Am J Transl Res 2021;13(4):2962-2968
www.ajtr.org /ISSN:1943-8141/AJTR0121966

Original Article

Nursing postoperative lung cancer patients using continuous positive airway pressure treatment

Qiaodan Jiang[1], Weicong Zheng[2], Beilei Chen[3]

[1]Department of Pulmonary and Critical Care Medicine, The First People's Hospital of Wenling, Wenling 317500, Zhejiang Province, China; [2]Lithotripsy Center, The First People's Hospital of Wenling, Wenling 317500, Zhejiang Province, China; [3]Department of Pulmonary and Critical Care Medicine II, The First People's Hospital of Wenling, Wenling 317500, Zhejiang Province, China

Received September 8, 2020; Accepted November 6, 2020; Epub April 15, 2021; Published April 30, 2021

Abstract: Objective: This study aimed to investigate the nursing of postoperative lung cancer patients treated with continuous positive airway pressure (CPAP). Methods: A total of 64 lung cancer patients in our hospital were recruited as the study cohort and randomly divided into a CPAP group and a control group. The patients in the CPAP group (n=30) were administered CPAP, while those in the control group (n=34) were given routine low flow oxygen inhalation, a respiratory stimulant, a bronchodilator, antibiotics, antitussives, anti-inflammatories (glucocorticoids), an apophlegmatisant (ambroxol), basic nutritional support, correcting acidosis, *etc*. Results: The patients in the CPAP group showed a more significant improvement in their blood gas analysis, and they also had better airway patency and secretion cleaning effects compared with those in the control group. One month after the treatment, the patients in the CPAP group had significantly less inappetence, weight loss, electrolyte disturbance, dyspnea, and pulmonary encephalopathy than the patients in the control group. One week after the treatment, the patients in the CPAP group had higher maximum ventilatory volumes (MVV), higher maximum mid-expiratory flows (MMF), higher forced expiratory volumes in 1s/forced vital capacity (FEV1/FVC), higher peak expiratory flows (PEF), and higher total lung capacity (TLC) than the patients in the control group. Conclusion: CPAP can significantly improve postoperative dyspnea in lung cancer patients.

Keywords: CPAP, non-invasive ventilator, lung cancer

Introduction

Lung cancer is a common malignant tumor, which is mainly treated surgically, mostly unilateral lobectomy, accompanied by radiotherapy and chemotherapy [1]. From a microscopic point of view, lung cancer patients have increasing alveolar elastic resistance, which impedes their breathing. Consequently, their alveoli gradually undergo atrophy or form bullae over time [2]. In particular, elderly patients with other underlying diseases may encounter the major problem of surgical tolerance when they also have lung cancer [3]. Due to lung tissue loss after surgery, there is also the problem of respiratory failure, which is a postoperative complication of lung cancer surgery [4]. Therefore, the postoperative care for lung cancer patients is extremely important, and previous efforts may be wasted if it is done carelessly [5]. Clinically, we usually provide symptomatic treatment for postoperative lung cancer patients, including low-flow oxygen inhalation, respiratory stimulants, bronchodilators, antibiotics, antitussives, anti-inflammatories (glucocorticoids), apophlegmatisant (ambroxol) [6], basic nutritional support, correcting acidosis, *etc*. [7].

Among the abovementioned methods, oxygen inhalation is the first option [8]. Ventilators are of two types: invasive and non-invasive. The former has a variety of complications, including airway injury, bleeding, hemolysis, secondary infections, neurological complications, limb necrosis, gas embolism, patients' intolerance, aspiration, *etc*., while the latter is more commonly used and is also more widely accepted by patients [9]. Therefore, this study mainly discusses the nursing of and the matters needing attention in postoperative lung cancer patients treated with continuous positive airway pressure (CPAP), a non-invasive respiratory ventilation technique.

Table 1. Comparison of the patients' general clinical data between the two groups ($\overline{x} \pm s$)/n (%)

General clinical data		CPAP group (n=30)	Control group (n=34)
Gender	Male	16	19
	Female	14	15
Average age (years)		79.55 ± 5	74.93 ± 6
Smoking history (years)		9.55 ± 2.36	8.27 ± 2.11
COPD course (years)		10.35 ± 3.15	11.25 ± 4.21
Adenocarcinoma		13	12
Squamous carcinoma		8	9
Adenosquamous carcinoma		5	7
Small-cell carcinoma		4	6

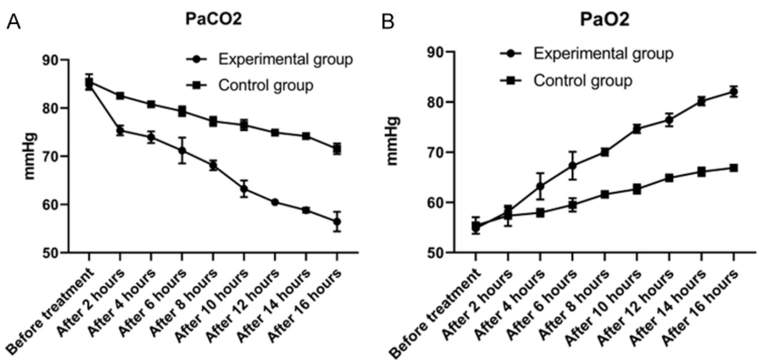

Figure 1. Comparison of the $PaCO_2$ and PaO_2 between the two groups before and at 2, 4, 6, 8, 10, 12, 14, and 16 hours after treatment. The $PaCO_2$ levels decreased gradually in the CPAP and control groups, but it decreased more faster and greater in the CPAP group than in the control group ($P<0.05$, A); The PaO_2 levels increased gradually in both groups, but the PaO_2 levels in the CPAP group increased faster and finally increased more than they did in the control group ($P<0.05$, B).

Materials and methods

General materials

Sixty-four lung cancer patients admitted to our hospital from February 2019 to August 2020 were recruited as the study cohort and randomly divided into the CPAP group and the control group. The patients in the CPAP group (n=30) were administered CPAP, and the patients in the control group (n=34) were given routine low flow oxygen inhalation, respiratory stimulants, bronchodilators, antibiotics, antitussives, anti-inflammatories (glucocorticoids), apophlegmatisants (ambroxol), basic nutritional support, correcting acidosis, *etc*. This study was approved by the Ethics Committee of the First People's Hospital of Wenling.

Inclusion criteria: (1) patients who were diagnosed with lung cancer through pathology; (2) patients from whom an informed consent form was obtained; (3) patients who did not undergo radiotherapy or chemotherapy because they could not tolerate the side effects; and (4) patients over 70 years old.

Exclusion criteria: (1) patients who were emotionally unstable and unable to cooperate with the treatment; (2) patients with cardiovascular dysfunction, acute cerebrovascular events or a history of mental illness; (3) patients with respiratory obstruction or facial deformities who were unable to inhale oxygen effectively or wear a mask; and (4) patients with severe liver or renal insufficiency.

Methods

The patients in the control group received routine low-flow oxygen inhalation, respiratory stimulants, bronchodilators, antibiotics, antitussives, anti-inflammatories (glucocorticoids), apophlegmatisants (ambroxol), basic nutritional support, correcting acidosis, *etc*.

In addition to the treatments administered in the control group, the patients in the CPAP group were given CPAP with a nasal mask or face mask. The vital signs of all patients were closely monitored throughout the process, and the respiratory parameters of CPAP were adjusted promptly if any problems occurred.

Statistical analysis

SPSS software was used for the statistical analysis. The measurement data were expressed as the mean ± standard deviation ($\overline{x} \pm$ SD). One-way analyses of variance (ANOVA) were used to analyze the differences between

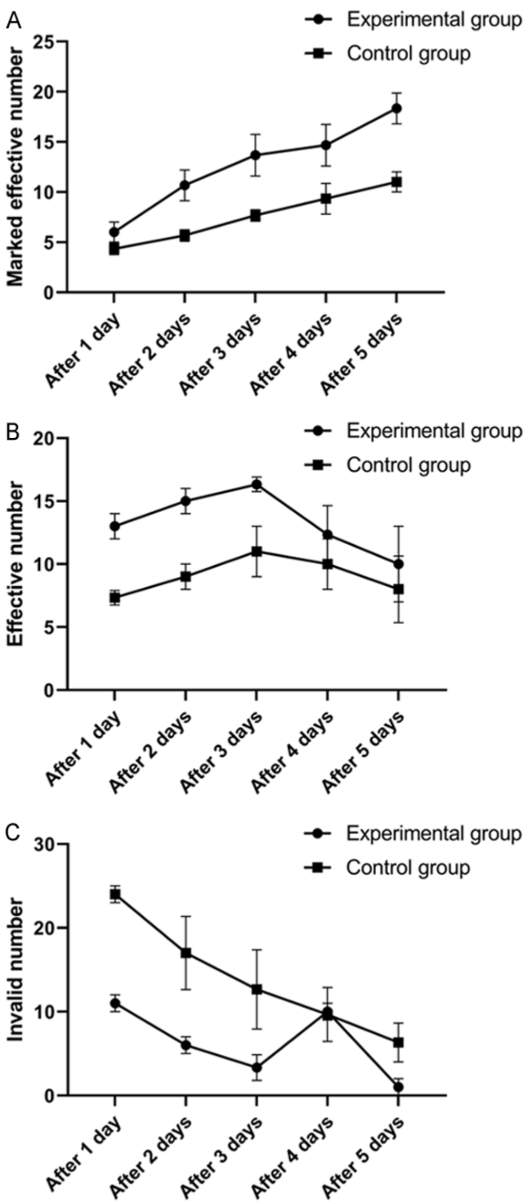

Figure 2. Comparison of airway patency between the two groups at 1, 2, 3, 3, 4, and 5 days after the oxygen inhalation. (A-C) refers to the number of patients presenting markedly effective, effective, and ineffective outcomes in each group, respectively, indicating that the markedly effective number gradually increased in the two groups, but the CPAP group had a greater speed and extent of the increase ($P<0.05$, A). The effective number in the two groups fluctuated over time, and there was no significant upward or downward trend, but the vertical coordinate height in the CPAP group was generally higher than it was in the control group ($P<0.05$, B). The number of ineffective patients decreased gradually in both groups, but the speed and extent of the decrease in the CPAP group was much more significant ($P<0.05$, C).

groups (≥ 3 groups), and *t*-tests were used for the comparisons between two groups. $P<0.05$ was considered statistically significant.

Results

Comparison of the general clinical indices between the two groups

There were no significant differences in terms of the general clinical indices of the patients including gender, average age, smoking history, or COPD history between the two groups ($P>0.05$, **Table 1**).

Comparison of the improvement in the blood gas analyses between the two groups

The $PaCO_2$ levels decreased gradually in the CPAP and control groups; however, they decreased faster and greater in the CPAP group ($P<0.05$). In addition, the PaO_2 levels increased gradually in both groups, but the CPAP group showed a faster and greater increase of PaO_2 than the control group ($P<0.05$, **Figure 1**).

Comparison of the airway patency and secretion cleaning effects between the two groups

Figure 2A-C refers to the number of patients presenting marked effective, effective, and ineffective outcomes in each group, respectively. Both groups showed a growing number of patients with a marked effect, while the CPAP group had a faster and greater increase than the control group ($P<0.05$). The effective number in the two groups fluctuated with time, and there was no significant upward or downward trend. However, the vertical coordinate height in the CPAP group was generally higher than it was in the control group ($P<0.05$). The number of ineffective outcome patients decreased gradually in both groups, but the CPAP group showed a greater speed and extent of the decrease ($P<0.05$, **Figure 2**).

Comparison of the symptoms after 1 month between the two groups

After 1 month, the number of patients with inappetence, weight loss, electrolyte disturbance, dyspnea, and pulmonary encephalopathy in the CPAP group was significantly less than it was in the control group, and the differ-

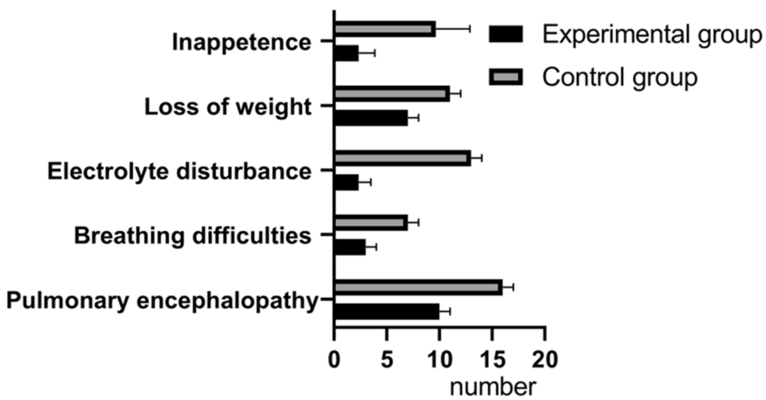

Figure 3. Comparison of the symptoms between the two groups after 1 month. After 1 month, there were fewer patients in the CPAP group who experienced symptoms of inappetence, weight loss, electrolyte disturbance, dyspnea, or pulmonary encephalopathy compared to the patients in the control group, and the difference was statistically significant (*P*<0.05).

ence was statistically significant (*P*<0.05, **Figure 3**).

Comparison of maximum ventilatory volumes (MVV), maximum mid-expiratory flows (MMF), forced expiratory volume ins 1s/forced vital capacity (FEV1/FVC), peak expiratory flows (PEF) and total lung capacities (TLC) at 1 week after the treatment between the two groups

There were no significant differences in the MVV, MMF, FEV1/FVC, PEF or TLC levels before the oxygen inhalation between the two groups (*P*>0.05). However, at 1 week after the treatment, the patients in the CPAP group had significantly higher MVV, MMF, FEV1/FVC, PEF and TLC than those in the control group (*P*<0.05, **Figure 4**).

Discussion

Lung cancer is a common malignant tumor, and smoking is the main culprit [10]. At present, surgery is still the main treatment method for lung cancer patients, accompanied by radiotherapy and chemotherapy [11]. Thoracotomy was commonly used in the past, but now it has been less and less utilized in clinical practice because of its multiple complications and great trauma. Instead, thoracoscopic lobectomy has attracted more attention [12]. However, with any type of surgery, there is a risk of damage to the respiratory muscles, making the normal alveoli with a small amount lose even more [13]. Therefore, patients may develop respiratory failure, lung atrophy, infection and other problems after surgery [14]. To address these problems listed above, we have taken a variety of measures, including low-flow oxygen inhalation, respiratory stimulants, bronchodilators, antibiotics, antitussives, anti-inflammatories (glucocorticoids), apophlegmatisants (ambroxol), basic nutritional support, correcting acidosis, *etc*. [15]. Mechanical ventilation should be used immediately in patients with respiratory failure. However, as an invasive ventilator, mechanical ventilation also has a lot of complications, such as severe trauma, patients intolerance, late extubation, *etc*. [16]. Hopefully, the emergence of non-invasive ventilators is of great significance, as they make up for the disadvantages of invasive ventilators [17]. Moreover, non-invasive ventilators are also easy to learn due to their simple and convenient operating modes, thus contributing to their more and more frequent application in various clinical respiratory diseases such as chronic bronchitis, COPD, lung cancer, lung transplantation, *etc*. [18, 19].

In this study, CPAP (a non-invasive respiratory aid device) was used in lung cancer patients after surgery to treat postoperative respiratory insufficiency, alveolar atrophy, and even respiratory failure [20]. The results proved that patients treated with CPAP had a better improvement of their blood gas analyses, airway patency, and secretion cleaning effects. After 1 month, the number of patients with inappetence, weight loss, electrolyte disturbance, dyspnea, and pulmonary encephalopathy in the CPAP group was significantly less than it was in the control group. At 1 week after treatment, the MVV, MMF, FEV1/FVC, PEF and TLC in the CPAP group were significantly higher than they were in the control group. There are various connections among these indicators, with consistent logic and a correlated direction. The indices of blood gas analysis (namely $PaCO_2$ and PaO_2), MVV, MMF, FEV1/FVC, PEF and TLC all directly reflect that CPAP can better

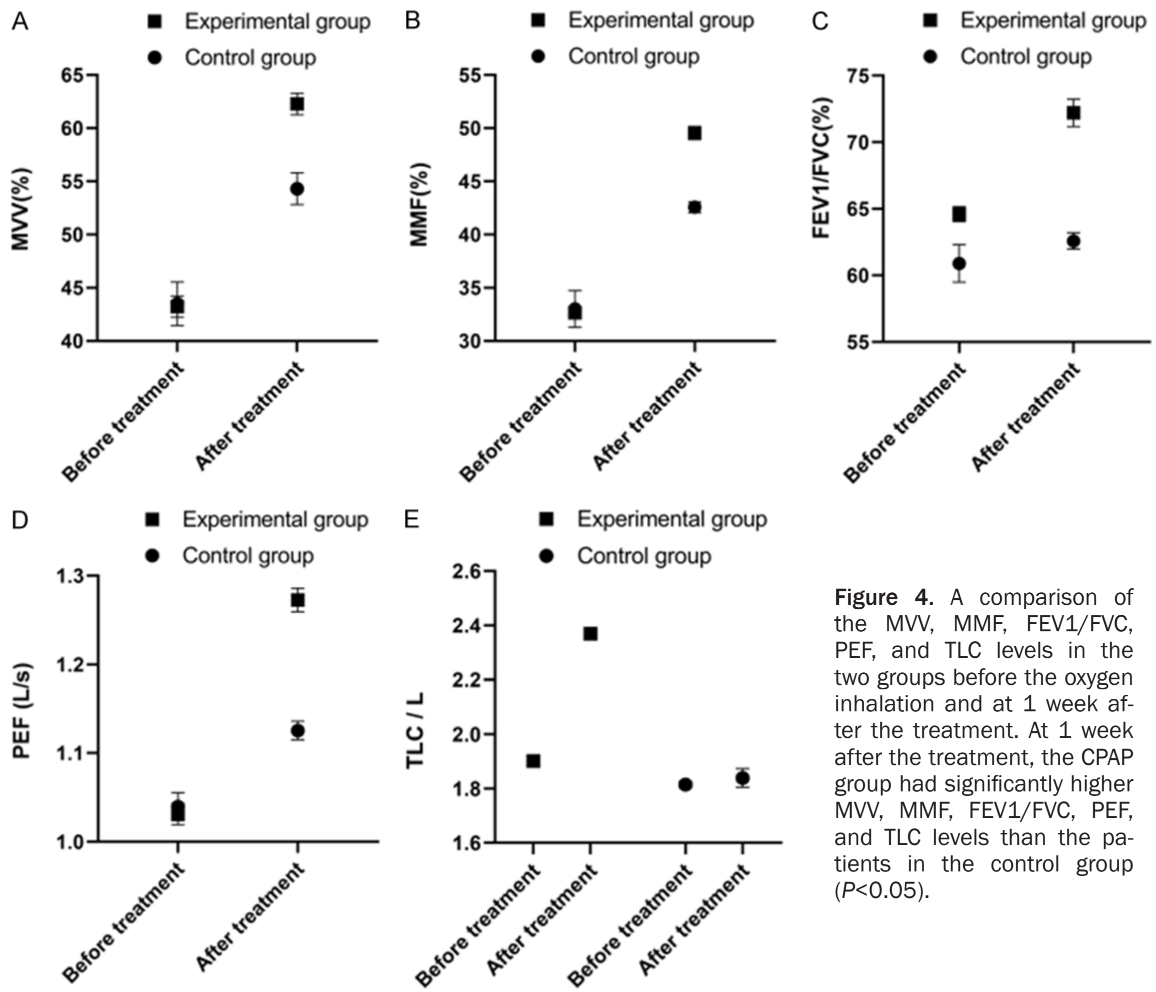

Figure 4. A comparison of the MVV, MMF, FEV1/FVC, PEF, and TLC levels in the two groups before the oxygen inhalation and at 1 week after the treatment. At 1 week after the treatment, the CPAP group had significantly higher MVV, MMF, FEV1/FVC, PEF, and TLC levels than the patients in the control group ($P<0.05$).

improve the postoperative respiratory ventilation of lung cancer patients, that is to say, CPAP can facilitate the patients breathing more smoothly [21]. Therefore, more patients in the CPAP group did show marked effective and effective outcomes in the CPAP group when we evaluated the effectiveness of CPAP, that is, more patients were more efficient and had better airway patency. As a result, the CPAP group had fewer patients with inappetence, weight loss, electrolyte disturbance, dyspnea and pulmonary encephalopathy than the control group after 1 month.

However, the non-invasive ventilator also has shortcomings. For example, it is prone to air leakage, and the patients' airway secretions cannot be completely drained due to the simplicity of the device. These issues have not yet been resolved [22-24].

This study demonstrated the huge benefits of non-invasive ventilator CPAPs for postoperative lung cancer patients, but there are still many limitations, such as the small sample size, the limited geographical location, no separate comparison of the invasive ventilator and the non-invasive ventilator, *etc*. The application of CPAP in postoperative lung cancer patients remains to be further explored [25].

Disclosure of conflict of interest

None.

Address correspondence to: Beilei Chen, Department of Pulmonary and Critical Care Medicine II, The First People's Hospital of Wenling, No. 333, Chuanan South Road, Chengxi Street, Wenling 317500, Zhejiang Province, China. Tel: +86-13958629785; E-mail: beileichen785@163.com

References

[1] Zwischenberger JB and Alpard SK. Artificial lungs: a new inspiration. Perfusion 2002; 17: 253-268.

[2] Rodríguez A, Alvarez-Rocha L, Sirvent JM, Zaragoza R, Nieto M, Arenzana A, Luque P, Socías L, Martín M, Navarro D, Camarena J, Lorente L, Trefler S, Vidaur L, Solé-Violán J, Barcenilla F, Pobo A, Vallés J, Ferri C, Martín-Loeches I, Díaz E, López D, López-Pueyo MJ, Gordo F, del Nogal F, Marqués A, Tormo S, Fuset MP, Pérez F, Bonastre J, Suberviola B, Navas E and León C. [Recommendations of the Infectious Diseases Work Group (GTEI) of the Spanish Society of Intensive and Critical Care Medicine and Coronary Units (SEMICYUC) and the Infections in Critically Ill Patients Study Group (GEIPC) of the Spanish Society of Infectious Diseases and Clinical Microbiology (SEIMC) for the diagnosis and treatment of influenza A/H1N1 in seriously ill adults admitted to the Intensive Care Unit]. Med Intensiva 2012; 36: 103-137.

[3] Zhang J, He X, Hu J and Li T. Failure of early extubation among cases of coronavirus disease-19 respiratory failure: case report and clinical experience. Medicine (Baltimore) 2020; 99: e20843.

[4] Zantah M, Dotan Y, Dass C, Zhao H, Marchetti N and Criner GJ. Acute exacerbations of COPD versus IPF in patients with combined pulmonary fibrosis and emphysema. Respir Res 2020; 21: 164.

[5] You B, Zhao Y, Hou S, Hu B and Li H. Lung volume reduction surgery in hypercapnic patients: a single-center experience from China. J Thorac Dis 2018; 10: S2698-S2703.

[6] Yazıcıoğlu A, Subaşı M, Türkkan S, Turan S, Tüfekçioğlu O and Yekeler E. An uncommon cause for grade 3 primary graft dysfunction after lung transplantation: Takotsubo cardiomyopathy. Turk Gogus Kalp Damar Cerrahisi Derg 2018; 26: 487-491.

[7] Williams L, Kermeen F, Mullany D and Thomson B. Successful use of pre and post-operative ECMO for pulmonary endarterectomy, mitral valve replacement and myomectomy in a patient with chronic thromboembolic pulmonary hypertension and hypertrophic cardiomyopathy. Heart Lung Circ 2015; 24: e153-156.

[8] Wearden PD, Federspiel WJ, Morley SW, Rosenberg M, Bieniek PD, Lund LW and Ochs BD. Respiratory dialysis with an active-mixing extracorporeal carbon dioxide removal system in a chronic sheep study. Intensive Care Med 2012; 38: 1705-1711.

[9] Wilcox SR, Kabrhel C and Channick RN. Pulmonary hypertension and right ventricular failure in emergency medicine. Ann Emerg Med 2015; 66: 619-628.

[10] Warren WA, Franco-Palacios D, King CS, Shlobin OA, Nathan SD, Katugaha SB, Mani H and Brown AW. A 24-year-old woman with precipitous respiratory failure after lung transplantation. Chest 2018; 153: e53-e56.

[11] Trahanas JM, Lynch WR and Bartlett RH. Extracorporeal support for chronic obstructive pulmonary disease: a bright future. J Intensive Care Med 2017; 32: 411-420.

[12] Toledo Del Castillo B, Gordillo I, Rubio García E, Fernández Lafever SN, Gonzalez Cortés R, Urbano Villaescusa J, López González J, Solana García MJ and López-Herce Cid J. Diffuse persistent pulmonary interstitial emphysema secondary to mechanical ventilation in bronchiolitis. BMC Pulm Med 2016; 16: 139.

[13] Terragni P, Maiolo G and Ranieri VM. Role and potentials of low-flow CO(2) removal system in mechanical ventilation. Curr Opin Crit Care 2012; 18: 93-98.

[14] Tatsumi K, Hamai Y, Mizota T and Fukuda K. Intraoperative aortic dissection during lung transplantation in a patient with alpha-1 antitrypsin deficiency. Masui 2017; 66: 530-534.

[15] Takagaki M, Yamaguchi H, Mitsuyama S, Kadowaki T and Ando T. Successful management of prolonged venovenous extracorporeal membrane oxygenation in an octogenarian. J Artif Organs 2017; 20: 377-380.

[16] Slama A, Taube C, Kamler M and Aigner C. Lung volume reduction followed by lung transplantation-considerations on selection criteria and outcome. J Thorac Dis 2018; 10: S3366-S3375.

[17] Seiler F, Trudzinski FC, Kredel M, Lotz C, Lepper PM and Muellenbach RM. [Update: acute hypercapnic respiratory failure]. Med Klin Intensivmed Notfmed 2019; 114: 234-239.

[18] Schraven L, Kaesler A, Flege C, Kopp R, Schmitz-Rode T, Steinseifer U and Arens J. Effects of pulsatile blood flow on oxygenator performance. Artif Organs 2018; 42: 410-419.

[19] Salna M and Bacchetta M. Extracorporeal lung support. Curr Opin Anaesthesiol 2017; 30: 50-57.

[20] Safka KA and McIvor RA. Non-pharmacological management of chronic obstructive pulmonary disease. Ulster Med J 2015; 84: 13-21.

[21] Russo MJ, Davies RR, Hong KN, Iribarne A, Kawut S, Bacchetta M, D'Ovidio F, Arcasoy S and Sonett JR. Who is the high-risk recipient? predicting mortality after lung transplantation using pretransplant risk factors. J Thorac Cardiovasc Surg 2009; 138: 1234-1238, e1231.

[22] Romero A, Alonso B, Latorre I and García J. Respiratory monitoring with electrical impedance tomography for lung protective ventilation and alveolar recruitment maneuver in a patient with a single lung transplant and early graft dysfunction. Rev Esp Anestesiol Reanim 2016; 63: 347-352.

[23] Romay E and Ferrer R. Extracorporeal CO2 removal: technical and physiological fundaments and principal indications. Med Intensiva 2016; 40: 33-38.

[24] Romagnoli S, Zagli G, Ricci Z, Villa G, Barbani F, Pinelli F, De Gaudio R and Chelazzi C. Cardiac output: a central issue in patients with respiratory extracorporeal support. Perfusion 2017; 32: 44-49.

[25] Reyher C, Muellenbach RM, Lepper PM and Mutlak H. [Update extracorporeal lung support]. Anasthesiol Intensivmed Notfallmed Schmerzther 2020; 55: 165-177.