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Original Article

Study on effects of care bundles on patients with severe pneumonia complicated with respiratory failure

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Abstract: Objective: This study was designed to determine the effects of care bundles on patients with severe pneumonia complicated with respiratory failure and to discuss the adverse reaction rate in prognosis. Methods: A total of 64 patients with both severe pneumonia and respiratory failure admitted to the intensive care unit (ICU) of our hospital from January 2019 to December 2020 were enrolled as research objects. These patients were equally divided into a control group and an experimental group in a random manner. The experimental group was given care bundles, while the control group was given conventional nursing. Then the nursing effect, adverse reactions, and nursing satisfaction of the two groups were compared and analyzed. Results: The experimental group experienced shorter mechanical ventilation time and hospital stay than the control group. After nursing, both groups got apparent improvements on the levels of partial pressure of carbon dioxide ($PaCO_2$), partial pressure of oxygen (PaO_2), and oxygen saturation, with better improvements in the experimental group than those in the control group. In terms of the incidence of ventilator-associated pneumonia (VAP), chest ultrasound imaging, and nursing satisfaction, the experimental group garnered more positive results than the control group (all $P<0.05$). Conclusions: Care bundles can greatly improve the nursing effect on patients with severe pneumonia complicated with respiratory failure. Compared with conventional nursing, it can contribute to considerably shorter mechanical ventilation time and hospital stay, optimal blood gas indexes and oxygen saturation, substantially lower incidence of ventilator-related diseases, and better prognostic recovery effect.

Keywords: Incidence of adverse reactions, respiratory failure, severe pneumonia, care bundles

Introduction

In general, pneumonia refers to infectious inflammation of the alveoli, pulmonary interstitium, or distal airways, with a high incidence among the elderly population, and its predominant contributory factors are viruses and bacteria [1-4]. Its severity evaluation mainly depends on the development of local inflammation, spread of lung inflammation, and degree of systemic inflammation. For example, pneumonia patients with severe hypoxemia or acute respiratory failure that entails ventilatory support, or complicated with circulatory failure symptoms such as shock, hypotension, and other organ dysfunctions can be diagnosed as severe pneumonia. Severe pneumonia is usually accompanied by clinical manifestations such as respiratory failure and neurologically manifested as malaise, disturbance of consciousness, papilledema, convulsions, coma, etc., and it may induce brain herniation that further triggers central respiratory failure as it progresses [5-8]. For patients with severe pneumonia comorbid with respiratory failure who are also ICU patients in most cases, mechanical ventilation is considered indispensable for respiration, as it plays an essential role in patients' recovery by substantially abating their respiratory failure symptoms and demonstrates a significant clinical improvement value for their respiratory functions. Nonetheless, multiple complications still occur frequently especially within 48 hours of mechanical ventilation, such as ventilator-associated pneumonia (VAP), a typical one in hospital-acquired pneumonia. Pati-

Table 1. Comparison of general information between the two groups

Items	Control group (n=32)	Experimental group (n=32)	t/χ^2	*P*-value
Age (year)	74.44±14.18	73.56±14.06	0.5743	0.5677
BMI (kg/m^2)	21.81±3.67	22.45±4.21	0.6779	0.5001
Gender			0.2333	0.629
Male	12 (37.50%)	14 (43.75%)		
Female	20 (62.50%)	18 (56.25%)		
Types of respiratory failure			0.2652	0.607
I	23 (65.71%)	25 (71.43%)		
II	12 (34.29%)	10 (28.57%)		
Hypertension	14 (40%)	16 (45.71%)	0.2333	0.629
Diabetes	18 (51.43%)	17 (48.57%)	0.0571	0.811

ents with severe pneumonia complicated with respiratory failure are in worse conditions and face more severe economic burden and a higher mortality, and thus get notably worse therapeutic effect and quality of life [9-12]. Therefore, this study enrolled 70 cases conforming to the diagnostic criteria of severe pneumonia complicated with respiratory failures as research objects to evaluate the nursing effect and safety of care bundles on such patients, with the goal of optimizing the present curative effect on the comorbidity.

This research innovatively adopted the concept of "tri-management and uni-exchange" in nursing. Tri-management mainly covers three aspects: management of the ward, management of patients (it indicates the full responsibility of the nurses in charge of all treatments, changes in condition, basic nursing, life needs, mental conditions, and health education of the patient during the hospitalization period), and management of complete, accurate and timely record, such as nursing records, nursing orders, nursing plans, and the signature of medical advice. The uni-exchange refers to major shift exchange and bedside shifts for critically ill patients. Bedside nursing and ward-rounds are carried out for newly admitted critically ill patients, surgical patients, critically ill patients with exacerbation of disease condition during the hospitalization, and patients with bedsores above grade III.

Materials and methods

General information

Sixty-four patients with both severe pneumonia and respiratory failure admitted to the intensive care unit (ICU) of our hospital from January 2019 to December 2020 were enrolled as research objects and equally divided into a control group and an experimental group in a random manner. No statistical differences were found between the two groups regarding their general information such as gender, age, and the type of disease (all P>0.05, **Table 1**). This study was conducted strictly according to the regulations of the ethics committee (no.: 2018-12-11), and the family members signed the consent forms.

Inclusion criteria

Patients without pulmonary hemorrhage in chest ultrasound examination; patients with APACHE ≥ 10; patients without contraindications to vibration sputum excretion; patients with complete clinical data; patients who met the clinical diagnostic criteria for severe pneumonia complicated with a respiratory infection.

Exclusion criteria

Patients with pulmonary tuberculosis or pneumothorax; patients with contraindications to lung physical therapy.

Methods

The control group (conventional nursing): Nursing measures for the control group mainly included ward cleaning, sterile operation, hand hygiene, cooperation with sputum suction, etc.

The experimental group (care bundles): A special care bundle nursing team was established

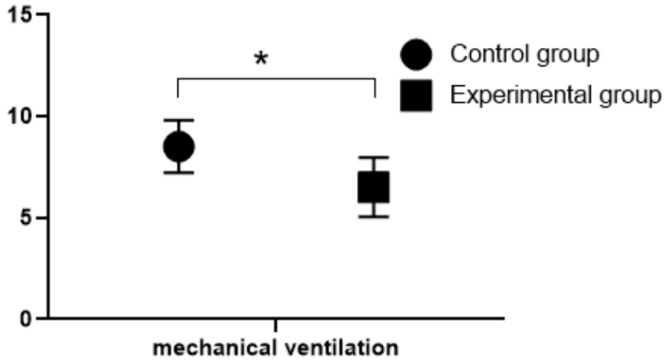

Figure 1. Comparison of mechanical ventilation time between the two groups of patients ($\bar{x}\pm s$). Notes: The abscissa represents mechanical ventilation, and the ordinate represents time (d); The mechanical ventilation time of the control group and experimental group was (8.52±1.29) days and (6.51±1.47) days, respectively; *Indicates that the mechanical ventilation time between the two groups was significantly different (t=6.0802, P=0.000).

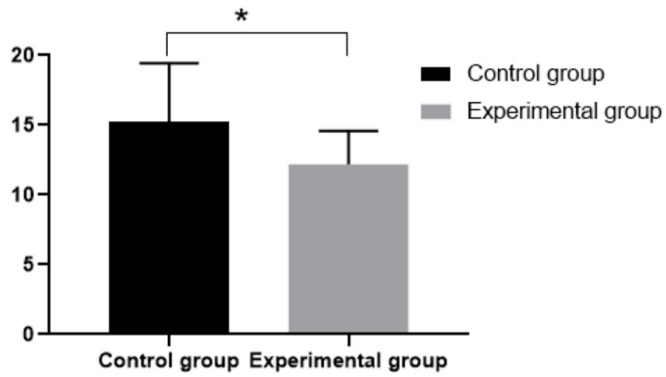

Figure 2. Comparison of average length of stay between the two groups of patients ($\bar{x}\pm s$). Notes: The abscissa represents the control group and the experimental group, and the ordinate represents the hospital stay (d); The length of stay of the control group and experimental group was (15.25±4.19) days and (12.17±2.41) days, respectively; *Indicates that there was a significant difference in hospital stay between the two groups (t=3.7697, P=0.0003).

with a duty nurse, a nursing guide, and nurses. First and foremost, regular care-bundle-nursing-related training was carried out to all nursing staff to systemically improve their awareness and attention on care bundle nursing, during which the responsibilities of all posts were clarified and job requirements were required to be strictly implemented [13, 14]. The specific operations of various basic nursing mainly covered the following items: closed suction, oral care, application of anti-white thrombus pressure pump, raise of the bed head by 35°-45° to avoid vomiting and aspiration, breathing machine pipeline management, enteral nutrition support and retention observation to prevent the patient from aspiration, gas gauge pressure monitoring, airway humidification, and air disinfection machine or disinfection cabinet for environmental management.

Chest ultrasound and lung ultrasound: With the parasternal line, anterior and posterior axillary line, posterior midline, and mammillary line as guide-lines, the lung on each side was equally divided into 6 different areas: the upper front, the lower front, the upper armpit, the lower armpit, the upper back, and the lower back. The scanning was carried out by starting at the second intercostal space of the patient. First, the intercostal space was scanned vertically and longitudinally and then scanned horizontally by rotating the probe by 90°. The ultrasound images were saved and recorded. Three experienced sonographers in our hospital were arranged to assess lung ultrasound results, including the characteristics of lung ultrasound changes and the involved parts.

Outcome measures

The mechanical ventilation time and average hospital stay of the two groups were recorded, and the results of blood gas analysis ($PaCO_2$ and PaO_2), oxygen saturation changes, VAP incidence rate, and chest ultrasound examination were compared and analyzed. In addition, a self-made scale was used to compare the nursing satisfaction of the two groups of patients, with liability and validity of 0.85. Satisfaction rate = (the number of cases with satisfaction + the number of cases with moderate satisfaction)/total number of cases*100%.

Statistical processing

SPSS20.0 was used for data analysis, and GraphPad Prism 7 (GraphPad Software, San Diego, USA) for graphic plotting. In this study, counting data were analyzed by the χ^2 test, and measurement data by the t-test. In addition, a

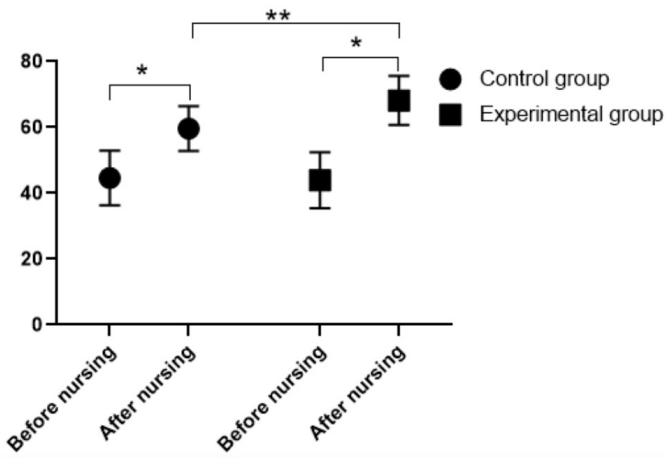

Figure 3. Comparison of $PaCO_2$ changes between the two groups of patients ($\overline{x}\pm s$). Notes: The abscissa represents Before and after nursing, and the ordinate represents $PaCO_2$ (mmHg); $PaCO_2$ of the control group before and after nursing were (44.62±8.35) mmHg and (59.62±6.82) mmHg, respectively; $PaCO_2$ of the experimental group before and after nursing were (43.95±8.51) mmHg and (68.17±7.45) mmHg, respectively; *indicates that from left to right, there was a significant difference in $PaCO_2$ between the control group and the experimental group before and after nursing (t=8.2311, 12.6845, both P=0.000); **indicates that the $PaCO_2$ difference between the two groups of patients after nursing was significant (t=5.0080, P=0.000).

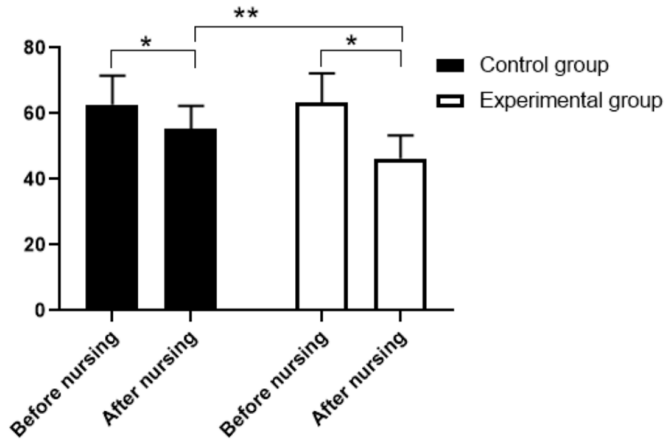

Figure 4. Comparison of PaO_2 changes between the two groups of patients ($\overline{x}\pm s$). Notes: The abscissa represents Before and after nursing, and the ordinate represents PaO_2 (mmHg); PaO_2 of the control group before and after nursing were (62.75±8.77) mmHg and (55.25±7.14) mmHg, respectively; PaO_2 of the experimental group before and after nursing were (63.29±8.92) mmHg and (46.34±6.95) mmHg, respectively; *indicates that from left to right, the PaO_2 difference between the control group and the experimental group before and after nursing was significant (t=3.9235, 8.8679, P=0.0002, 0.000); **indicates that PaO_2 between the two groups of patients after nursing was significantly different (t=5.2903, P=0.000).

normality test was employed to examine the normal distribution of the data. The difference was considered significant when a *P*-value was less than 0.05.

Results

Comparison of mechanical ventilation time between the two groups of patients

The experimental group experienced markedly shorter mechanical ventilation time than the control group (P<0.05, **Figure 1**).

Comparison of the hospital stays between the two groups of patients

It could be clearly seen from **Figure 2** that patients in the experimental group experienced a desirably shorter hospital stay than the control group (P<0.05).

Comparison of the blood gas analysis results between the two groups

As shown in **Figures 3**, **4**, more favorable outcomes about the levels of $PaCO_2$ and PaO_2 were observed in both groups after nursing as compared to those before nursing, with better results in the group treated with care bundles than those in the group treated with conventional nursing (all P< 0.05).

Comparison of changes in oxygen saturation between the two groups of patients

Table 2 displays a markedly higher oxygen saturation in the two groups after nursing as compared to that before nursing, with a better oxygen saturation in the experimental group than that in the control group (P<0.05).

Comparison of the incidence of VAP and chest ultrasound examination results between the two groups of patients

The results revealed that care bundles had a lower possibility of triggering VAP than conventional nursing (P<0.05), and patients in experimental group exhibited better results in chest ultrasound examination than those in the control group (P<0.05) (**Table 3**).

Table 2. Comparison of oxygen saturation between the two groups of patients ($\bar{x}$±s, %)

Groups	Before nursing	After nursing	t	*P*-value
Control group (n=32)	74.12±5.25	80.35±6.11	4.5753	0.002
Experimental group (n=32)	73.98±5.21	92.16±5.95	13.59996	0.001
t		8.1924		
P		0.001		

Table 3. Comparison of the incidence of VAP and chest ultrasound examination results between the two groups of patients [n (%)]

Groups	Control group (n=32)	Experimental group (n=32)	χ^2	P
VAP rate	11 (34.38)	3 (9.38)	5.7143	0.017
Chest ultrasound examinations				
Normal	11 (34.38)	15 (46.88)	0.979	0.322
Declined	8 (25.0)	15 (46.88)	5.04	0.025
Not declined	13 (40.63)	2 (6.25)	12.2085	0.001

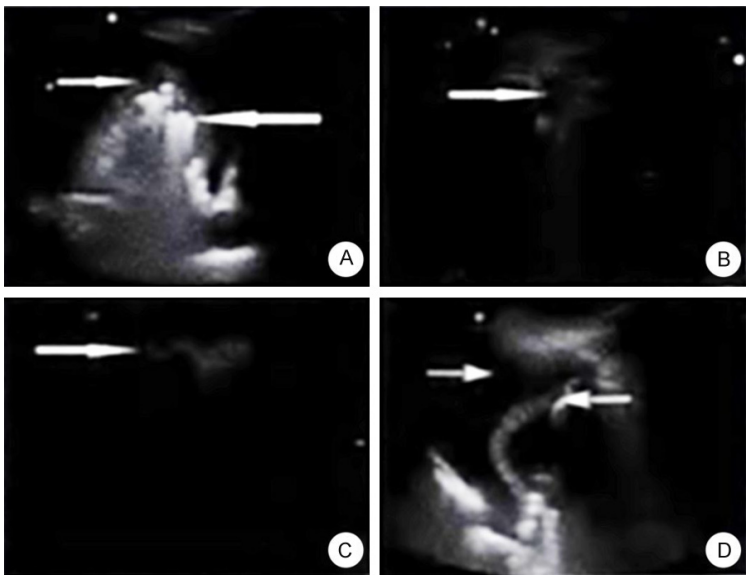

Figure 5. Chest ultrasound image of a patient with severe pneumonia. Notes: A. The left arrow points out the lung consolidation, and the right arrow indicates the inflated bronchi; B. The arrow indicates subpleural lesions, which are hypoechoic nodules, with a shape of triangular, circular, linear, or polygonal; C. The arrow indicates a thickened, "serrated" lesion in the pleura; D. The left arrow represents pleural effusion, and the right arrow represents pulmonary atelectasis.

Chest ultrasound of patients

Chest ultrasound image of a patient with severe pneumonia demonstrated that there were lung consolidation, inflated bronchi, subpleural lesions (hypoechoic nodules, with a shape of triangular, circular, linear or polygonal, a thickened, "serrated" lesion in the pleura), pleural effusion and pulmonary atelectasis, as shown in **Figure 5**.

Comparison of nursing satisfaction

As shown in **Table 4**, patients in the observation group were more satisfied with the nursing results compared with those in the control group (P<0.05).

Discussion

Severe pneumonia may give rise to respiratory failure at its late stage that entails nutritional support and stable indoor environment for treatment. Specifically, fat emulsion, amino acids (17), and glucose (1%) injection are provided for patients with difficulty in eating, prompt electrolytes for those with low potassium and low sodium, and corresponding correction treatments for those with acidosis [15-17]. For primary diseases and complications such as infection, spasm, and asthma, active respiratory support including invasive and non-invasive respiratory support is required, namely nasal catheter oxygen inhalation, mask oxygen inhalation, and artificial mechanical ventilation [18-21]. However, if the above treatments fail to control it, severe pneumonia

Table 4. Comparison of patients' satisfaction rate between the two groups

Groups	Satisfied	Moderately satisfied	Unsatisfied	Satisfaction rate
Control group (n=32)	26 (81.25)	6 (18.75)	0 (0)	100%
Experimental group (n=32)	20 (62.50)	5 (15.63)	7 (21.88)	78.13
χ^2				1.365
P				0.014

might consequently develop into a disease complicated with serious respiratory failure which is mainly attributed to inflammatory mediators produced by over-activated inflammatory cells in critical pulmonary infection, and finally decreases the immune function. Therefore, close observation of patients and implementation of predictive care schemes are indispensable for the prevention of possible complications. In the routine nursing process, the accurate implementation of specific nursing measures may be hindered by multiple factors such as nursing staff's indifference to the nursing plan and process, which may lead to negative conditions such as low nursing satisfaction and high prognostic complication rate [22-25]. On the contrary, care bundles that highly target severe pneumonia complicated with respiratory failure are nursing schemes jointly formulated by medical staff based on the observation of patients. All these schemes are carefully and comprehensively deliberated and supervised by the duty nurse to guarantee their smooth implementation. Care bundles are an advanced nursing concept highly promoted in clinical practice in recent years, with an aim to develop a series of targeted nursing schemes against a specific disease on the basis of evidence-based medicine through continuous nursing measures to elevate the nursing effect. Conventional nursing measures focus more on the suction of the airway secretions and the maintenance of an unobstructed duct but fail to take patients' various needs from the perspectives of position change, physiology, psychology, and oxygen inhalation into consideration. In comparison, the method of care bundles tends to be more comprehensive, targeted, systematic, and goal-oriented [26-29]. In this study, more scientific care bundles were implemented for patients in the experimental group. As a result, they effectively drove down the incidence of VAP in the patients. Statistically, patients in the experimental group experienced shorter mechanical ventilation time and hospital stay than those in the control group. In addition, the two kinds of nursing both evidently elevated the levels of $PaCO_2$ and PaO_2 and oxygen saturation of the two groups, in which the experimental group yielded more desirable outcomes than the control group. Moreover, the experimental group presented a superior VAP result compared with the control group, and patients in the experimental group treated by care bundles were more satisfied with the nursing results than those treated by conventional nursing. Based on the above results, we can come to the conclusion that implementation of care bundles can effectively prevent ventilator-related diseases. Furthermore, treatment measures based on the efficient prediction of potential problems by nursing staff are considered predictive and forward-looking. In the experimental group, the nursing responsibility system, scientific and rational arrangement of shift exchange, and the hierarchical management of nurses were all implemented. The responsibility of nurses includes the implementation of complete and continuous care of the patients [30], that is, the duty nurse is fully responsible for the patients.

Similar results were obtained from one study by WangWei [31] et al. who stated that respiratory failure was a relatively frequent complication of severe pneumonia. Conventional care is insufficient for the nursing needs of patients with severe pneumonia complicated with respiratory failure, while care bundles turn out to be more prospective, scientific, and suitable for patients with the comorbidity. The limitation of this study lies in the absence of long-term follow-up and assessment of the long-term quality of life and psychological status of patients. Therefore, the research time will be extended in the future to better evaluate the long-term prognosis of patients.

Conclusion

In conclusion, care bundles can greatly improve the nursing effect on patients with severe

pneumonia complicated with respiratory failure. Compared with conventional nursing, care bundles can contribute to considerably shorter mechanical ventilation time and hospital stay, optimal blood gas indexes and oxygen saturation, substantially lower incidence of ventilator-related diseases, and better prognostic recovery effect, so they are highly applicable in clinical practice.

Disclosure of conflict of interest

None.

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