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Original Article

The effects of specialized emergency and intensive nursing team on arterial blood gas and pulmonary function in pulmonary infection with respiratory failure

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Abstract: Objective: To investigate effects of specialized emergency and intensive nursing team on arterial blood gas and pulmonary function in pulmonary infected patients with respiratory failure. Methods: 126 patients with pulmonary infection and respiratory failure admitted to our hospital were chosen and randomly divided into observation group and control group, with 63 cases in each group. The control-group received specialized routine nursing care, and the observation-group was treated with the emergency and intensive nursing care. Subsequently, the arterial blood gas, pulmonary function, inflammatory biomarkers, complication rate, recovery course and nursing satisfaction between the two groups were compared accordingly. Results: After nursing care, the arterial blood gas and pulmonary function indexes of the two groups were remarkably improved than before, and the improvement in observation-group was superior to that in control-group (*P<0.05*); The inflammatory indicators of hs-CRP and PCT in two groups decreased substantially than before, and observation-group had remarkably lower indicators than that of the control-group (*P<0.05*); The incidence of complications in observation-group was 4.76%, significantly lower than 19.05% in control-group (*P<0.05*); The objects in observation-group spent exactly shorter time on ventilator than whom in control-group, and the difference was statistically significant (*P<0.05*); The observation-group had critically shorter length of hospital stay than those in control-group (*P<0.05*). The satisfaction of the observation-group with nursing care was 93.65%, which was dramatically higher than 73.02% in control-group (*P<0.05*). Conclusions: For pulmonary infection and respiratory failure, the nursing intervention carried by the specialized emergency and intensive nursing team can remarkably improve the arterial blood gas and pulmonary function, reduce the patients' inflammatory indicators and incidence of complications. The application of the nursing team can reduce the time on ventilator and length of hospital stay, and improve patients' satisfaction with nursing care.

Keywords: Specialized emergency and intensive nursing team, pulmonary infection, respiratory failure, arterial blood gas, pulmonary function

Introduction

The pulmonary infection is an inflammatory reaction of alveoli, pulmonary interstitium and terminal airways caused by a variety of pathogens, and can be divided into medical related-pneumonia, hospital acquired-pneumonia, community acquired-pneumonia, bronchiectasis accompanied by infection and pulmonary abscess, etc. [1, 2]. Pulmonary infection is usually caused by pathogenic bacteria, including bacteria, legionella, chlamydia, mycoplasma, viruses, fungi, parasites and toxoplasma, among which bacterial pneumonia is the most common pulmonary infectious disease in clinical practice. This disease is a serious threat to human's health, especially to the elderly and children with weak immunity [3, 4]. In early stage, the clinical symptoms of pulmonary infection include fever, cough and sputum, etc. As the disease progresses, it will trigger chest tightness, wheezing and dyspnea, and eventually lead to respiratory failure that seriously threatens patients' lives [5, 6]. The primary principle in treating pulmonary infection with respiratory failure is to keep the patient's respi-

ratory tract open and correct their hypoxemia in time [7]. Ventilator-improved-respiration is an important measure in treatment, and it can effectively improve the hypoxic state of the body [8]. However, most patients have various degrees of psychological barriers when they withdraw from the ventilator, which reduces the clinical curative effect. Studies have revealed that strengthening the nursing intervention during the treatment is conduive to improving the effect, and is of great significance to promote the rehabilitation of patients [9, 10]. This study proposed for the first time to apply the nursing mode of critical care professional nursing group to patients with pulmonary infection and respiratory failure, which provides a nursing basis for improving the clinical prognosis. In light of this, this study applied the nursing mode of specialized emergency and intensive nursing team to the patients, and achieved satisfactory clinical effects.

Cases and methods

General information

During June 2019 to December 2020, a total of 126 patients that admitted with pulmonary infection and respiratory failure were selected as the research objects. The patients were equally divided into observation-group and control-group (n=63, respectively) according to random number table. The observation-group included 36 males and 27 females, with an average age of (66.78±4.67) years old; and the control-group included 38 males and 25 females, with the average age of (65.14±5.25). The difference of comparison in general data, e.g., gender ratio or average age between the two groups, was not statistically significant ($P>0.05$), and the groups were comparable. The study was carried out after acquiring the approval of the Ethics Committee of hospital.

Inclusion and exclusion criteria

Inclusion criteria: (1) The patients were diagnosed with pulmonary infection and respiratory failure by related examinations. (2) Patients that conscious on admission and eligible for cooperation; (3) The patients and their families were aware and signed the informed consent forms.

Exclusion criteria: (1) Patients with malignant tumor; (2) Patients with insufficiency of vital organs, such as heart, liver, kidney or lung; (3) Patients with immunodeficiency; (4) Patients with hematological diseases; or (5) Patients experienced with mental illness or difficulty in communication.

Methods

The control-group received specialized routine nursing care. After the patients admitted to hospital, the nursing staff carried out routine oral education, and promptly enlightened the patients' negative psychological emotions; The patients were instructed to arrange diet and medication correctly; The ward remained clean and tidy, and the temperature and humidity were adjusted to a comfortable state; The wards and bed units were disinfected regularly; Paid attention to hand hygiene during process of nursing; The patient's disease progression was closely monitored and the airway was kept clear.

The observation-group received the nursing care by specialized emergency and intensive nursing team, and the specific measures are as follows: (1) Establishment of the specialized emergency and intensive nursing team. The head nurse worked as the team-leader, and 8 nurses with 3-5 years of ICU work experience, strong sense of responsibility, rich professional knowledge, nursing and operational ability and good communication capacity were chosen as team members. The head nurse was responsible for the group training. The disease features, clinical symptoms, pathophysiological changes, risk factors for complications, comprehensive oral care methods, scientific and effective respiratory care management, and advanced expectoration technique, etc. were focused in the training. The team members were trained for 1 month and passed the test before conducting the nursing work. (2) Establishment of nursing policies and review standards. The nursing department and infection department jointly formulated the nursing policies and review standards, which including infection control standards, implementation and quality supervision of ventilator ventilation, and standardized nursing procedures, etc. The team-leader monitored the ward environment, the removal quality of patients' respiratory secretions, the mechanical ventilation quality of the ventilator, and the nursing quality of the ventilator pipes, etc. The team regularly conducted

seminars on quality management of mechanical ventilation every month. The group members provided feedbacks on potential problems raised during the work, and jointly discussed and formulated improvement measures. (3) Implementation of nursing measures. The team members strictly followed the ward rounds, conducted daily observation and evaluation of patients' disease progression, adjusted and improved the nursing schedule in line with their 'actual situation. The team members carried out health education for patients and promptly informed of their disease improvement to help them improve the poor psychological states. By encouraging and listing the cases recovery from the same disease, the nursing member eased the patients' negative emotions, and improved their rehabilitating confidence; Properly fixed the catheter, and paid close attention to the skin color of patients. If there was any skin irritation, treated in time and promptly sucked the sputum; Regularly cleaned the patient's mouth with chlorhexidine solution, and instructed the family members to wash the patient's skin with warm water and wear comfortable and loose clothes every day; Assisted the patients to change position every 2 h, and massaged their limbs and vulnerable body parts; Instructed the patients to consume high-protein and easily digestible food, and carried out enteral nutrition support when necessary; Encourage the patients to get out as early as possible, and increased their daily activity gradually in the premise of no fatigue was brought.

Observation of indexes

(1) Arterial blood gas indexes. The arterial blood gas indexes of arterial partial pressure of oxygen (PaO_2), partial pressure of carbon dioxide ($PaCO_2$), and oxygen saturation (SaO_2) between the two groups in pre- and post-nursing were detected by blood gas analyzer.

(2) Pulmonary function indexes. The pulmonary functions of forced vital capacity (FVC) and forced expiratory volume in one second (FEV) were measured by pulmonary function meter in pre- and post-nursing care.

(3) Inflammatory biomarkers. The changes of inflammatory indexes such as hypersensitive C-reactive protein (hs-CRP) and procalcitonin (PCT) between the two groups were compared in pre- and post-nursing care.

(4) Complications. The complications between the two groups during treatment were recorded and compared accordingly.

(5) Progress of recovery. The ventilator supporting time, length of hospital stays and other recovery progressions between the two groups were compared.

(6) Satisfaction degree with nursing. The Newcastle Nursing Service Satisfaction Scale (NSNS) [11] was applied to inquiry the patient's satisfaction with nursing care during hospital stays. The scale consisted of 19 items, and focused on nurses' service attitudes and attention to patients, nursing quality, and the professional competence of nurses, etc. In this study, we modified the scale by adding the overall satisfaction of patients to nursing service in accordance with the actual situation of our hospital and the research purposes. The scoring was conducted by Likert 3-level method (unsatisfied, primarily satisfied and satisfied), and the total satisfaction = (satisfied + primarily satisfied)/total number of cases ×100.

Statistical analysis

The statistical processing and analysis were carried out by statistical software SPSS19.0. The measurement data were expressed as ($\overline{x}$ ±s), the comparison between groups was by t-test of independent samples, the enumeration data were expressed as percentage, and the results were adopted by X^2 test. A difference of $P<0.05$ indicated statistical significance.

Results

Comparison of blood gas indexes

After nursing care, the arterial blood gas of the two groups were remarkably improved than before receiving nursing cares, and the improvement in observation-group was superior to that in control-group ($P<0.05$), as shown in **Table 1**.

Comparison of pulmonary function indexes

Compared with before taking care, the pulmonary function indexes of the two groups were

Table 1. Comparison of blood gas indexes before and after nursing in the two groups ($\bar{x}\pm s$)

Group	PaO_2 (mmHg)		$PaCO_2$ (mmHg)		SaO_2	
	Before nursing care	After nursing care	Before nursing care	After nursing care	Before nursing care	After nursing care
Control-group (n=63)	53.24±3.16	79.62±5.25*	57.22±2.68	49.93±3.14*	83.18±4.61	91.72±4.38*
Observation-group (n=63)	54.13±3.88	91.53±4.54*	56.83±2.57	37.48±2.65*	82.85±4.35	98.51±3.62*
t	1.4117	13.6199	0.8337	24.0506	0.4132	9.4845
P	0.1605	<0.0001	0.4061	<0.0001	0.6801	<0.0001

Note: Compared with before treatment, *$P<0.05$.

Table 2. Comparison of pulmonary function indexes in two groups before and after nursing ($\bar{x}\pm s$, L)

Group	FVC		FEV	
	Before nursing care	After nursing care	Before nursing care	After nursing care
Control-group (n=63)	1.29±0.24	2.37±0.35*	1.14±0.12	2.21±0.23*
Observation-group (n=63)	1.31±0.26	2.61±0.43*	1.13±0.17	2.38±0.36*
t	0.4486	3.4358	0.3814	3.1586
P	0.6545	0.0008	0.7035	0.0020

Note: Compared with before treatment, *$P<0.05$.

Table 3. Comparison of changes in inflammatory indicators in two groups of patients before and after nursing ($\bar{x}\pm s$)

Group	hs-CRP (mg/L)		PCT (ng/L)	
	Before nursing care	After nursing care	Before nursing care	After nursing care
Control-group (n=63)	44.64±4.12	32.38±3.15*	1.94±0.26	1.21±0.13*
Observation-group (n=63)	45.92±4.27	22.45±4.29*	1.96±0.19	0.68±0.19*
t	1.7122	14.8089	0.4930	18.2729
P	0.0894	<0.0001	0.6229	<0.0001

Note: Compared with before treatment, *$P<0.05$.

Table 4. Comparison of complications between the two groups [cases, (%)]

Group	Pressure sores	Glottidial edema	Deep Venous Thrombosis	Total incidence rate
Control-group (n=63)	2 (3.17)	5 (7.94)	5 (7.94)	12 (19.05)
Observation-group (n=63)	0 (0)	2 (3.17)	1 (1.59)	3 (4.76)
X^2	-	-	-	6.1297
P	-	-	-	0.0133

obviously improved, and the improvement in observation-group was higher than in control-group ($P<0.05$) (**Table 2**).

Comparison of inflammatory indicators

The inflammatory indicators of hs-CRP and PCT in two groups decreased substantially than before nursing; the observation-group had remarkably lower indicators than control-group ($P<0.05$) (**Table 3**).

Comparison of complications

The incidence of complications in observation-group was 4.76%, significantly lower than 19.05% in control-group, and the difference was statistically significant (X^2=6.1297, P=0.0133) (**Table 4**).

Comparison of the course of recovery

The objects in observation-group spent exactly shorter time on ventilator than whom in

Table 5. Comparison of the course of recovery between the two groups ($\bar{x}$±s, d)

Group	Ventilator supporting time	Length of hospital stays
Control-group (n=63)	8.37±2.12	18.27±2.84
Observation-group (n=63)	6.54±1.23	14.35±1.26
t	5.9263	10.0143
P	<0.0001	<0.0001

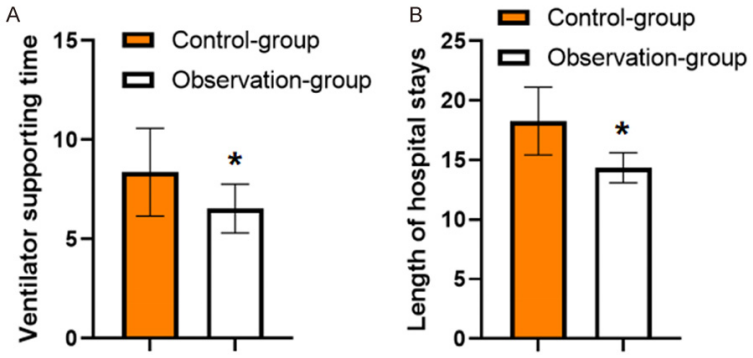

Figure 1. Comparison of the course of recovery between the two groups. Note: Compare with control-group, *P<0.05. A: Ventilator supporting time; B: Length of hospital stays.

control-group, and the difference was statistically significant [(6.54±1.23) d, (8.37±2.12) d, *t*=5.9263, *P*=0.0000]; The observation-group had critically shorter length of hospital stay than those in control-group, and the difference was statistically significant [(14.35±1.26) d, (18.27±2.84) d, *t*=10.0143, *P*=0.0000] (**Table 5** and **Figure 1**).

Comparison of nursing satisfaction

The satisfaction of the observation-group with nursing care was 93.65%, which was dramatically higher than 73.02% in control-group, and the difference was statistically significant (X^2=9.6571, *P*=0.0019) (**Table 6**).

Discussion

Pulmonary infection with respiratory failure is a common respiratory disease in clinical practice, and its incidence has been increasing for years with the acceleration of aging process in China. Due to respiratory dysfunction, patients can easily lead to decreased pulmonary function and disorder of blood gas indicators, and then leads to carbon dioxide retention or hypoxemia in the body. Hypoxic injury of trachea may occur in severe cases, which increases the disability and mortality rates of the patients, and seriously affects and threatens the quality of life and health of patients [12, 13]. In addition, due to the influence of body infection or poor nutrition absorption, patients will encounter increased inflammation and reduced immunity, seriously affecting the treatment efficiency and prognosis [14]. With the improvement of living standards in recent years, patients and their families have showed increased requirements for nursing services. The conventional and traditional nursing measures, which carried out according to the common problems of patients and the clinical experiences of nurses, are difficult to achieve targeted nursing care and the requirements of patients [15, 16]. The nursing work for pulmonary infected patients with respiratory failure has been the focus of clinical medical staff. Under the guiding concept of "people-oriented and patient-centered", our hospital has set up the professional nursing group for critical patients, and developed standard special care measures. The nursing team were composed of nurses who have years of clinical nursing experience, a wealth of professional knowledge reserves, strong nursing and operational skills and professional training. During nursing process, they can quickly make responding measures according to the specific situation of patients, and meet the various nursing needs of patients [17, 18].

In this study, we applied the specialized emergency and intensive nursing team in patients with pulmonary infection and respiratory failure. It was observed that the indicators of blood gas and pulmonary functions of the two groups after nursing were critically improved comparing to pre-nursing period, and the improvement in observation-group was superior to that in control-group (*P<0.05*). This suggests that the nursing intervention of this type of nursing team can remarkably improve the blood gas and pulmonary functions in patients

Table 6. Comparison of satisfaction with nursing care between the two groups [cases, (%)]

Group	Satisfied	Primarily satisfied	Unsatisfied	Satisfaction rate
Control-group (n=63)	25 (38.10)	22 (34.92)	17 (26.98)	46 (73.02)
Observation-group (n=63)	32 (50.79)	27 (42.86)	4 (6.35)	59 (93.65)
X^2	-	-	-	9.6571
P	-	-	-	0.0019

with pulmonary infection and respiratory failure. The reason is that by using scientific and reasonable measures, the sputum in patient's lungs can be effectively cleared, thus their respiratory disorders are alleviated and their respiratory functions have been improved [19, 20]. The hs-CRP level in pulmonary infected patients was dramatically increased, and such high hs-CRP level can promote the release of PCT pro-inflammatory factors to form a cascade reaction; The mutual expression and promotion of hs-CRP and PCT further aggravate the inflammatory response of patients. According to related literature reports, hs-CRP and PCT levels are closely related to the degree of infection and body injury of patients [21, 23]. The inflammatory indicators of hs-CRP and PCT in two groups decreased substantially than before-nursing, and the observation-group had remarkably lower post-treatment indicators than control-group (*P<0.05*). It indicates that the nursing interventions carried through the specialized emergency and intensive nursing team can evidently reduce the inflammatory response of patients. This is due to the food intake guidance of nurses has improved the malnutrition status of patients, thus improving their immune function and anti-inflammatory ability; Meanwhile, the effective sputum removal measures also exert a certain positive function in alleviating patients' pulmonary inflammation [24]. The incidence of complications in observation-group was 4.76%, significantly lower than 19.05% in control-group (X^2=6.1297, *P*=0.0133); The objects in observation-group had exactly shorter ventilator time [(6.54±1.23) d, (8.37±2.12) d, *t*=5.9263, *P*=0.0000], as well as shorter length of hospital stay than the control-group [(14.35±1.26) d, (18.27±2.84) d, *t*=10.0143, *P*=0.0000]. This shows that the interventions of nursing team can obviously shorten the 'ventilator spent time and hospital stay of patients, and reduce their incidence of complications. Through psychological counseling, patient's negative psychological mood has been improved, their confidence and enthusiasm for treatment have been enhanced; In addition, the encouragement of the early exercises t to patients can prevent the complications of pressure sores, glottis edema, and deep veins of lower extremities, and shorten their courses of recovery. We have found that patients in observation-group were more satisfied with nursing care, which indicates that the formation of the specialized nursing care team is a nursing model that can better meet the nursing needs of patients. The results of this study are consisted with those reported by scholars [25, 26], that the effective nursing care of the professional nursing group can improve the clinical treatment prognosis of patients with pulmonary infection and respiratory failure. The primary reason is that the standardization of nursing personnel and nursing content by professional nursing group enable a higher nursing quality of patients, which improves the clinical prognosis.

However, the sample size included in this study is limited, and the long-term observational study on patients has not been carried out. This suggests that further improvement of nursing schedule should be made and the sample quantity should be expanded to acquire more reliable clinical data.

To summary, for patients with pulmonary infection and respiratory failure, the nursing intervention carried by the specialized emergency and intensive nursing team can remarkably improve the arterial blood gas and pulmonary function of patients, reduce their inflammatory indicators and incidence of complications. The application of nursing team can meanwhile reduce the time on ventilator and the length of hospital stay, and improve patients' satisfaction with nursing care.

Disclosure of conflict of interest

None.

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References

[1] Ho DK, Nichols BLB, Edgar KJ, Murgia X, Loretz B and Lehr CM. Challenges and strategies in drug delivery systems for treatment of pulmonary infections. Eur J Pharm Biopharm 2019; 144: 110-124.

[2] Li H and Mao XH. Effects of nursing intervention on lung infection prevention in patients with tracheotomy. Medicine (Baltimore) 2019; 98: e17063.

[3] Corleis B, Bucsan AN, Deruaz M, Vrbanac VD, Lisanti-Park AC, Gates SJ, Linder AH, Paer JM, Olson GS, Bowman BA, Schiff AE, Medoff BD, Tager AM, Luster AD, Khader SA, Kaushal D and Kwon DS. HIV-1 and SIV infection are associated with early loss of lung interstitial CD4+ T cells and dissemination of pulmonary tuberculosis. Cell Rep 2019; 26: 1409-1418, e5.

[4] Alastruey-Izquierdo A, Cadranel J, Flick H, Godet C, Hennequin C, Hoenigl M, Kosmidis C, Lange C, Munteanu O, Page I and Salzer HJF; on behalf of CPAnet. Treatment of chronic pulmonary aspergillosis: current standards and future perspectives. Respiration 2018; 96: 159-170.

[5] Kurosaki F, Yoshimoto T, Nakayama M, Bando M and Hagiwara K. Pulmonary Mycobacterium heckeshornense infection in a healthy woman. J Infect Chemother 2018; 24: 483-486.

[6] Lin WV, Kruse RL, Yang K and Musher DM. Diagnosis and management of pulmonary infection due to rhodococcus equi. Clin Microbiol Infect 2019; 25: 310-315.

[7] Ji X, Cui W, Zhang B and Shan S. Effect of lung protective ventilation on perioperative pulmonary infection in elderly patients with mild to moderate COPD under general anesthesia. J Infect Public Health 2020; 13: 281-286.

[8] Buonsenso D, Piano A, Raffaelli F, Bonadia N, de Gaetano Donati K and Franceschi F. Point-of-Care Lung Ultrasound findings in novel coronavirus disease-19 pnemoniae: a case report and potential applications during COVID-19 outbreak. Eur Rev Med Pharmacol Sci 2020; 24: 2776-2780.

[9] Porotto M, Ferren M, Chen YW, Siu Y, Makhsous N, Rima B, Briese T, Greninger AL, Snoeck HW and Moscona A. Authentic modeling of human respiratory virus infection in human pluripotent stem cell-derived lung organoids. mBio 2019; 10: e00723-19.

[10] Scheithauer L and Steinert M. Infection of human lung tissue explants (HLTEs) with legionella pneumophila. Methods Mol Biol 2019; 1921: 323-331.

[11] Singanayagam A, Glanville N, Cuthbertson L, Bartlett NW, Finney LJ, Turek E, Bakhsoliani E, Calderazzo MA, Trujillo-Torralbo MB, Footitt J, James PL, Fenwick P, Kemp SV, Clarke TB, Wedzicha JA, Edwards MR, Moffatt M, Cookson WO, Mallia P and Johnston SL. Inhaled corticosteroid suppression of cathelicidin drives dysbiosis and bacterial infection in chronic obstructive pulmonary disease. Sci Transl Med 2019; 11: eaav3879.

[12] Balczon R, Francis M, Leavesley S and Stevens T. Methods for detecting cytotoxic amyloids following infection of pulmonary endothelial cells by pseudomonas aeruginosa. J Vis Exp 2018; 137: 57447.

[13] Curran CS, Bolig T and Torabi-Parizi P. Mechanisms and targeted therapies for pseudomonas aeruginosa lung infection. Am J Respir Crit Care Med 2018; 197: 708-727.

[14] Recio R, Brañas P, Martínez MT, Chaves F and Orellana MA. Effect of respiratory Achromobacter spp. infection on pulmonary function in patients with cystic fibrosis. J Med Microbiol 2018; 67: 952-956.

[15] Vanderheiden A, Ralfs P, Chirkova T, Upadhyay AA, Zimmerman MG, Bedoya S, Aoued H, Tharp GM, Pellegrini KL, Manfredi C, Sorscher E, Mainou B, Lobby JL, Kohlmeier JE, Lowen AC, Shi PY, Menachery VD, Anderson LJ, Grakoui A, Bosinger SE and Suthar MS. Type I and type III interferons restrict SARS-CoV-2 infection of human airway epithelial cultures. J Virol 2020; 94: e00985-20.

[16] Kwon YS, Lee HW and Kim HJ. Paragonimus westermani infection manifesting as a pulmonary cavity and adrenal gland mass: a case report. J Infect Chemother 2019; 25: 200-203.

[17] Zhu B, Zhang R, Li C, Jiang L, Xiang M, Ye Z, Kita H, Melnick AM, Dent AL and Sun J. BCL6 modulates tissue neutrophil survival and exacerbates pulmonary inflammation following influenza virus infection. Proc Natl Acad Sci U S A 2019; 116: 11888-11893.

[18] Wang W, Shao Y, Li S, Xin N, Ma T, Zhao C and Song M. Caspase-11 plays a protective role in pulmonary acinetobacter baumannii infection. Infect Immun 2017; 85: e00350-17.

[19] Wan S, Yi Q, Fan S, Lv J, Zhang X, Guo L, Lang C, Xiao Q, Xiao K, Yi Z, Qiang M, Xiang J, Zhang B, Chen Y and Gao C. Relationships among lymphocyte subsets, cytokines, and the pulmonary inflammation index in coronavirus (COV-

ID-19) infected patients. Br J Haematol 2020; 189: 428-437.
[20] Alfaraj SH, Al-Tawfiq JA, Altuwaijri TA and Memish ZA. Middle East respiratory syndrome coronavirus and pulmonary tuberculosis coinfection: implications for infection control. Intervirology 2017; 60: 53-55.
[21] Invernizzi R and Molyneaux PL. The contribution of infection and the respiratory microbiome in acute exacerbations of idiopathic pulmonary fibrosis. Eur Respir Rev 2019; 28: 190045.
[22] Hewitt R, Farne H, Ritchie A, Luke E, Johnston SL and Mallia P. The role of viral infections in exacerbations of chronic obstructive pulmonary disease and asthma. Ther Adv Respir Dis 2016; 10: 158-174.
[23] Brann KR, Fullerton MS, Onyilagha FI, Prince AA, Kurten RC, Rom JS, Blevins JS, Smeltzer MS and Voth DE. Infection of primary human alveolar macrophages alters staphylococcus aureus toxin production and activity. Infect Immun 2019; 87: e00167-19.
[24] Cribbs SK, Crothers K and Morris A. Pathogenesis of HIV-related lung disease: immunity, infection, and inflammation. Physiol Rev 2020; 100: 603-632.
[25] Deng H, Zhang J, Li J, Wang D, Pan L and Xue X. Clinical features and radiological characteristics of pulmonary cryptococcosis. J Int Med Res 2018; 46: 2687-2695.
[26] Vermillion MS, Nelson A, Vom Steeg L, Loube J, Mitzner W and Klein SL. Pregnancy preserves pulmonary function following influenza virus infection in C57BL/6 mice. Am J Physiol Lung Cell Mol Physiol 2018; 315: L517-L525.