Effect Of Cluster Intervention Strategy Combined with Targeted Nursing on Prevention of Ventilator-Associated Pneumonia in Icu Patients

XueQin Li
XiuYing Chen

Background VAP is a common complication of ventilator maintenance therapy. The occurrence of VAP is related to many factors such as long duration of breathing, invasive operation, pollution of respiratory tubes and instruments, and low immunity of patients. The prevention of VAP in critically ill patients I the primary problem for clinical medical staff. Avoiding exogenous bacteria invading the respiratory tract and endogenous bacterial infection is the main method. **Objective** To investigate the value of optimized cluster nursing intervention combined with targeted nursing measures in reducing the incidence of ventilator-associated pneumonia (VAP) in patients with mechanical ventilation in intensive care unit (ICU). **Methods** 200 patients with mechanical ventilation in ICU of our institute from January 2017 to June 2020 were selected and randomly divided into study group and control group, with 100 cases in each group. The study group was treated with cluster nursing intervention combined with targeted nursing measures optimized by multi-criteria decision analysis method, and the control group was treated with targeted nursing measures. The incidence of VAP, the detection rate of pathogenic bacteria in sputum specimens and the effect of nursing execution were compared between the two groups. 200 patients were divided into VAP group and non-VAP group according to whether VAP occurred. Multivariate Logistic regression model analysis was used to explore the risk factors of VAP in AECOPD patients. **Results** A total of 4 strains were detected in the study group and 18 strains were detected in the control group. The detection rate of pathogenic bacteria in the study group was higher than that in the control group ($\chi2=10.010$, $P=0.002<0.05$). The incidence of VAP in the study group was 4.00% lower than 17.00% in the control group, and the difference was statistically significant ($P<0.05$). Compared with VAP group and non-VAP group, the proportion of patients with serum albumin<30g/L, diabetes mellitus rate, APACHE II score≥15 points, tracheotomy rate and mechanical ventilation time≥5 days in VAP group were significantly higher than those in non-VAP group, which had statistical significance（$P<0.05$）.The results of logistic regression model showed that serum albumin ≥30g/L and optimized cluster nursing could effectively reduce the risk of VAP in ICU patients with mechanical ventilation ($P<0.05$). The risk of VAP in ICU patients with mechanical ventilation was increased by the combination of diabetes rate. APACHE II score≥15 points, tracheotomy and mechanical ventilation time ≥ 5 days ($P<0.05$). **Conclusion** The risk of VAP in ICU patients with mechanical ventilation is high, and the optimized cluster nursing intervention combined with targeted nursing measures can effectively reduce the incidence of VAP.

Keywords: optimization; Cluster nursing; Nursing.; intensive care unit (ICU). ventilator-associated pneumonia
Tob Regul Sci.™ 2021;7(6): 6395-6401
DOI: doi.org/10.18001/TRS.7.6.112

*XueQin Li, XiuYing Chen Nursing Department, West China Second University Hospital, Sichuan University, No.20, Section 3, Renmin Nan Lu, Chengdu 610041, Sichuan Province, China. Key Laboratory of Birth Defects and Related Diseases of Women and Children (Sichuan University), Ministry of Education, Chengdu, Sichuan, China. *Corresponding Author: XiuYing Chen E-mail address: 1826792290@qq.com*

Ventilator-associated pneumonia (VAP) is the most common nosocomial infection in intensive care unit (ICU), which refers to respiratory failure patients without pulmonary infection who receive mechanical ventilation for 48 hours after tracheotomy or tracheal intubation, or who develop

pulmonary infection within 48 hours after extubation [1, 2].

The results of relevant reports in China and abroad [3, 4] shows that the incidence and mortality of VAP are high, but its occurrence is preventable. The occurrence of VAP is closely related to the nursing operation of medical staff. Therefore, effective nursing measures play an important role in reducing the incidence of VAP.

Cluster nursing can effectively reduce the incidence of VAP, but the sequence of bundle elements of VAP is not formed by evidence-based methods [5]. Multi - Criteria Decision Analysis (MCDA) is a method of decision making when there are multiple irreplaceable criteria at the same time, which aims to provide support for the evaluation of decision makers facing numerous and conflicting criteria. The cluster intervention strategy formed by weight and assignment becomes the optimized cluster nursing intervention [6]. This study mainly discussed the value of optimized cluster nursing intervention combined with targeted nursing measures in reducing the incidence of VAP in ICU patients with mechanical ventilation.

MATERIALS AND METHODS

Information

200 patients with mechanical ventilation in ICU of our institute from January 2017 to June 2020 were selected and randomly divided into study group and control group, with 100 cases in each group. Inclusion criteria: (1) Diagnostic criteria for VAP reference《Guidelines for diagnosis, prevention and treatment of ventilator-associated pneumonia (2013) 》[7], (2) Patients need to receive adjuvant mechanical ventilation for more than 48h. (3) Patients aged 55–82 years old. (4) The data of sputum culture bacteriology and laboratory examination are complete. Exclusion criteria: (1) acquired immunodeficiency syndrome. (2) Malignant tumors. (3) Pulmonary infection has occurred before mechanical ventilation. (4) Patients who died within 48-72 hours of mechanical ventilation. Before the implementation of this study, the research plan was submitted to the Medical Ethics Committee of our hospital for approval, and was implemented after the decision of the Medical Ethics Committee of our hospital (No.18: Ethics (Trial) (2016)).

Intervention measures

Control group: Intervention with targeted nursing measures. Strengthen the nursing monitoring of elderly patients and serious patients, nursing staff strictly aseptic operation.

Strengthen the nursing monitoring of elderly patients and serious patients, nursing staff strictly aseptic operation. Indications for ventilator use should be evaluated regularly to achieve early withdrawal and extubation. Accurately assess the nutritional status of patients, provide early nutritional support for patients, avoid intestinal flora shift or aspiration. Improve the quality of ventilator management, establish strict supervision system, keep the airbag pressure at the level of 20~30cmH2O, and timely check the cleanliness of the pipeline, regularly clean or replace the pipeline.

Observation group

using multi-criteria decision analysis method optimized cluster nursing intervention combined with targeted nursing measures, reference《Guidelines for Diagnosis and Treatment of Hospital Acquired Pneumonia and Ventilator Associated Pneumonia in Chinese Adults (2018 Edition)[8], Including twelve items: ①Strict implementation of hand hygiene. ②Using non-invasive respiratory therapy as much as possible. ③To evaluate the necessity of daily invasive mechanical ventilation and tracheal intubation, and daily wake-up plan, ④subglottic secretion drainage（SSD）. ⑤The filling pressure of the balloon should be kept at least 25cm H2O (1cmH2O=0.098kPa). ⑥head elevation. ⑦Oral care. ⑧Strengthening the cleaning and disinfection of the internal and external pipelines of the ventilator. ⑨When performing airway-related operations, the sterile technical operation procedures should be strictly observed. ⑩Encouraging and assisting early activities of patients with mechanical ventilation. ⑪Medical cooperation, daily assessment of preventive measures compliance. ⑫Prevention of stress ulcer.

Detection method of pathogens in sputum

Sputum culture or bronchial lavage fluid culture were performed every 3 days after airway opening. The samples were placed in sterile containers and immediately sent to the bacterial chamber. After smearing, microscopic examination was performed and qualified sputum specimens (leukocytes > 25 / low-power field, epithelial cells 2.5) were re-cultured. The same dominant strain was identified as pathogenic bacteria for two consecutive times. The same pathogen with different drug sensitivity results was regarded as different strains, and the pathogen with the same drug sensitivity results was regarded as the same strain. Bacterial culture and identification Vitek-2 automatic bacterial identification and drug sensitivity system, ATB Express semi-automatic bacterial identification and drug sensitivity system were used for identification and drug sensitivity test. Bacterial medium is M-H agar recommended by WHO. Drug sensitivity test using K-B method, the quality control strains were Staphylococcus aureus ATCC25923, Enterococcus faecalis ATCC29212, Streptococcus pneumoniae ATCC49619, Pseudomonas aeruginosa ATCC27853, Escherichia coli ATCC25922 and Klebsiella pneumoniae ATCC700603 [9].

Statistical Treatment

The measurement indexes such as age and BMI in this study were tested by normal distribution, which were in accordance with the approximate normal distribution or normal distribution. denoted by（$\bar{x}\pm s$. T test in SPPS software. χ^2 test analyzes the measurement data. Logistic regression model was used for multivariate analysis. Test level $\alpha = 0.05$.

RESULTS

Comparison of baseline data between study group and control group

Comparison of baseline data between study group and control group, the two groups of patients had good balance and comparability (P>0.05). See Table 1.

Detection of pathogens in sputum of study group and control group

A total of 4 strains were detected in the study group and 18 strains were detected in the control group. The detection rate of pathogenic bacteria in the study group was higher than that in the control group (χ^2=10.010，P=0.002<0.05). See Table 2 for details.

Comparison of VAP incidence between study group and control group

The incidence of VAP in the study group was 4.00 % lower than 17.00 % in the control group, which had statistical significance（P<0.05）. See Table 3.

Single factor analysis of VAP and non-VAP patients

Compared with VAP group and non VAP group, the proportion of patients with serum albumin < 30 g / L, diabetes mellitus rate, APACHE II score ≥ 15 points, tracheotomy rate and mechanical ventilation time ≥ 5 days in VAP group were significantly higher than those in non VAP group, which had statistical significance（P<0.05）, See Table 3.

Multivariate analysis of influencing factors of VAP

Univariate analysis was used to analyze serum albumin, diabetes, APACHE II score, tracheotomy, mechanical ventilation time and whether patients were treated with optimized cluster nursing as independent variables. Logistic regression model was established with VAP as dependent variable. The results showed that serum albumin ≥ 30 g / L and optimized cluster nursing could effectively reduce the risk of VAP in ICU patients with mechanical ventilation (P< 0.05). The incidence of diabetes, APACHE II score ≥15 points, tracheotomy and mechanical ventilation time ≥ 5 d increased the risk of VAP in ICU patients with mechanical ventilation (P< 0.05). See Table 5.

DISCUSSION

The implementation of VAP cluster nursing strategy is related to the significant decrease in the incidence of VAP. The purpose of VAP cluster nursing is to make the routine implementation rate of each patient reach 100 % every day[10]. However,

the compliance of patients with VAP cluster nursing is not high, and a fixed index analysis method has not been formed. Therefore, this study used multi-criteria decision analysis to carry out evidence-based and optimized cluster nursing strategies, and analyzed the risk factors leading to VAP, and explored effective nursing measures.

The results of this study showed that a total of 4 strains were detected in the study group and 18 strains were detected in the control group. The detection rate of pathogens in the study group was significantly higher than that in the control group (P<0.05). The main pathogens detected in sputum specimens were Gram-negative bacteria. The incidence of VAP in the study group was significantly lower than that in the control group (P<0.05). It shows that the optimized cluster intervention combined with targeted nursing intervention can significantly reduce the incidence of VAP. The reason is that after targeted nursing, the nursing staff of patients with mechanical ventilation is more targeted, so as to reduce the ventilation time, so that patients can remove mechanical ventilation as soon as possible, return to conventional treatment, and strengthen the management of the mechanical treatment environment of patients, reduce the way of cross infection, promote the rehabilitation of patients, and through oral care and sputum suction care, reduce the invasion of bacteria, and reduce the occurrence of VAP.

The results showed that the proportion of patients with serum albumin <30g/L, diabetes mellitus rate, APACHE II score ≥15, tracheotomy rate and mechanical ventilation time ≥ 5d in VAP group were significantly higher than those in non-VAP group, which had statistical significance （P<0.05）. Moreover, serum albumin ≥ 30g/L and optimized cluster nursing can effectively reduce the risk of VAP in patients with mechanical ventilation in ICU (P< 0.05). The risk of VAP in patients with mechanical ventilation in ICU will be increased by the combination of diabetes rate, APACHE II score ≥ 15 points, tracheotomy and mechanical ventilation time ≥5 days. At present, studies have found [11][11] that mechanical ventilation time is positively correlated with the occurrence of VAP. Therefore, we should carefully observe the patient ' s weaning indications to choose the appropriate time to weaning, to avoid long-term mechanical ventilation. Serum albumin level is an objective index reflecting the nutritional level of human body. The worse the nutritional level of patients, the worse the resistance to infection, and it is easy to cause infection. Especially when patients suffer from hypoalbuminemia, the immunity is seriously damaged, which accelerates the growth of conditional pathogens and fungi, and is easy to cause pulmonary infection to be difficult to control [12]. It is suggested to closely monitor the serum albumin level of patients to enhance nutrition, enhance body resistance, and prevent and control the occurrence of VAP. Diabetic patients are affected by stress response, blood glucose levels increased significantly [13]. Hyperglycemia can cause hyperosmolar state of blood, which seriously affects the chemotaxis, phagocytosis and bactericidal ability of neutrophils. The immune system of the human body is significantly lower than that of patients with normal blood glucose, resulting in an increase in the incidence of VAP.

Therefore, the blood glucose level of patients should be closely observed to maintain a stable blood glucose level, improve immunity and resist infection, thereby reducing the incidence of VAP. APACHEII score is the worst physiological parameter index and laboratory test index within 24 hours before mechanical ventilation treatment, which reflects the severity of the disease. The higher the score, the weaker the patient ' s resistance at this time, and the more vulnerable to pathogenic bacteria infection [14]. Airway secretions produced by tracheotomy are relatively large, incisions are easily contaminated, long-term use of bacteria is easy to reproduce, and open bacteria are more likely to invade the lower respiratory tract, thereby increasing the chance of respiratory tract infection.

At present, multi-criteria decision analysis has been applied to the construction of different types of cluster nursing strategies, such as the prevention of central venous catheter-related bloodstream infections, the prevention of lower extremity deep venous thrombosis and the analgesic and sedative effects of mechanically ventilated patients [15]. In this

study, multi-standard decision-making analysis has been innovatively applied to cluster nursing, forming cluster nursing mode for nursing intervention of ICU patients with mechanical ventilation, and analyzing related risk factors, in order to better prevent VAP, shorten mechanical ventilation time, and improve the utilization rate of medical resources. However, the survey objects required for the sample are only from one hospital, so the representativeness is not ideal, and the research time is relatively short, and there are fewer cases included. Therefore, it is necessary to further study the large sample size.

In summary, the risk of VAP in ICU patients with mechanical ventilation is high. The optimized cluster nursing intervention combined with targeted nursing measures can effectively reduce the incidence of VAP.

参考文献

REFERENCE

1. Satheeshkumar PS, Papatheodorou S, Sonis S. Enhanced oral hygiene interventions as a risk mitigation strategy for the prevention of non-ventilator-associated pneumonia: a systematic review and meta-analysis. *British Dental Journal*. 2020/04/01 2020;228(8):615-622. doi:https://doi.org/10.1038/s41415-020-1452-7
2. Esperatti M, Fuentes N, Ferrer M, et al. Association between sepsis at ICU admission and mortality in patients with ICU-acquired pneumonia: An infectious second-hit model. *Journal of Critical Care*. 2020/10/01/ 2020;59:207-214. doi:https://doi.org/10.1016/j.jcrc.2020.06.012
3. Rouby JJ, Sole-Lleonart C, Rello J, et al. Ventilator-associated pneumonia caused by multidrug-resistant Gram-negative bacteria: understanding nebulization of aminoglycosides and colistin. *Intensive Care Medicine*. 2020/04/01 2020;46(4):766-770. doi:https://doi.org/10.1007/s00134-019-05890-w
4. McCue MK, Palmer GA. Use of Chlorhexidine to Prevent Ventilator-Associated Pneumonia in a Long-term Care Setting: A Retrospective Medical Record Review. *Journal of Nursing Care Quality*. 2019;34(3):263-268. doi:https://doi.org/10.1097/NCQ.0000000000000367
5. Wang R, Zhen X, Yang B-Y, Guo X-Z, Zeng X, Deng C-Y. Subglottic secretion drainage for preventing ventilator associated pneumonia: A meta-analysis. *Chinese Nursing Research*. 2015/06/01/ 2015;2(2):55-60. doi:https://doi.org/10.1016/j.cnre.2015.03.001
6. Cheung NW, Campbell LV, Fulcher GR, et al. Routine glucose assessment in the emergency department for detecting unrecognised diabetes: a cluster randomised trial. *Medical Journal of Australia*. 2019;211(10):454-459. doi:https://doi.org/10.5694/mja2.50394
7. Medicine CMABoc. Guidelines for the diagnosis and treatment of ventilator-associated pneumonia(2013). *CHINESE JOURNAL OF INTERNAL MEDICINE* 2013;52(6):524-543.
8. Association TIGotRDCAotCM. Guidelines for the diagnosis and treatment of acquired pneumonia and ventilator - related pneumonia in adult hospitals in China(2018). *Chinese Journal of Tuberculosis and Respiratory*. 2018;41(4):255-280.
9. Ditz B, Christenson S, Rossen J, et al. Sputum microbiome profiling in COPD: beyond singular pathogen detection. *Thorax*. 2020;75(4):338-344. doi:http://dx.doi.org/10.1136/thoraxjnl-2019-214168
10. Wang W, Tang C, Ji Q-L, Xiu H, Shao H, Yu X-M. Use of multiple nursing interventions (cluster nursing) in ABO hemolytic disease of neonates and evaluation of its effect. *Journal of International Medical Research*. 2020;48(1):0300060519887630. doi:https://doi.org/10.1177%2F0300060519887630
11. Yao J, Guan S, Liu Z, Li X, Zhou Q. Changes in immune indicators and bacteriologic profile were associated with patients with ventilator-associated pneumonia. *Medicine (Baltimore)*. 2020;99(16):e19716-e19716. doi:https://dx.doi.org/10.1097%2FMD.0000000000019716
12. Nanao T, Nishizawa H, Fujimoto J, Ogawa T. Additional medical costs associated with ventilator-associated pneumonia in an intensive care unit in Japan. *American Journal of Infection Control*. 2021/03/01/ 2021;49(3):340-344. doi:https://doi.org/10.1016/j.ajic.2020.07.027
13. De Souza PR, De Andrade D, Cabral DB, Watanabe E. Endotracheal tube biofilm and ventilator-associated pneumonia with mechanical ventilation. *Microscopy Research and Technique*. 2014;77(4):305-312. doi:https://doi.org/10.1002/jemt.22344
14. Knaus WA, Draper EA, Wagner DP, Zimmerman JE. APACHE II: a severity of disease classification system. *Crit Care Med*. 1985/10// 1985;13(10):818-829.
15. Masuyama T, Yasuda H, Sanui M, Lefor AK. Effect of skin antiseptic solutions on the incidence of catheter-related bloodstream infection: a systematic review and network meta-analysis. *Journal of Hospital Infection*. 2021/04/01/ 2021;110:156-164. doi:https://doi.org/10.1016/j.jhin.2021.01.017

Table 1
Comparison of baseline data between study and control groups

General information	Study Group（n=100）	control group（n=100）	t/χ2	P
age（year）	68.9±6.6	67.4±7.5	1.501	0.135
BMI（kg/m2）	23.8±2.5	24.0±2.2	-0.601	0.549
sex（%）			1.323	0.250
man	55(55)	63(63)		
woman	45(45)	37(37)		
Smoking（%）			0.791	0.374
yes	38(38)	32(32)		
no	62(62)	68(68)		
blood albumin（g/L）			0.439	0.508
<30	22(22)	26(26)		
≥30	78(78)	74(74)		
diabetes			0.613	0.434
yes	31(31)	26(26)		
no	69(69)	74(74)		
APACHE II			1.293	0.256
<15	59(59)	51(51)		
≥15	41(41)	49(49)		
hypertension			1.202	0.273
yes	32(32)	25(25)		
no	68(68)	75(75)		
Use of glucocorticoids			1.747	0.185
yes	32(32)	41(41)		
no	68(68)	59(59)		
Type of antibiotic			1.624	0.203
<2	23(23)	31(31)		
≥2	77(77)	69(69)		
disturbance of consciousness			0.980	0.322
yes	47(47)	54(54)		
no	53(53)	46(46)		
tracheotomy			0.744	0.388
yes	62(62)	56(56)		
no	38(38)	44(44)		
Mechanical ventilation time			0.381	0.537
<5d	32(32)	28(28)		
≥5d	68(68)	72(72)		

Table 2
Detection of sputum pathogens in the Study and control groups

nosophyte	Study Group（n=100）	control group（n=100）
gram positive bacterium	1(1.00)	3(3.00)
MRSA	1(1.00)	2(2.00)
others	0(0.00)	1(1.00)
gram negative bacterium	3(3.00)	14(14.00)
acinetobacter baumannii	1(1.00)	7(7.00)
Pseudomonas aeruginosa	1(1.00)	3(3.00)
Klebsiella pneumoniae	1(1.00)	3(3.00)
x.maltophilia	0(0.00)	1(1.00)
mycotic infection	0(0.00)	1(1.00)
aggregate	4(4.00)	18(18.00)

Table 3
Comparison of VAP in Study and control

group	n	VAP	非 VAP
Study Group	100	4（4.00）	96（96.00）
control group	100	17（17.00）	83（83.00）
X2		8.992	
P		0.003	

Table 4.
Form factor analysis results

General information	VAP（n=21）	control group（n=179）	t/χ2	P
age（year）	68.4±7.2	67.6±7.0	0.494	0.622
BMI（kg/m2）	24.1±2.3	23.9±2.5	0.350	0.727
sex（%）			0.425	0.514
man	11(52.38)	107(59.78)		
woman	10(47.62)	72(40.22)		
Smoking（%）			0.637	0.425
yes	9(42.86)	61(34.08)		
no	12(57.14)	118(65.92)		
blood albumin（g/L）			7.167	0.007
<30	10(47.62)	38(21.23)		
≥30	11(52.38)	141(78.77)		
diabetes			4.890	0.027
yes	9(42.86)	48(26.82)		
no	12(57.14)	131(73.18)		
APACHE II			6.622	0.010
<15	6(28.57)	104(58.1)		
≥15	15(71.43)	75(41.9)		
hypertension			1.060	0.303
yes	8(38.1)	49(27.37)		
no	13(61.9)	130(72.63)		
Use of glucocorticoids			0.409	0.522
yes	9(42.86)	64(35.75)		
no	12(57.14)	115(64.25)		
Type of antibiotic			2.993	0.084
<2	9(42.86)	45(25.14)		
≥2	12(57.14)	134(74.86)		
disturbance of consciousness			1.221	0.269
yes	13(61.9)	88(49.16)		
no	8(38.1)	91(50.84)		
tracheotomy			4.674	0.031
yes	17(80.95)	101(56.42)		
no	4(19.05)	78(43.58)		
Mechanical ventilation time			4.685	0.030
<5d	2(9.52)	58(32.40)		
≥5d	19(90.48)	121(67.60)		

Table 5
Logistic Regression models

factors	b	SE	Walds	P	OR	95%*CI*	
blood albumin	-0.574	0.274	4.389	0.047	0.563	0.329	0.964
diabetes mellitus	0.811	0.414	3.837	0.061	2.250	1.000	5.065
APACHE II	0.762	0.358	4.530	0.043	2.143	1.062	4.322
tracheotomy	0.964	0.400	5.808	0.021	2.622	1.197	5.743
Mechanical ventilation time	0.753	0.358	4.424	0.046	2.123	1.053	4.283
Cluster nursing after optimization	-0.688	0.269	6.541	0.007	0.503	0.297	0.851
constant term	1.420	0.557	6.499	0.008	4.137	1.389	12.326