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Original Article

Effect of PDCA circulation nursing intervention on prognosis of patients with severe pneumonia

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Abstract: Objectives: To investigate the effect of a new nursing method combining Plan-Do-Check-Act (PDCA) circulation management and nursing on the prognosis of patients with severe pneumonia. Methods: The clinical records of 98 patients treated in the Second Affiliated Hospital of Xi'an Jiaotong University from January 2019 to January 2021 were retrospectively analyzed. Patients were divided into the control group (n=49) and the PDCA group (n=49), which were intervened by routine nursing and PDCA nursing based on routine nursing, respectively, by the same group of nursing staff. Results: After PDCA care, the nutritional status (body weight; total protein, TP; albumin, ALB) and immune function (immunoglobulin A, IgA; immunoglobulin G, IgG) in the PDCA group were significantly higher than those in the control group. Compared with routine nursing, PDCA care significantly increased the levels of PaO_2 and oxygenation index, and reduced $PaCO_2$, thus improving patients' ventilation function. The levels of interleukin-6 (IL-6), C-reactive protein (CRP) and procalcitonin (PCT) decreased more significantly in the PDCA group, thus better inhibiting the inflammatory response. The PDCA group also had fewer cases of invasive mechanical ventilation, shorter time of invasive ventilation, noninvasive ventilation, total oxygen therapy, and hospitalization, and better prognosis. Conclusions: PDCA care can effectively improve the nursing quality and patients' satisfaction, and better alleviate patients' poor psychological emotions, which is conducive to building a harmonious doctor-patient relationship.

Keywords: PDCA circulation management, severe pneumonia, nursing, prognosis

Introduction

Severe pneumonia, a critically ill condition, is a serious infectious disease that requires immediate treatment and is often accompanied with one or more drug-resistant bacteria. Clinically, severe pneumonia is very urgent and progresses rapidly, which easily causes multiple organ failure and inflammatory response syndrome [1]. Severe pneumonia refers to a pulmonary inflammatory disease with severe circulation disorders such as severe hypoxia, respiratory failure or hypotensive shock [2]. Among them, respiratory failure is a common and severe complication of the disease. Without timely and effective treatment, it will lead to high mortality. At present, the treatment of severe pneumonia is mainly to kill pathogenic microorganisms, improve ventilation and improve the immune function of patients [3]. In order to better guide the treatment of patients, improve the quality of nursing, and restore the respiratory function of patients with severe pneumonia [4], a large number of scholars have been committed to the study of etiological assessment and clinical prognosis. In the process of treatment, the nursing staff also play a vital role in improving the curative effect. Nurses are responsible for the implementation of daily medical orders, treatment safety, communication, mediation, and coordination with medical and technical departments, and thus irreplaceable for the treatment of severe pneumonia [5]. Some scholars [6] put forward that targeted nursing model should be adopted in the treatment of severe pneumonia, so as to improve the clinical symptoms of patients, enhance their quality of life, lower the incidence of complications, and reduce mortality. However, the general shortage of intensive care personnel in China, as well as the deficiency in pulmonary care theory and operation experience for critically ill patients

has made it impossible to provide targeted, accurate and effective nursing to patients immediately. Therefore, the treatment and nursing of patients has always been one of the key issues clinically [7]. Patients with lung infection often have inflammatory reactions such as trachea and alveoli, especially those with respiratory failure [8]. In addition, they suffered from respiratory dysfunction, blood gas index disorder, carbon dioxide retention, severe acid-base imbalance, trachea hypoxia injury, and even death [9]. All of these seriously affect the quality of life of patients and threaten their life safety. What's more, affected by malnutrition and infection factors, patients often show symptoms such as suppressed immunity and increased inflammation, which adversely affect the treatment effect and prognosis. Therefore, improving the quality of nursing and providing effective and targeted nursing care for patients with severe pneumonia is an effective way to solve the shortage of key nursing staff.

With the continuous progress of society, conventional nursing has been unable to meet the nursing needs of patients, nor can it effectively improve the quality of life of patients or reduce the complication rate, with a long-lasting course. Plan-Do-Check-Act (PDCA) management was first used in the United States to improve the quality of management. In recent years, with the constant development and progress of nursing discipline, PDCA management system has been increasingly used in nursing, which can assist nurses to accumulate practical and effective nursing experience, avoid nursing errors, and gradually improve the quality of nursing management [10]. As a circular management method, PDCA mainly includes four aspects of plan, do, check and act in accordance with the principles of "large ring nests the small ring, while the small ring props up the large ring" [11]. In every circulation management, problems existing in nursing work can be summarized and analyzed, successful and effective nursing management experience can be saved, and insufficient experience and hidden nursing problems can be addressed in the next circulation, so as to gradually improve the quality and experience of nursing personnel [12]. Besides, the successful experience can be formed into rules to provide theoretical guidance for later clinical nursing. The innovation of this study lies in the combination of PDCA management and nursing to form a new nursing model, and the exploration of its effect on improving the nursing quality and prognosis of patients with severe pneumonia.

Materials and methods

The choice of research object

The nursing research group was composed of nurses in the Emergency Department. Inclusion criteria: 1. Nurses who remained on duty during the experiment; 2. Nurses with the nursing level of N2, N3 or N4. A total of 20 nurses were enrolled, and the average age was 32.53±4.75 years old. In addition, 1 deputy chief nurse, 5 competent nurses, and 14 nurses were included in the nursing group.

Ninety-eight patients with severe pneumonia treated in the Second Affiliated Hospital of Xi'an Jiaotong University from January 2019 to January 2021 were selected as the research subjects. All the included patients gave informed consent to the study and voluntarily signed the informed consent. The study was approved by the Institutional Board Review at the Second Affiliated Hospital of Xi'an Jiaotong University. Inclusion criteria of patients: Patients diagnosed of severe pneumonia according to the *Diagnosis and Treatment of Adults with Community-acquired Pneumonia An Official Clinical Practice Guideline of the American Thoracic Society and Infectious Diseases Society of America* [13], Patients with the main symptoms of septic shock and mechanical ventilation; Patients with an age of 18-70 years old; Patients with a duration from onset to treatment less than 14 days; Patients with high treatment compliance. Exclusion criteria of patients: Patients with malignant tumors, heart failure, exhaustion, or respiratory failure; Patients with severe cardiovascular and cerebrovascular diseases; Patients with other diseases that can cause a decline in lung function; Patients with previous lung surgery; Patients with diseases that require immunosuppressive therapy. The patients were divided into two groups: the control group (n=49) intervened by routine nursing, and the PDCA group (n=49) intervened by PDCA circulation management nursing based on routine nursing. The care implemented in both groups was performed by the same group of nursing staff. This

Table 1. Comparison of baseline data between the two groups [n (%), $\bar{x} \pm s$]

Baseline date	Control group (n=49)	PDCA group (n=49)	t/χ^2	*P*
Age (years)	44.68±2.19	45.14±2.23	-1.030	0.305
Gender				
Male	23 (46.94)	21 (42.86)	0.165	0.685
Female	26 (53.06)	28 (57.14)		
Course of disease (d)	6.48±1.56	6.77±1.49	-0.941	0.349
BMI (kg/m^2)	24.71±2.68	23.85±2.56	1.624	0.108
Basic diseases				
Diabetes	17 (34.69)	24 (48.98)	2.055	0.152
Hypertension	16 (32.65)	15 (30.61)	0.047	0.828
Coronary heart disease	13 (26.53)	18 (36.73)	1.180	0.277
Hyperlipidemia	19 (38.78)	22 (44.90)	0.377	0.539

is a retrospective study. The general data of the two groups are shown in **Table 1**.

Basic treatment after hospitalization

Electrocardiograph (ECG) and pulse oxygen monitoring were performed to maintain continuous low flow oxygen inhalation. Mechanical ventilation was used for patients with blood oxygen saturation <90%. In the early stage of treatment, broad-spectrum antibiotics were given to fight infection, and sensitive antibiotics were used according to drug sensitivity results. Attention was also paid to correcting water-electrolyte disorders and acid-base imbalance of patients.

Routine nursing program

The nurses paid attention to the monitoring of the patient's vital signs, and well-maintained various pipelines in the patient's body on a daily basis (including dressing change, flushing, sealing, fixation, etc.). In addition, health education was conducted to guide family members to help patients move their limbs, and keep wards clean to provide patients with a comfortable medical environment.

PDCA circulation management nursing plan

Plan: The PDCA team sorted out and summarized the hidden dangers and problems of nursing in the treatment of patients with severe pneumonia, and proposed the following key nursing points affecting the prognosis of patients with severe pneumonia: 1. Insufficient nursing education was easy to aggravate patients' negative emotions and affect their treatment compliance; 2. Inadequate airway management during mechanical ventilation could easily lead to related complications; 3. Lack of theoretical knowledge on the timing, mode and composition of nutritional supplement for patients would affect patients' nutritional status and immune function; 4. Improper catheter care may lead to catheter-related infection; 5. There were deficiencies in ward management and aseptic operation, which was easy to produce iatrogenic infection. The PDCA team discussed the factors affecting the prognosis of patients in the above nursing aspects and formed plans and schemes to improve the nursing quality and prognosis of patients with severe pneumonia (**Figure 1**).

Do: Strengthening of health education and psychological nursing. In the nursing process, nurses not only learned the basic information of patients, but also strengthened the publicity and education of severe pneumonia. Multimedia and brochures were used to let patients understand the etiology, treatment and prognosis of severe pneumonia, so as to improve their acceptance and cooperation with treatment. At the same time, the nurses paid attention to the emotional management of patients, communicated with patients and their families in time, and conducted effective psychological counseling, so as to effectively alleviate the negative emotions of patients and ensure their good attitude in the treatment process.

Strengthening of the study of airway nursing theory and related operation. In terms of the selection of airway humidifying solution, normal saline, sterilized water, and 1.25% sodium bicarbonate have their own advantages in sputum dilution and airway humidification [14, 15]. Some researchers also advocate the combined use of humidifying solution [16]. Integrating relevant data and accumulated previous experience, we used 0.45% normal saline as humidifying solution, combined with 1.25% sodium bicarbonate solution for airway flushing [17], so

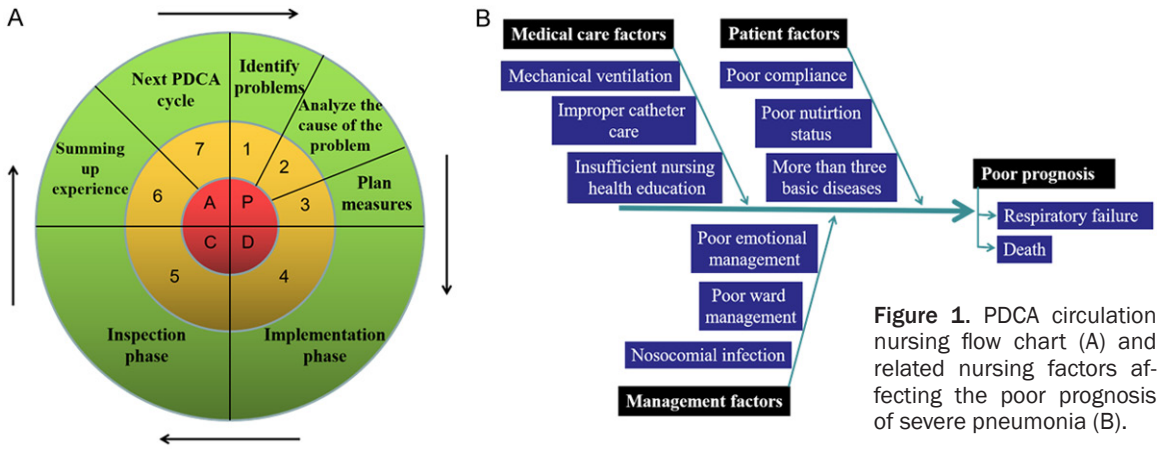

Figure 1. PDCA circulation nursing flow chart (A) and related nursing factors affecting the poor prognosis of severe pneumonia (B).

as to better discharge sputum. As for airbag management, cannula with subglottic suction function was selected to avoid the accumulation of sputum and secretions at the junction of airbag and mucosa, thus lowering the risk of bacteria breeding and ventilator associated pneumonia (VAP) [18]. Maintaining the air bag pressure at 25-30 cmH_2O helps to prevent airway mucosal damage [19]. Relevant studies have found that nurses' subjective perception of airbag pressure by their hands is prone to produce large errors, resulting in the actual pressure higher than the standard airbag pressure [20]. Therefore, an airbag manometer was used as recommended.

Control of nutritional intake. The nutritional status of patients was assessed using Nutritional Risk Screening 2002 (NRS2002). Nasojejunal enteral nutrition (EN) was used for patients undergoing invasive ventilation, so as to protect the gastrointestinal function of patients [21]. Parenteral nutrition (PN) was used in combination if nutritional intake was insufficient. Although intermittent EN is more consistent with the physiological characteristics of patients, it is easy to cause gastrointestinal symptoms such as abdominal distention and nausea [22]. Therefore, continuous EN should be considered as it can better improve the nutritional status and tolerance of patients when a choice has to be made between continuous and intermittent EN. In terms of energy supplement, high calorie energy supplement should be avoided at the early stage. Relevant study suggested that critically ill patients had the lowest mortality rates when they received 40%-60% of the standard calories at the early stage (7-12 d) [23, 24]. Meanwhile, with the increase of high-quality protein from 0.79 g/kg/d to 1.46 g/kg/d, the mortality of severe patients showed a decreasing trend [25, 26]. Therefore, in the study, 60% of the standard calories were supplemented, and the content of high-quality protein was 1.5 g/kg/d.

Prevention of catheter-related infection. For patients with central venous catheterization, the nurses made adequate efforts to prevent infection, sterilized the skin before catheterization, and reduced the catheterization time as much as possible. Evidence-based data suggested that the femoral vein catheterization should not exceed 7 days, while the internal jugular vein and subclavian vein catheterization should not exceed 3 weeks [27]. In addition, the nurses regularly changed the dressing and disinfected the catheter joint. Evidence suggests that gauze dressings should be replaced within 2 days and transparent dressings within 5-7 days [28].

Ward safety control. According to the layout of the ward, the pollution area and cleaning area were reasonably divided, and the access of personnel was strictly controlled to avoid cross infection. Attention was also paid to keep the medical environment ventilated, the ambient temperature at 25°C and the humidity at 55-65%, so as to provide a comfortable environment for patients. In addition, the nurses disinfected object surfaces with 0.5% chlorine disinfectant twice a day.

Check and act: The PDCA team checked the implementation of the plan weekly and recorded the problems in time. The members of the nursing research team regularly organized discussions, proposed solutions, and practiced

them in time, so as to promote the nursing quality in the next circulation.

Evaluation of nutritional status and immune function

Good nutritional and immune function can help patients resist the invasion of pathogens, what is conducive to the early recovery of patients. The nutritional level was detected by measuring the patient's weight, total protein (TP) and albumin (ALB) before and 2 weeks after care. Venous blood (5 mL) was extracted on an empty stomach in the morning before and 2 weeks after care and centrifuged at 3000 rpm for 6 min. The resultant supernatant was collected to detect the levels of TP and ALB using an automatic biochemical analyzer (BS-250, Mindray, Shenzhen, China). The immune function of patients was determined by the levels of immunoglobulin A (IgA) and immunoglobulin G (IgG). Venous blood (5 mL) was drawn from each patient before and after 2 weeks of care to determine the levels of IgA and IgG by the immunoturbidimetric method.

Blood gas analysis and inflammatory factor detection

The key to the treatment of patients with severe pulmonary inflammation is to clear the sputum blocking the airway and restore normal ventilation as soon as possible. Blood gas analysis can effectively reflect the recovery of lung function, and inflammatory factors can effectively evaluate the degree of inflammatory reaction *in vivo*. The levels of PaO_2 and $PaCO_2$ in arterial blood were detected by blood gas analyzer (RAPIDPoint 500, Siemens, Germany), and the oxygenation index (OI) was calculated. Before and 1 week after care, 5 mL venous blood was extracted on an empty stomach in the morning and centrifuged at 3000 rpm for 6 min. The supernatant was obtained to detect the levels of interleukin-6 (IL-6) and C-reactive protein (CRP) by ELISA, as well as the level of procalcitonin (PCT) by transmission immunoturbidimetry. All the kits were purchased from Nanjing Jiancheng Bioengineering Institute.

Primary outcome measures

Clinical treatment and prognosis: The overall survival rate of the patients is the primary outcome measure. The clinical treatment of patients was evaluated in terms of mechanical ventilation cases, invasive ventilation time, noninvasive ventilation time, total oxygen therapy time, and length of stay. The prognosis of patients was followed up after 28 days of treatment, and the endpoint was all-cause death.

Secondary outcome measures

Satisfaction and ward management quality evaluation: Self-designed satisfaction scale and ward nursing management scale were used to evaluate nursing satisfaction and ward management quality. Patients' satisfaction was evaluated in terms of service attitude, health education, psychological intervention, medical environment, and professional ability. Each content was tested by the 4-level scoring method (1-4 points). The quality of nursing management was evaluated from the aspects of ward management, handover management, first aid nursing, nursing registration statistics, and crisis management. It was jointly evaluated by the head of the nursing department, patients and their families. The maximum score of each item was 10 points.

Negative emotion and sleep quality detection: The Self-rating Anxiety Scale (SAS), Self-rating Depression Scale (SDS) and Pittsburgh Sleep Quality Index (PSQI) were used to evaluate the anxiety, depression and sleep quality of patients, respectively.

Statistical methods

SPSS 21.0 statistical software was used to process the data and Graphpad Prism 8.0 to draw the graph. Continuous variables were expressed by mean ± SD; the comparison between two groups was performed by independent sample t-test for normally distributed continuous variables; while for those did not conform to normal distribution, the non-parametric Wilcoxon-Mann-Whitney test was used. Categorical variables, described as n (%), were analyzed using the Chi-square test. Multiple groups were compared using one-way ANOVA analysis followed by Bonferroni's post-hoc testing. For all the statistical tests, P values <0.05 were considered statistically significant.

Results and discussion

Changes in nutritional status of patients

Severe pneumonia will increase the nutritional consumption of patients, so good nutritional

Table 2. Nutritional status of patients ($\bar{x} \pm s$)

Group	Case	Weight (kg)		TP (g/L)		ALB (g/L)	
		Before care	2 weeks after care	Before care	2 weeks after care	Before care	2 weeks after care
Control group	49	53.82±2.23	51.12±1.63*	68.06±4.26	65.01±3.19*	43.36±3.68	39.62±3.43*
PDCA group	49	54.26±2.39	52.28±2.31*	67.72±4.30	66.45±3.28*	42.48±3.32	41.56±3.53*
t		-0.942	-2.872	0.393	-2.203	1.243	-2.759
P		0.348	0.005	0.695	0.030	0.217	0.007

Note: Compared with before care, *P<0.05.

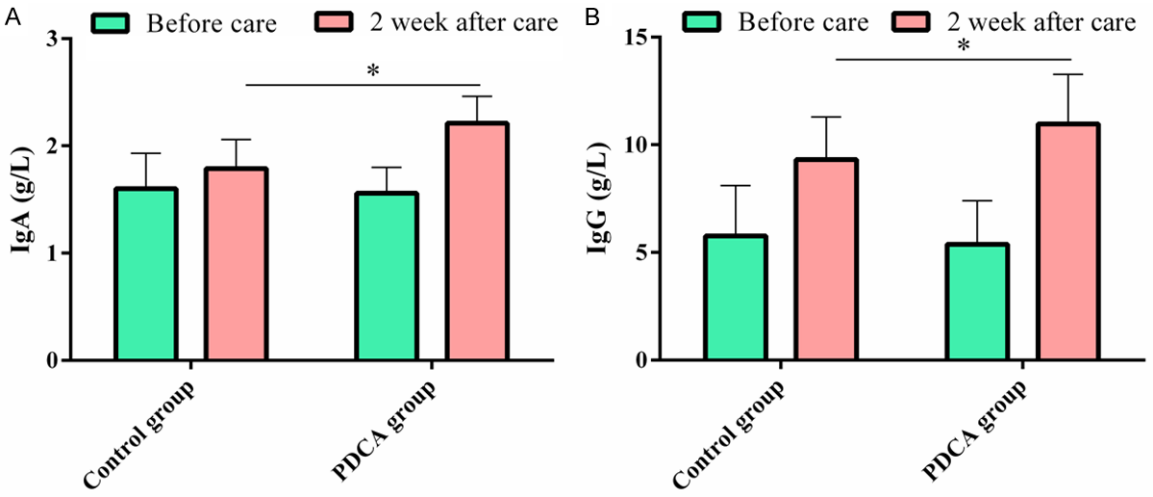

Figure 2. Immune factors detection in both groups. A: Changes of IgA in blood; B: Changes of IgG in blood. *P<0.05.

status is significantly helpful for disease recovery. After two weeks of treatment, the body weight, TP and ALB in both groups decreased to varying degrees compared with those before treatment, especially in the control group (**Table 2**). The above results suggested that severe pneumonia consumed a large amount of patients' own nutritional reserves, but after PDCA nursing, patients' nutritional intake was better managed, avoiding the impact of malnutrition on disease recovery.

Immune function detection of patients

The establishment and recovery of human immune function is of great significance to improve the body's repair ability and immune level of severe patients. As shown in **Figure 2**, before nursing, there were no significant differences in the levels of IgA and IgG between the two groups. After two weeks of nursing, the immune function significantly improved in both groups, especially in the PDCA group, suggesting that PDCA nursing could better help to restore the immune function of severe patients.

Arterial blood gas changes detection

Blood gas analysis of patients with severe pneumonia is helpful to objectively evaluate the recovery of lung function. The study found that before nursing, there was no significant difference between the two groups in PaO_2, $PaCO_2$ and FiO_2. One week after nursing, the blood gas results of severe patients in the two groups were significantly improved, in which PaO_2 and FiO_2 increased significantly, and $PaCO_2$ decreased obviously, especially in the PDCA group (**Table 3**). The above results suggested that after PDCA care, the pulmonary function of patients was more significantly improved.

Inflammatory response detection

A detailed detection of a patient's inflammatory response can help medical staff predict the improvement of the disease. As shown in **Table 4**, there were no significant differences in the levels of IL-6, CRP and PCT between the two groups before nursing. After one week of nurs-

Table 3. Comparison of Blood gas analysis results ($\bar{x} \pm s$)

Group	Case	PaO_2 (mmHg)		$PaCO_2$ (mmHg)		FiO_2 (mmHg)	
		Before care	1 week after care	Before care	1 week after care	Before care	1 week after care
Control group	49	49.12±8.26	84.93±4.13*	70.52±6.33	37.48±4.12*	133.12±28.05	270.25±24.08*
PDCA group	49	50.13±7.34	90.49±5.70*	71.81±6.16	34.16±4.18*	124.11±27.06	303.31±25.13*
t		-0.640	-5.529	-1.022	3.960	1.618	-6.649
P		0.524	<0.001	0.309	<0.001	0.109	<0.001

Note: Compared with before care, *P<0.05.

Table 4. Comparison of inflammatory response ($\bar{x} \pm s$)

Group	Case	IL-6 (ng/L)		CRP (mg/L)		PCT (μg/L)	
		Before care	1 week after care	Before care	1 week after care	Before care	1 week after care
Control group	49	204.22±14.23	21.12±2.31*	107.06±21.26	16.82±3.21*	16.22±3.08	6.82±1.12*
PDCA group	49	200.26±12.39	17.28±1.28*	112.72±24.30	10.45±2.89*	17.11±3.88	4.22±0.98*
t		1.469	10.178	-1.227	10.323	-1.258	12.229
P		0.145	<0.001	0.223	<0.001	0.212	<0.001

Note: Compared with before care, *P<0.05.

Table 5. Comparison of patient treatment [n (%), $\bar{x} \pm s$]

Group	Case	Mechanical ventilation cases	Invasive ventilation time (d)	Noninvasive ventilation time (d)	Total oxygen therapy time (d)
Control group	49	41 (83.67)	10.41±2.72	6.41±1.72	19.36±4.58
PDCA group	49	32 (65.31)	8.53±2.25	5.43±1.75	16.84±4.41
t/χ^2		4.350	3.728	2.796	2.774
P		0.037	<0.001	0.006	0.007

ing, the inflammatory response of the two groups was significantly reduced, and the above inflammatory indicators decreased more significantly in the PDCA group, suggesting that PDCA nursing could better inhibit the inflammatory response in patients and promote their recovery.

General treatment of patients

This study evaluated the treatment of patients during hospitalization in terms of mechanical ventilation cases, invasive ventilation time, noninvasive ventilation time, total oxygen therapy time, and length of stay. As shown in **Table 5**, during hospitalization, the number of patients in the PDCA group with invasive mechanical ventilation was significantly less than that in the control group (65.31% vs 83.67%). In addition, the time in terms of invasive ventilation, noninvasive ventilation, and total oxygen therapy in the PDCA group was significantly lower.

Discharge rate and overall survival of patients at 28 days

As shown in **Figure 3**, the discharge rate and survival rate of the PDCA group were significantly higher than those of the control group after 28 days of treatment, indicating that PDCA nursing could better promote the rehabilitation of patients with severe pneumonia and reduce mortality.

Evaluation of patient satisfaction and nursing management quality

Patient satisfaction is the best evaluation for nursing quality. At the same time, quantitative evaluation of nursing management quality can better evaluate nursing quality. The study found that the scores of nursing satisfaction in terms of service attitude, health education, psychological intervention, medical environment, and professional ability were significantly higher in

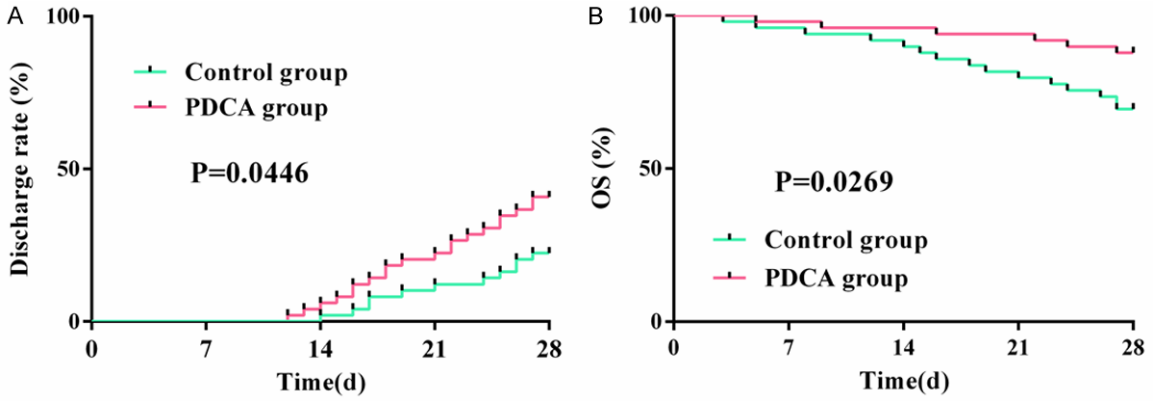

Figure 3. The discharge rate (A) and overall survival rate (B) of the control group and the PDCA group after 28 days of treatment.

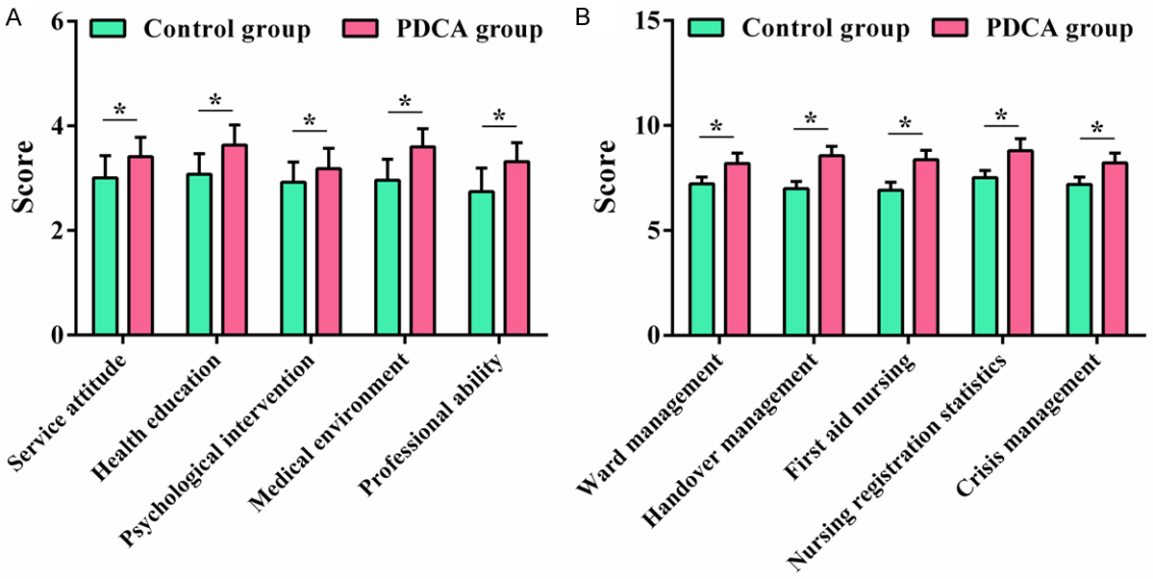

Figure 4. Patient satisfaction and nursing management quality evaluation. A: The comparison of satisfaction degree in terms of service attitude, health education, psychological intervention, medical environment, and professional ability; B: The comparison of nursing management quality in terms of ward management, handover management, first aid nursing, nursing registration statistics, and crisis management. *P<0.05.

the PDCA group (**Figure 4A**). In addition, the scores of nursing management quality assessed from the aspects of ward management, handover management, first aid nursing, nursing registration statistics, and crisis management were also higher in the PDCA group (**Figure 4B**). The above results suggested that PDCA nursing could effectively improve nursing quality and patient satisfaction.

Changes in patients' negative emotions

The mood and sleep quality of patients during treatment are of great significance to their treatment compliance. The study found that after nursing, the anxiety (**Figure 5A**), depression (**Figure 5B**), and sleep quality (**Figure 5C**) of patients in both groups were greatly improved, especially in the PDCA group, suggesting that PDCA nursing had more advantages in alleviating adverse emotions and improving sleep quality.

Discussion

The importance of nursing in clinical treatment is becoming more and more prominent. With the progress and development of medical tech-

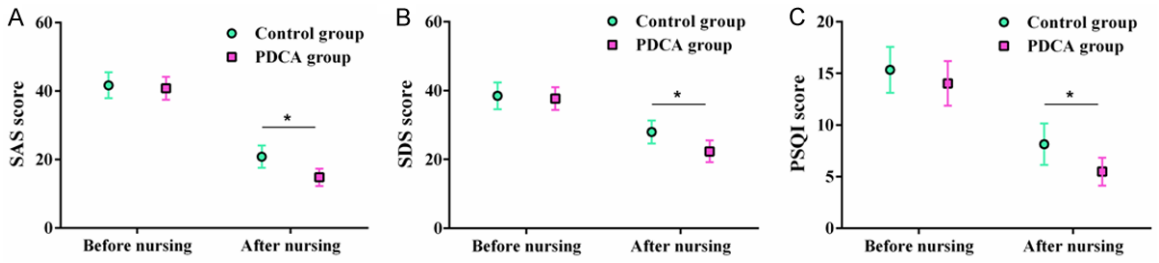

Figure 5. The comparison of anxiety (SAS) (A), depression (SDS) (B) and sleep quality (PSQI) (C) scores. *P<0.05.

nology, clinical nursing in the treatment of severe pneumonia has become increasingly sophisticated. In addition, patients' requirements for nursing quality are also getting highly expected. However, the shortage of critical care staff/nurses and the long cultivation cycle of nursing staff have become the main bottleneck restricting the improvement of nursing quality for critical diseases [29]. And the most effective method to solve this problem is to summarize effective nursing experience and formulate it into a norm, so as to effectively improve the theoretical and operational level of nurses. Therefore, how to choose the most effective nursing in various complex nursing models is a problem to be solved in clinical nursing. The new nursing mode, which is formed by combining PDCA management system with clinical nursing, can help nurses standardize the nursing experience and continuously discover and solve the hidden dangers through continuous reciprocating circulation, so as to ensure that patients receive practical and effective nursing in the clinical medical process under safe medical behavior [30]. Therefore, applying PDCA circulation method to the nursing of patients with severe pneumonia is of great significance to provide patients with high-quality nursing services and improve the clinical efficacy.

During the progression of severe diseases, the body is in a hypercatabolic state due to inflammatory stress reaction and metabolic disorders [31]. A large number of proteins and skeletal muscles in the body are decomposed to supplement the lack of sugar and energy [32]. Therefore, in the process of treatment, improving patients' nutritional status and immunity are of great significance to better resist pathogens [33]. The results showed that although the nutritional status of patients in both groups decreased during treatment, PDCA nursing better reduced the nutritional decline and improved the anti-pathogen immunity of patients. The reason may be the early supplementation of high-quality protein in the PDCA group, which effectively inhibited autophagy metabolism and corrected the negative nitrogen balance *in vivo*. At the same time, EN could effectively restore and maintain intestinal function. As the largest immune system, the intestine plays an important role in immune barrier function *in vivo*, and the maintenance of its function could further improve patients' immune function [34, 35]. Therefore, the nutritional status and immune function of patients in the PDCA group were improved.

The pathogenic microorganisms infected in patients with severe pneumonia will invade and destroy the structure and function of lung epithelial cells, resulting in hypoxemia and even respiratory failure [36]. Furthermore, the release of massive inflammatory factors will further destroy the internal organs. Therefore, blood gas results and inflammatory factors can be used as effective indicators to evaluate the curative effect of severe pneumonia. The study found that PDCA nursing could better improve the patient's blood oxygen level and OI and reduce the level of inflammatory factors in the blood, suggesting that PDCA nursing could better improve the patient's ventilation level and inhibit inflammation. This may be due to the use of individualized assisted ventilation in PDCA nursing and fine airway nursing during mechanical ventilation, such as airway humidification management and airbag pressure control, which effectively maintained the functionality of the catheter, and inhibited the occurrence of VAP, thus better restoring patients' ventilation function. In addition, a better job was done in catheter care of patients in the PDCA group, which effectively avoided the occurrence catheter-related infections. Furthermore, benefiting from better nutritional sta-

tus and immunity, the levels of inflammatory factors were further reduced in the PDCA group. Therefore, the time of invasive ventilation, noninvasive ventilation, oxygen therapy, and hospitalization was significantly shorter in the PDCA group, and the mortality was lower.

Patient satisfaction is the highest reward for nurses, and the quantitative evaluation of nursing management quality can further evaluate the nursing level. After the quantitative evaluation of satisfaction and nursing management quality, it was found that PDCA nursing could better improve patient satisfaction and nursing quality. In addition, following the concept of patient-centered, the nurses took some measures such as health education and psychological intervention while fully considering the psychological feelings of patients, which could effectively inhibit patients' poor psychological emotions and better ensure their good mental state and sleep, so as to further improve patients' satisfaction.

This study still has some limitations. First, the major problems in retrospective cohort studies were that two groups of patients cannot be randomly selected, thus selection bias occurs when the selection of individuals, groups, or data for analysis is not random. Second, the sample size may also be too small to detect differences between the two groups. Third, the relationship between different nurses and patients is a wild card. Thus, a well-designed randomized controlled trial with prospective data collection and sample size calculation is needed to confirm the findings of this study and to explore a new nursing approach that combines PDCA circulation management with nursing for improving the prognosis and clinical outcomes of patients with severe pneumonia.

Conclusion

In this study, PDCA circulation management was applied to the clinical nursing of patients with severe pneumonia, and its effect on the prognosis of patients was discussed. The study found that PDCA circulation nursing can effectively summarize nursing experience and improve nursing work through continuous circulation management, and apply successful experience to the daily care of patients, so as to more effectively enhance their nutritional status and immune function in the treatment process, better improve ventilation function and inhibit the degree of inflammation. Therefore, the PDCA group had fewer cases of invasive mechanical ventilation, shorter time of invasive ventilation, noninvasive ventilation and total oxygen therapy, shorter hospitalization, and better prognosis, compared with conventional nursing. On the other hand, PDCA circulation nursing can effectively improve the quality of nursing management and help patients maintain a positive mental state, which is helpful to establish a harmonious doctor-patient relationship.

Disclosure of conflict of interest

None.

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