cluster nursing, the hospital stay was shortened significantly, the hospitalization expenses were decreased notably, and the medical resources were saved efficiently compared with those in the control group, which are similar to the literature reports [19].

Cluster nursing is currently identified as a type of advanced nursing system which provides detailed nursing protocols on basis of the varied development processes of each disease. Meanwhile, it emphasizes on the bio-psycho-social medical model and finally promotes the effective improvement of patient's prognosis [20]. The results of this study manifested that the nursing satisfaction rate and score on nursing comfort in research group treated with cluster nursing were obviously higher than those in control group. It is because attentions are paid to the physiological change of the patients in the process of cluster nursing, which focuses on eliminating nervousness and anxiety of the patients, thus increasing the nursing comfort and satisfaction significantly. All these are identical to the findings of previous studies [21]. However, there were still 6 patients dissatisfied with the nursing in this study, which may be caused by difference in communication modes between different nursing staff and patients' families. Moreover, a certain degree of difference exists in the educational level as well as relevant medical knowledge of the patients and their families, so the training of communication skills should be enhanced in future work, so as to further elevate the nursing satisfaction rate.

In conclusion, cluster nursing can decrease the incidence of VAP, as well as the incidence of adverse reactions and mortality rate in elderly

patients with chronic respiratory failure during the application of ventilator. Furthermore, it can increase the possibility of ventilator weaning, reduce hospital stay, alleviate the economic burden on the patients and their families and remarkably improve the nursing satisfaction rate and nursing comfort. The innovations of this study are as follows: there were fairly detailed observation indexes, evaluation on nursing comfort and satisfaction was integrated, and more importance was attached to the physiological changes in the disease progression at the same time.

Bias may exist in the results since the follow-up time was not long enough and the sample size was relatively small in this study. Therefore, prospective trials with a larger sample size and longer follow-up time will be performed in subsequent studies to testify the test results of this study, providing possible bases for extensive application of the cluster nursing mode in the clinic.

Disclosure of conflict of interest

None.

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