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Research Article

Data-Driven Multicriteria Decision Analysis of Bundles of Care for Patients with Ventilator-Associated Pneumonia

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Objective. The study focused on the nursing strategies of patients with ventilator-associated pneumonia (VAP) and multicriteria decision analysis (MCDA) in nursing supervision, so as to improve the survival rate and prognosis of patients with VAP. *Methods*. 200 patients of the database in the ICU who required mechanical ventilation were selected as research subjects. They were divided into control group and intervention group according to different nursing measures. The incidence of VAP was compared between the two groups, and 15 experts were consulted on the prevention measures of VAP. On the basis of ARIMA-GARCH mathematical modeling, using the method of multicriteria decision analysis, the cluster nursing strategy for ventilator-associated pneumonia patients was developed and verified. *Results*. In the control group, of the 34 patients infected with VAP, Gram-positive bacteria were detected in 11 cases, including 6 cases of *Streptococcus pneumoniae*, 3 cases of *Escherichia coli*, and 2 cases of golden yellow *Staphylococcus*. Gram-negative bacteria were detected in 10 cases, including 5 (50%) cases of *Acinetobacter baumannii*, 2 cases of *Klebsiella pneumoniae*, 2 cases of Brucella Bacillus, and 1 case of *Pseudomonas aeruginosa*. In the intervention group, 18 cases were diagnosed with VAP, including 4 (44.4%) cases of bacterial infection, 3 (44.4%) cases of virus infection, and 2 (22.2%) cases of fungal infection. According to the opinions of the 15 experts, a total of 6 bundled measures were adopted to prevent VAP, including 0.1% chlorhexidine for oral care; strict implementation of hand hygiene; the daily wake-up for spontaneous breath training and extubation assessment; continuous subglottic suction; raising the bed head by 30°–45°; and nasal feeding through the nasal tube without special condition. *Conclusion*. There are many factors that affect the occurrence of VAP in mechanically ventilated patients in the ICU, and the imperfect measures of bundles of care are the main one. The implementation rates of distinct intervention strategies are different. The implementation rate of 2 measures is lower than 95%, which are the continuous subglottic suction and daily wake-up for spontaneous breath training and extubation assessment.

1. Introduction

In clinic, mechanical ventilation is increasingly used to maintain patients' lives. As a result, the infection rate of ventilator-associated pneumonia (VAP) has been increased year by year [1]. VAP refers to pneumonia that occurs in patients with artificial airways after 2 days of mechanical ventilation (within 48 hours after weaning and extubation) [2]. Statistics have shown that the incidence and mortality of VAP are both high. 5%–15% of patients with mechanical ventilation may develop VAP, and the mortality rate is as high as 10% [3]. Generally, patients in the intensive care unit (ICU) are seriously ill and have poor resistance [4]. The occurrence of VAP not only affects the prognosis of the patient but also brings an economic burden to the family. At present, there is an increasing probability to develop VAP for patients with mechanical ventilation, leading to an increased mortality rate and extended mechanical ventilation time and time spent in the ICU [5]. In some Western countries, the prevention of VAP has become the goal of national health and safety [6]. The bundles of care can more effectively reduce the risk of infection and have become an important means to prevent the occurrence of VAP. However, medical staff have poor compliance in the process

of bundles of care, and it requires much manpower and time. It has been reported that the compliance of medical staff is 63.0%–76.2%, so how to improve the compliance of medical staff remains to be explored.

Multicriteria decision analysis (MCDA) is used to solve decision-making problems about multiple criteria that cannot be replaced with each other. In recent years, scientific research institutions and health management departments in many countries have applied the MCDA concept to medicine. For example, it is used to evaluate the efficacy of drugs [7]. With the development of evidence-based medicine, the relevant guidelines for VAP prevention at home and abroad are constantly updated. In the face of endless recommendations, the choice of combination and cluster intervention strategy based on subjective will has become an important reason affecting the clinical effect of cluster intervention strategy. Some researchers even directly included all 11 preventive measures in the cluster intervention strategy, ignoring the logical association among all measures. Moreover, too many measures included in the cluster intervention strategy will affect the compliance of medical staff, making it difficult to achieve the expected effect. Therefore, selecting a scientific method to construct a cluster intervention strategy for the prevention of ventilator-associated pneumonia is the basis to ensure its clinical effectiveness. Multicriteria decision analysis has been used to construct a cluster intervention strategy for the prevention of central venous catheter-associated bloodstream infection and ensure its clinical effectiveness. Therefore, risk factors affecting the incidence of VAP were retrospectively investigated and effective preventive measures were summarized. Explore the rationality of cluster intervention strategies published by the Institute for Health Care Improvement (IHI), identify effective measures that can directly affect VAP, prioritize effective prevention measures through multicriteria decision analysis, and find out the key measures. Optimize current cluster intervention strategies for the prevention of ventilator-associated pneumonia to provide best practice evidence for clinical care providers. At the same time, through the analysis of the impact of various measures of cluster intervention strategy and the incidence of VAP, the shortcomings and weak links in the implementation process were identified, providing research direction for further improving compliance. The process of MCDA is as follows. First, research questions are classified. Then, evaluation criteria are identified, followed by weight assignment and scoring [8]. Finally, the total score of the program is calculated [9]. Bundles of care were proposed by the American Institute of Health Promotion (IAI) at the beginning of the twenty-first century. Its purpose is to realize the ideal intensive care unit (IDICU). It is a collection of evidence-based treatment and nursing measures and has been widely used to deal with refractory clinical diseases. Meanwhile, bundles of care were applied to brain-image fusion digital twins [10]. It has strong operability and can significantly improve the treatment effects and prognosis of patients [11]. In 2005, the US Institute for Health Promotion put forward 5 bundles of care measures for the prevention of VAP after extensive research, including raising the bed head by 30°–45°, daily wake-up for spontaneous breath training and extubation assessment, prevention of digestive tract stress ulcers, oral care, and prevention of deep vein thrombosis of the lower extremities [12]. These strategies have also been proven effective by many domestic and foreign scholars. With the development of evidence-based medicine, many new measures have gradually been incorporated into intervention strategies to prevent VAP, such as hand hygiene and continuous subglottic attraction [13]. The formulation of bundled care intervention strategies requires sufficient clinical evidence, as well as the safety, feasibility, and effectiveness of the measures [14]. A multicenter study showed that when compliance with bundles of care interventions to prevent VAP increased from 50% to 82%, the incidence of VAP decreased by 41%. High compliance is an important factor to ensure the clinical effectiveness of the bundles of care to prevent VAP [15].

The primary objective of the study was to explore preventive interventions for VAP, and the secondary purpose was to investigate how to improve the compliance of medical workers with bundles of care. 100 patients in the ICU of the database who needed mechanical ventilation were selected as the research subjects. They were divided into control group and intervention group according to different intervention measures, and the infection rate in the two groups was recorded. The study was intended to provide a reference for how to prevent VAP in patients with mechanical ventilation. This research innovatively uses multicriteria decision analysis to scientifically optimize cluster intervention strategies. And through compliance investigation, to ensure that the cluster intervention strategy optimizes the practicality of preventing ventilator-associated pneumonia.

2. Materials and Methods

2.1. Research Subjects. In this study, the basic data of 200 patients with mechanical ventilation in ICU were obtained from the database. The sample size is estimated as follows:

$$n = \left(U_\alpha + U_\beta\right)22P\frac{(1-P)}{(P1-P2)^2},$$
$$P = \frac{P1+P2}{2}\times 100\%. \tag{1}$$

According to preliminary experiments, $P1$ is the incidence of VAP in mechanically ventilated patients before the measures are taken, and $P2$ is the incidence of VAP in mechanically ventilated patients after the measures are taken. α is the test level; β is the probability of the second type of error; and U_α and U_β are the U values corresponding to the test level and the probability of the second type of error, respectively. The test level α is set to 0.05, $\beta = 0.05$, $U_\alpha = 1.78$, and $U_\beta = 1.28$.

Then, it is calculated that $n = 98.4$, approximately equal to 100. In this study, 100 cases were included in each group of patients.

Inclusion criteria were patients with invasive ventilation and mechanical ventilation for more than 48 hours.

Exclusion criteria were patients with infection or underlying lung diseases before mechanical ventilation; patients with spinal cord injury; patients with unstable hemodynamics; and patients who were participating in other studies.

Drop-out criteria were patients whose underlying disease progressively aggravated; patients with mental disorders; and patients who did not cooperate.

Grouping method: patients meeting the following conditions were the control group: (a) The pipe of the ventilator was fixed to keep the trachea unobstructed and prevent the pipe from falling off and causing suffocation. The room temperature and humidity were adjusted at an appropriate level. (b) The patient with tracheotomy shall take care of the wound and it was necessary to observe whether there were signs of infection, such as redness and swelling on the skin around the wound. (c) Vital signs were recorded every 30 minutes or 1 hour. (d) Sputum was cleared in time. (e) Basic care was given to patients who cannot take care of themselves.

Patients meeting the following conditions were the intervention group: (a) Patients started rehabilitation training every morning. (b) 0.12% chlorine was used 4 times a day for oral care. (c) The bed head was raised 30–45°. Prevent patients from vomiting and breathing when the bedside is too low. (d) The management of ventilators for mechanically ventilated patients was strengthened, and aseptic operation of artificial airway suction was strictly followed. (e) It was recommended that patients with artificial airways underwent daily assessments and extubate the tube as soon as possible to reduce the number of days of intubation. The bacteria were isolated from bronchial secretions after the onset of illness. (f) The damage of the ventilator was observed daily.

2.2. Evaluation Indexes of Two Groups of Patients. The two groups were compared for incidence of VAP, the length of time of mechanical ventilation, acute physiology and chronic health evaluation II (APACHEII) score, pathogen detection rate, and so on.

2.3. Data Collection Method. Before mechanical ventilation, the investigator collected the general data of the two groups of patients, including age, gender, APACHEII score, and ventilation type; the investigator assessed the APACHEII score of the patients in the worst condition within 48 hours after mechanical ventilation, then supervised the implementation of the bundles of care program, and analyzed the occurrence of VAP and the time of mechanical ventilation within 48 hours after the patient was weaned.

2.4. Investigation Method and Content. First, a special research group was set up, consisting of 15 staff including chief physicians, doctoral students, graduate students, chief nurses of the nursing department, deputy chief nurses, and supervisor nurses in the ICU. The problems existing in the process of mechanical ventilation and the influencing factors that may cause VAP were analyzed, and finally 14 related influencing factors were determined.

2.5. ARIMA-GARCH Model Modeling. The ARIMA model, which was first proposed by American statisticians in the 1970s, is an Autoregressive Integrated Moving Average. ARMA models mainly include MA (q) model, AR (p) model, and ARIMA (p, q) model, where p represents the order of autoregression, d represents the number of differences, and q represents the order of moving average. The mathematical expression of the ARIMA model is as follows:

$$\varnothing\left(B\nabla^d\right)X_t = \theta(B)\epsilon_t, \tag{2}$$

where X_t represents the time series at the moment of t, ε_t represents the white noise (zero mean, variance is a constant), d represents the difference order, B represents the backward operator, that is, $BX_t = X_{t-1}, \nabla = 1 - B, \phi\varepsilon(B)$ represents the autoregressive operator, and the autoregressive coefficient polynomial is

$$\phi(B) = 1 - \phi_1 B - \phi_2 B^2 - \cdots - \phi_p B^p. \tag{3}$$

$\theta(B)$ represents the moving average operator, and the moving average coefficient polynomial is

$$\theta(B) = 1 - \theta_1 B - \theta_2 B - \cdots - \phi_q B^q. \tag{4}$$

Around the 1990s, a scientist improved the ARCH model and obtained the GARCH model, which can eliminate the heteroscedasticity and aggregation of species in time series. The general expression of the GARCH model is as follows:

$$\begin{cases} Y_t = X_t\alpha + \varepsilon_t, \varepsilon_t \mid \varphi_t \sim \pi N(0, \delta), \quad t = 1, \ldots, T, \\ \delta_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{q} \beta_j + \varepsilon_{t-j}. \end{cases} \tag{5}$$

In the equation, φ_t is the sum of all data before time t and time t, ε_t is the error term, and δ_t is the variance of the error term. $P > 0, q \geq 0, \omega > 0, \alpha_i \geq 0, \beta_j \geq 0\,(j = 1, 2, \ldots q)$, and the conditional variance is also required to be positive.

2.6. Subjects of MCDA. 15 experts in the field of intensive clinical, intensive care, and infection control were selected to consult. The experts were selected as per the following inclusion criteria: (I) with more than 8 years of experience in clinical medicine, clinical nursing, and infection control; (II) intermediate title or above; (III) bachelor degree or above; (IV) experienced in preventing VAP; and (V) voluntary and enthusiastic about the work.

2.7. Elements of Bundles of Care. After the retrospective analysis of the influencing factors of VAP in ICU patients with mechanical ventilation, it was found that the incidence of VAP can be reduced by subglottic suction; enteral nutrition; monitoring the intratracheal tube balloon pressure at least every 24 h (maintain at 25–30 cm A2O); raising the bed head by 30°–45°; oral care to prevent peptic ulcer; and daily extubation assessment in the morning. Besides, except for visible contamination or damage, replacing the ventilator tube routinely was not recommended.

2.8. Specific Method of MCDA. All subjects adopted the MCDA cluster intervention strategy, with specific methods as follows:

(1) The establishment of the MCDA team. It was composed of physicians, responsible nurses, group leaders, and head nurses specializing in pulmonary infections. The team members formulated the MCDA questionnaire by referring to relevant pulmonary infection prevention guidelines and the ventilator cluster intervention strategies.

(2) The issue of the questionnaire. Questionnaires were sent to 10 experts specializing in infection, nursing, intervention, and microbiology. The score ranged between 0 and 20 points according to the importance of the nine criteria, used as the weight of this criterion. Next, in terms of the prevention measures, the score ranged between 0 and 10 points. Then, the score of each preventive measure was calculated according to the equation: Score = criterion weight × Average value + Criterion 2 weight × average score + ... + Criterion 9 weight × average score.

(3) The formulation of bundles of care. According to the final score of each prevention measure, the importance was determined, the cluster intervention strategy was formulated, including the implementation plan, operation method, and supervision method, and other criteria were formulated.

(4) The implementation of bundles of care. The MCDA group was transformed into a cluster intervention group to train group members. After the training, the responsible nurses flexibly adjusted the intervention strategies in the experimental group based on the different situations of patients.

(5) Supervision of the implementation of bundles of care. The group leader conducted spot checks on the specific operation details of the intervention strategy from time to time.

2.9. Statistics. Excel was used to collect relevant data, and SPSS19.0 software was used for statistical analysis of the data. The count data were expressed by (%), and χ^2 test was used. The measurement data were expressed as mean ± standard deviation, and t-test was used. $P < 0.05$ meant that the difference was statistically significant.

3. Results

3.1. Comparison of the Basic Data. In this study, 100 mechanically ventilated patients were included in each of the control group and the intervention group. There was no significant difference in basic data between the two groups ($P > 0.05$). In the control group, there were 66 males (66%) and 34 females (34%); in the intervention group, there were 62 male patients (62%) and 38 female patients (38%). In the control group, 86 people were older than 65 years old (86%), more than 80 in the intervention group (80.0%); 58 people (58.0%) had smoked before, more than 54 (54%) in the observation group; and 46 people had a history of diabetes (46.0%), less than 50 (50%) in the intervention group (Table 1).

3.2. Comparison of the Age Distribution. There was no statistically significant difference in the distribution of age and APACHE II scores between the two groups of patients, as shown in Figure 1. There were 10 people aged less than 45 years, including 4 in the control group and 6 in the intervention group. In the control group, there were 10 people aged between 45 and 65 (10.0%), less than 14 (14%) in the intervention group. In the control group, there were 70 people aged between 65 and 85 (70%), more than 66 (66%) in the observation group; there were 30 people older than 85 years old, including 16 (16%) in the control group and 14 in the intervention group (14%).

3.3. The Occurrence of VAP in the Two Groups. 34 (34%) patients in the control group were infected with VAP, more than 8 (8%) patients in the intervention group, and there was a statistically significant difference ($P < 0.05$), as shown in Figure 2.

3.4. Mechanical Ventilation Time and Apache II Score. There was a significant difference in the mechanical ventilation time and APACHE II scores of the two groups of patients. The mechanical ventilation time of the control group was 15.75 hours, which was significantly more than the 12.45 hours of the intervention group, and the APACHE II score in the control group significantly increased, $P < 0.05$ (Figure 3).

3.5. Detection Rate of Pathogenic Bacteria. In the control group, of the 17 patients infected with VAP, Gram-positive bacteria were detected in 11 cases, including 6 cases of *Streptococcus pneumoniae*, 3 cases of *Escherichia coli*, and 2 cases of golden yellow *Staphylococcus*. Gram-negative bacteria were detected in 10 cases, including 5 (50%) cases of *Acinetobacter baumannii*, 2 cases of *Klebsiella pneumoniae*, 2 cases of *Brucella Bacillus*, and 1 case of *Pseudomonas aeruginosa* (Figures 4(a)–4(c)). In the intervention group, 9 cases were diagnosed with VAP, including 4 (44.4%) cases of bacterial infection, 3 (44.4%) cases of virus infection, and 2 (22.2%) cases of fungal infection.

3.6. Expert Consultation Results. A total of 15 experienced VAP experts were consulted, and the specific values were shown in Table 2. They were from ICU of General Hospital of Tianjin Medical University, with an average age of 35–56 years and an average working time of 15.3 years. Of the 15 experts, clinicians accounted for 40%, and nursing physicians for 60%; doctoral degree for 20%, master's degree for 60%, and bachelor's degree for 20%; intermediate titles for 26.67%, deputy senior titles for 53.33%, and senior titles for 20%. The rich knowledge and experience of experts improved the standard level of treatment. The operation of

Table 1: Basic data of 100 patients in the control group and the intervention group.

Basic data		Control group (case)	The proportion (%)	Intervention group (cases)	The proportion (%)
Gender	Male	66	66.0	62	62.0
	Female	34	34.0	38	38.0
Age	Over 65 years old	86	86.0	80	80.0
	Less than 65 years old	14	14.0	20	20.0
Smoking history	Yes	58	58.0	54	54.0
	None	42	42.0	46	46.0
History of diabetes	Yes	46	46.0	50	50.0
	No	54	54.0	50	50.0
Central venous catheter	Yes	34	34.0	32	32.0
	No	66	66.0	68	68.0
Tracheotomy	Yes	22	22.0	26	26.0
	No	78	78.0	74	74.0
Ward type	Single room	16	16.0	18	18.0
	Multiple room	84	84.0	82	82.0
State of consciousness	Coma	60	60.0	68	68.0
	Awake	40	40.0	32	32.0
APACHE II score		18.98 ± 2.16		17.83 ± 1.93	

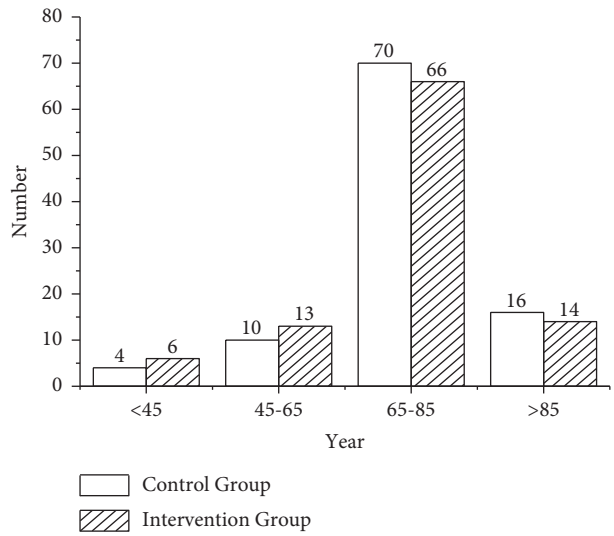

Figure 1: The age distribution of the two groups of patients.

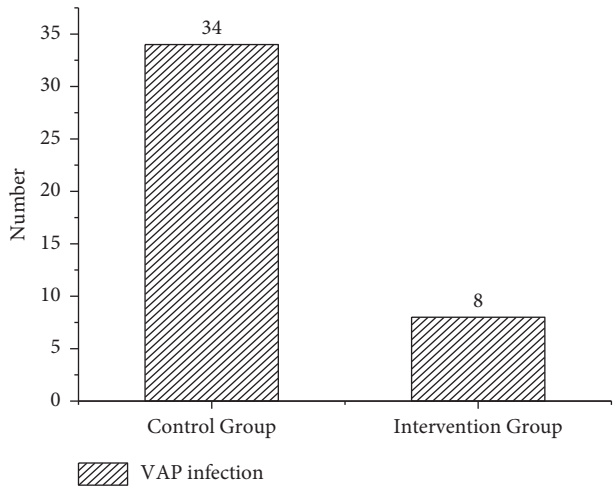

Figure 2: VAP infection rate of the two groups of patients.

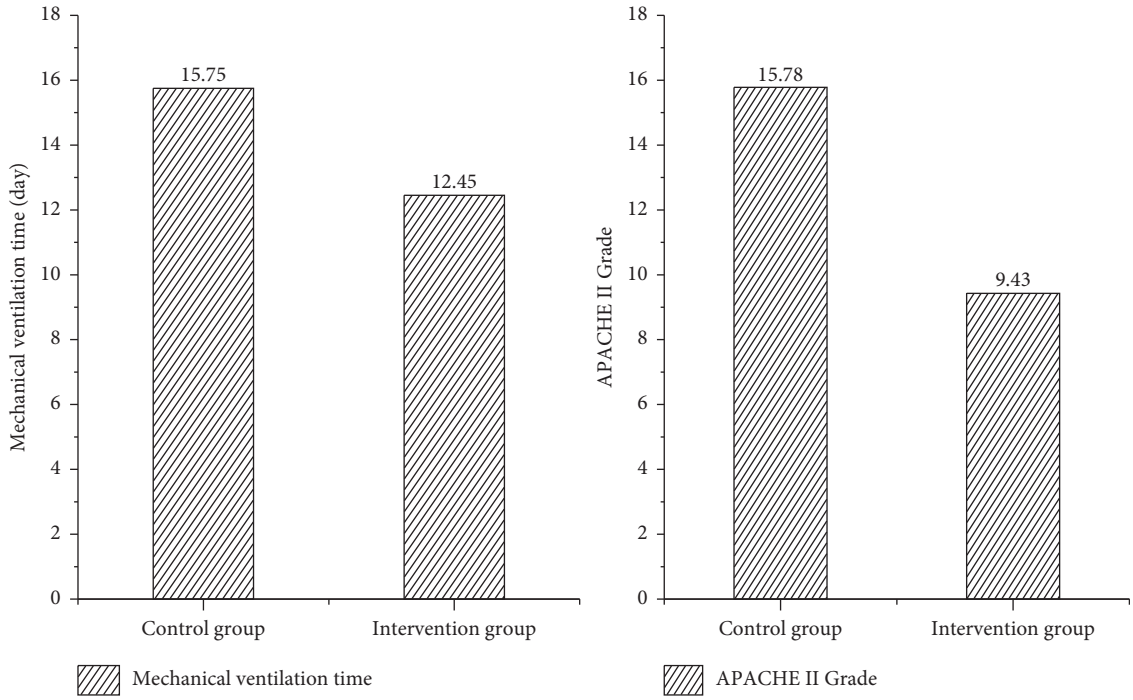

Figure 3: Mechanical ventilation time and APACHE II scores of the two groups of patients.

medical staff directly affected the results. Clear integrated intervention can improve the compliance of the patient and had better accuracy compared with traditional conventional nursing.

3.7. Intervention Strategies to Prevent VAP Clustering. According to the opinions of the 15 experts, a total of 6 bundled measures were adopted to prevent VAP, including 0.1% chlorhexidine for oral care; strict implementation of hand hygiene; daily wake-up for spontaneous breath training and extubation assessment; continuous subglottic suction; raising the bed head by 30°–45°; and nasal feeding through the nasal tube without special condition, as shown in Figure 5(a). In addition, 15 experts also pointed out to 6 nursing measures that had nothing to do with the prevention of VAP, including routine replacement of ventilator tubes, visitors wearing a full set of isolation supplies, control of visiting time within 30 minutes, slight elevation of lower limbs, prevention of irritant hyperglycemia, and regular ultraviolet disinfection of air, ground, and equipment (Figure 5(b)). The research on multiattribute utility theory (MAUT) is the main development of the research on multiattribute utility theory. Multiattribute decision-making has been gradually applied in the medical field. As shown in Table 3, the analysis results of multicriteria decision analysis and multiattribute decision analysis on cluster nursing-related measures were compared. It could be concluded that the application of MCDA in the cluster care of ventilators associated with pneumonia had a better effect.

3.8. ARIMA-GARCH Model Construction and Prediction Analysis. Since ARIMA models were all established on the basis of stationary time series, the Augmented Dickey Fuller (AFD) test was performed on the bundled nursing measures for patients with ventilator-associated pneumonia, and the test statistic was −1.1544. In addition, $P > 0.05$ was much higher than the critical value of ADF statistics at the significance level of 1%, 5%, and 10%. Therefore, the null hypothesis H0 was accepted: the original sequence of monthly incidence of HIV in Xinjiang had unit roots, indicating that this sequence was nonstationary (Table 4).

4. Discussion

Although bundles of care have been widely used in clinical practice and have received good results, scholars have pointed out to two measures of actively preventing peptic ulcer and preventing deep vein thrombosis which are not directly related to the prevention of VAP [16]. Also, it has been found that the routine use of proton pump inhibitors not only increases the pH of the gastric juice but also increases the colonization of Gram-negative bacilli. When gastric reflux occurs, it increases the risk of VAP [17]. In the latest guidelines, the application of MRI based on the Fuzzy System in ventilator-associated pneumonia can make an early diagnosis of the disease [18]. In this study, the basic information of all patients was obtained from the database. Studies have shown that, after the implementation of the bundles of care, the compliance rate of various measures exceeds 95%, and the incidence of VAP can be reduced to 0. In this study, after the implementation of the bundles of care, the incidence of VAP was reduced but not to 0. It may be related to the distinct combination of intervention measures [19].

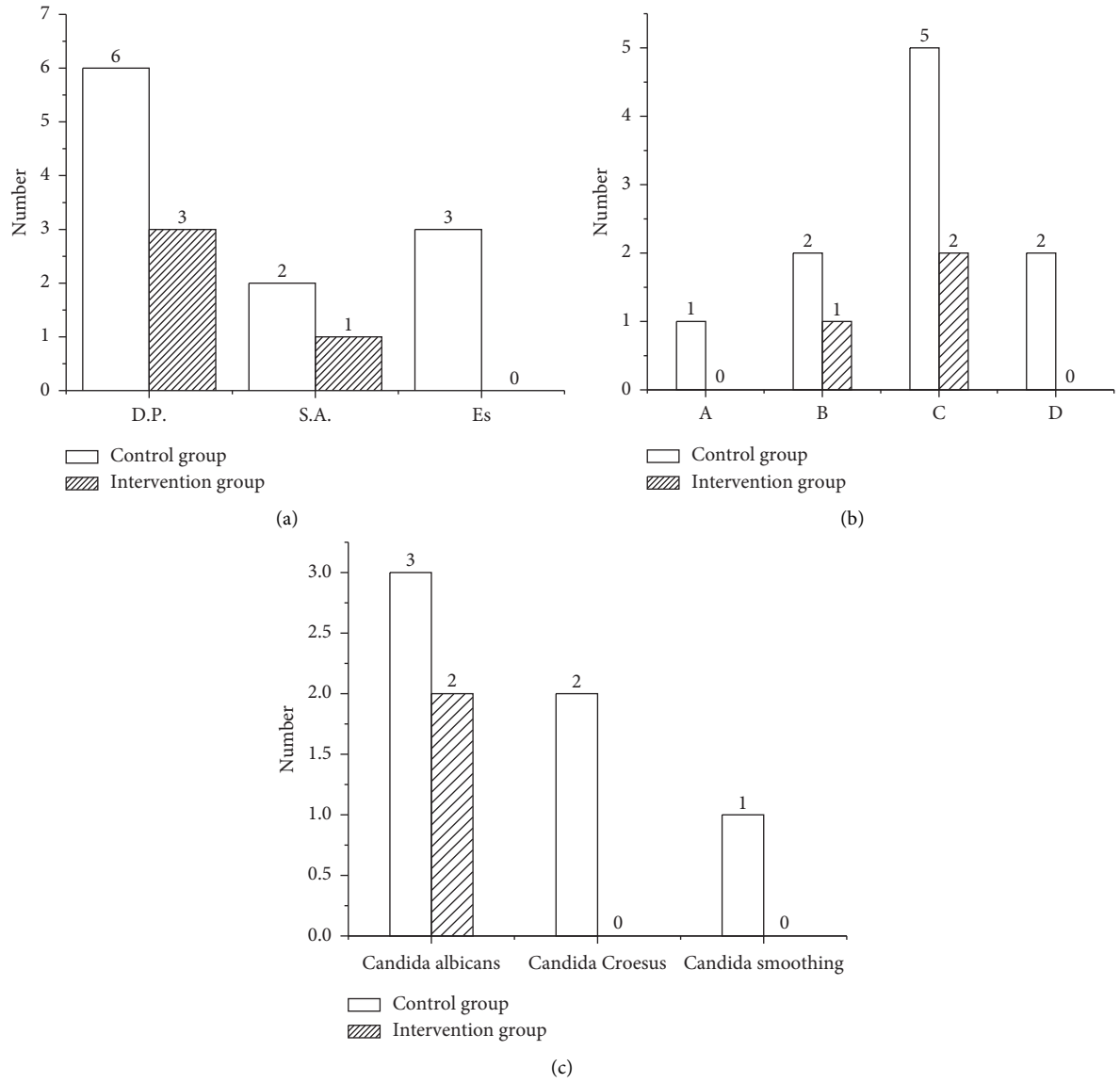

Figure 4: (a) Gram-positive bacterial infection. (b) Gram-negative bacteria infection. (c) Fungal infection. *Note.* D.P. is *Diplococcus pneumoniae*; S.A. is *Staphylococcus aureus*; Es is *Escherichia*. *Note.* A is *Pseudomonas aeruginosa*, B is *Klebsiella pneumoniae*, C is *Acinetobacter baumannii*, and D is *Brucella*.

Table 2: Basic information of 15 experts.

	Number
Clinicians	6
Doctor degree	3
Master degree	9
Bachelor degree	3
Nursing physician	9
Intermediate title	4
Deputy senior title	8
Positive senior title	3

The data characteristics of cluster nursing measures for patients with ventilator-associated pneumonia were explored and analyzed. It was found that the bias coefficient of the data was 0.74, and the peak coefficient was 11.34, with typical "sharp peak and thick tail" characteristics. By taking the logarithm and doing first-order difference to achieve stabilization, the ARIMA time series model was built on the stabilized data series, and the ARIMA model was finally selected to make a short-term prediction on the cluster nursing data of patients with ventilator-associated pneumonia. The results showed that both the predicted value and the actual value fell within the 95% confidence interval. In recent years, big data health service terminals are widely used in clinical practice, collecting electronic medical records of patients with ventilator-associated pneumonia, which greatly promotes the management of patients with ventilator-associated pneumonia [20]. Most studies use a single ARIMA model for prediction, but a single ARIMA model cannot fully mine data information [21]. Moreover, the prediction accuracy of the model is low [22]. Therefore, it

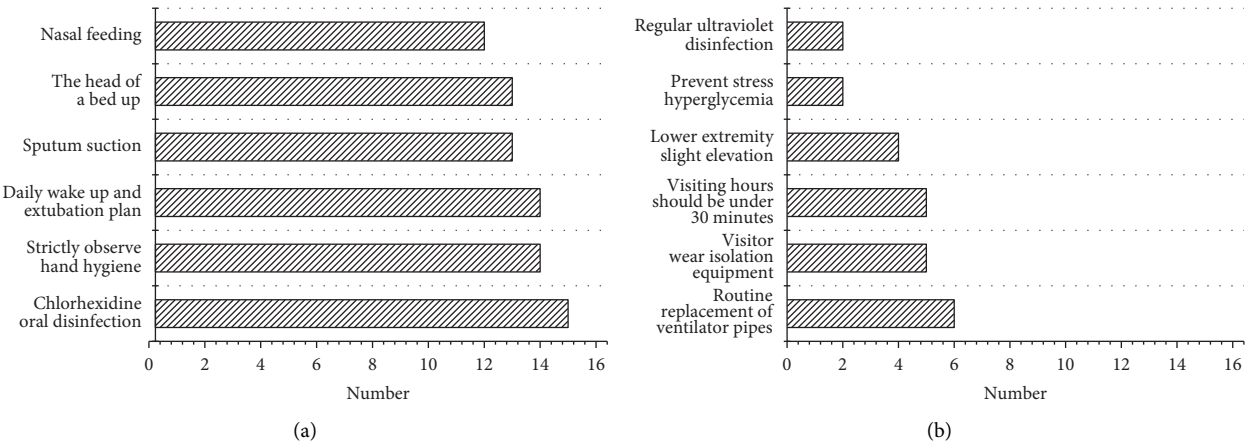

Figure 5: (a) 6 bundled measures to prevent VAP recommended by 15 experts. (b) 6 nursing measures that were not related to the prevention of VAP.

Table 3: Comparison of multicriteria decision analysis and multiattribute decision analysis.

Nursing measures	MCDA	MAUT
Nasal feeding	12	12
The head of a bed up	13	13
Sputum suction	13	12
Daily wake-up and extubation plan	14	13
Strictly observe hand hygiene	14	12
Chlorhexidine oral disinfection	15	14
Score	81	76

Table 4: Results of cluster nursing sequence ADF test for patients with ventilator-associated pneumonia.

Variable	t value	P value
ADF tests statistics	−1.1544	0.453
A significance level of 1%	−2.74	0.02
A significance level of 5%	−1.85	0.05
A significance level of 10%	−1.23	0.1

is suggested that, in future work, the actual characteristics of ventilator-associated pneumonia cluster nursing should be fully explored, and a more accurate model should be established based on the actual incidence characteristics of the incidence, so as to obtain a more accurate prediction effect, so as to provide more powerful data support for the relevant departments of the hospital. MCDA has been used in different types of cluster nursing strategies, such as the prevention of central venous catheter-related bloodstream infections, prevention of lower extremity deep vein thrombosis, and mechanical ventilation patients' analgesia composed of cluster treatment, and it achieved good results. In this study, MCDA of VAP cluster nursing strategy of optimization was applied. In the later stage, the compliance checklist of medical staff should be formulated according to the optimized cluster nursing strategy, in order to improve the compliance of clinical medical staff, reduce the incidence of VAP, and shorten the mechanical ventilation time and hospital stay, so as to reduce the hospitalization cost of patients and improve the utilization rate of medical resources.

In this study, the incidence of VAP in the intervention group was significantly lower than that in the control group ($P < 0.05$), suggesting that bundles of care can reduce the incidence of VAP in patients, shorten the time of mechanical ventilation, and reduce the APACHEII score. Studies have shown that nearly one-third of the lung infections in the intensive care unit arise from pathogen infections [23]. In the control group, of the 17 patients infected with VAP, Gram-positive bacteria were detected in 11 cases, including 6 cases of *Streptococcus pneumoniae*, 3 cases of *Escherichia coli*, and 2 cases of golden yellow *Staphylococcus*. Gram-negative bacteria were detected in 10 cases, including 5 (50%) cases of *Acinetobacter baumannii*, 2 cases of *Klebsiella pneumoniae*, 2 cases of *Brucella Bacillus*, and 1 case of *Pseudomonas aeruginosa*. The results were consistent with most domestic reports, but foreign literature mostly focuses on *Aspergillus* genus. This may be due to differences in the diagnostic criteria for VAP. On the other hand, it may be due to the differences in external medical environment.

5. Conclusions

This study drew attention to the MCDA in the bundles of care and effective nursing measures to prevent VAP. First, a total of 200 mechanically ventilated patients were selected from the database, according to different nursing measures of patients, 200 patients were divided into experimental group and control group. Secondly, bundles of care were

taken for the intervention group, and the two groups were compared for the probability of VAP and the differences in the types of pathogenic microorganisms. It was found that 34 patients in the control group were infected with VAP, accounting for 34%, which was significantly more than the 18 patients in the intervention group. The bundles of care can effectively reduce the incidence of VAP, thereby improving the survival rate of patients. Among the many infectious bacteria, *Streptococcus pneumoniae* accounted for the largest proportion of 54.5%. According to the opinions of 15 experts, the use of 0.1% chlorhexidine for oral care is the most recognized measure to prevent VAP. Other measures include strict implementation of hand hygiene, daily wake-up for spontaneous breath training and extubation assessment, continuous subglottic suction, raising bed head by 30°–45°, and nasal tube feeding without special condition. Additionally, experts believe that there are 6 measures that are not relevant to the prevention of VAP, including routine replacement of ventilator tubes, visitors wearing a full set of isolation supplies, control of the visit time within 30 minutes, slight elevation of the lower limbs, prevention of stress hyperglycemia, and regular ultraviolet disinfection of air, ground, and equipment. However, some limitations should be noted. The sample size is small, which will reduce the power of the study. In the follow-up, an expanded sample size is necessary to strengthen the findings of the study. In conclusion, the results of this study provide a reference for the prevention of VAP and the nursing measures for patients with mechanical ventilation.

Bundle of care is commonly used in the treatment of pulmonary diseases and it proves worth clinical promotion. However, the research on the decision information system combined with bundles of care is rare. The multicriteria analysis method is involved in many areas because it is easy to understand. It can be predicted that there will be more studies on the bundles of care in the future.

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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