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Original Research Article

Observational Study on Non Rebreathing Mask Versus Additional Low Flow Oxygen Supplementation with Non Rebreathing Mask Versus HFNC in Improving Oxygenation with Limited Resources in Situation Like COVID-19 Pandemic

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Abstract

Background: A novel coronavirus (SARS-CoV-2) is responsible for rapidly evolving illness called as COVID-19.while most patients present with mild illness, but a few presented with severe respiratory crisis requiring hospitalization and ICU admission and thus need of devices like HFNC and ventilators increased. This lead to increased pressure on ICUs and shortage of devices like HFNC and ventilators. Thus we incorporate easy-to-perform techniques to improve oxygenation with limited resources. We used high-flow nasal cannula (HFNC), Non-rebreathing face masks and additional low flow oxygen therapy through nasal prongs (6 L/min) along with a non-rebreathing mask, which helped to minimize air entrainment and thereby increase FiO2.

Aim: Aim of the study is to compare effective of non-rebreathing mask, additional low flow oxygen along with non-rebreathing mask and HFNC device in improving oxygenation parameters during respiratory crisis.

Material and Methods: This study was conducted in a 40-beded ICU at Bhopal which is a tertiary care centre associated with medical college. We enrolled a total of 72 patients and divided into three groups 'N' (those receiving non rebreathing mask), 'NL' (those receiving additional low flow oxygen along with non-rebreathing face mask) and 'H' (those receiving HFNC device). Primary data was collected including age, sex, initial vitals and ABG at the time of admission. Repeat ABG was done after 6 hours to compare the oxygenation. The pre and post therapy ABGs were analysed by paired t test and the outcome of the three modalities was compared using unpaired t test. A 'p-value 'of less than 0.05 is taken statistically significant.

Result: In our study we found that in group NL due to additional low flow oxygen with NRBM, PaO2 and SaO2 improved significantly with p values of 0.020 and 0.031 respectively. While comparing group NL and group H we found that PaO2 and SaO2 values improved significantly in group H with p value 0.001 and 0.001 respectively, thus proving that HFNC device is more efficient and standard treatment.

Conclusion: NRBM alone was not much effective during respiratory crisis. An additional low flow with NRBM improved oxygenation but was not as effective as HFNC device, thus this assembly can be used in resource limited settings. HFNC device proved best during respiratory crisis and is established modality for the same.

Keywords: COVID 19, Oxygen supplementation, NRBM, HFNC.

Introduction

A novel coronavirus named Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2) is responsible for an acute and a rapidly evolving illness that the World Health Organization termed Coronavirus Disease 2019(COVID-19) [1]. Most patients presented with mild symptoms, but few presented with severe respiratory distress requiring hospitalization and Intensive Care Unit (ICU) admission .This led to increased pressure on ICUs and hospitals, which were stretched beyond their capacity to provide needed care to severely ill patients including the need of specific equipment for preventing hypoxia specially ventilators [2]. Approximately 14% patients who were diagnosed with COVID-19 infection developed acute hypoxic respiratory failure. Data suggests that 5% of these patients required admission in intensive care unit [3]. COVID-19 associated pneumonia is mostly characterized by bilateral infiltrates on Chest X ray and ground-glass opacities with occasional consolidation in chest CT scan [4]. In this situation of pandemic, where the number of COVID-19 patients with severe respiratory symptoms requiring intensive care, ventilators and other oxygen delivery devices continued to rise, we were also facing problem of limited resources. Thus we incorporate easy-to-perform techniques to improve oxygenation of such patients.

Our ICU used high-flow nasal cannula (HFNC), as recommended by the guidelines for acute hypoxemic respiratory failure in COVID-19 adult patients who are not in need of urgent endotracheal intubation [5].

The High-flow nasal cannula is an established technique allowing humidified and heated gas with a maximum flow rate of 70-80 L/min and its oxygen fraction can be adjusted.

Non-rebreathing face masks have an additional one-way valve that prevents rebreathing of exhaled gases and entrainment of the room air. Non-rebreathing face mask with a reservoir bag can deliver up to 80% 0f fraction of inspired oxygen, provided there is a good fitting and seal of mask , and oxygen flow is three times more than of minute ventilation. However, there is always some rebreathing due to accumulation of exhaled gases in mask, which is not vented out. We used additional low flow oxygen therapy through nasal prongs (6 L/min) along with a non-rebreathing mask in patients whose oxygen requirement is not met by non-rebreathing mask alone. This technique helps to minimize air entrainment and thereby increase FiO2.

Materials and Methodology

This was a retrospective single centre study performed in a 40-beded ICU at the tertiary care centre LN Medical College and Research Centre, Bhopal. The duration of our study was 6 months.

Inclusion criteria**:** Patients above 18 years of age, ICU length of stay > 3 days, patients who were relatively stable under treatment and without a presumed need of higher modality or anticipated changes to respiratory clinical management within the next 6 hours.

Exclusion criteria: ICU length of stay <3 days, unstable patients requiring higher modality within 6 hours, denial for consent.

Patients were divided into three groups 'N', 'NL' and 'H' each containing 24 patients. Group 'N' patients received oxygen through Non rebreathing face mask. Group' NL' patients received additional low flow oxygen along with NRMB. Group 'H' patients received oxygen through HFNC device.

Primary data was collected including age, sex, initial vitals and ABG at the time of admission. Patients were then put on different oxygen delivery modalities as per requirement. Repeat ABG was done after 6 hours to compare the oxygenation status and access need for higher modality.

Statistical Analysis:

The statistical analysis was done using GNU PSPP1.4.1 and Microsoft offices excel 2007. The number of cases, arterial blood gas values was entered into software and analysed. The pre and post ABG of oxygen therapy were analysed by paired t test and the outcome of the three modalities was compared using unpaired t test. All the results are written as mean +/- standard deviation. A 'p value 'of less than 0.05 is taken statistically significant.

Result

Total 72 patients of COVID-19 were taken from records, of which 24 received oxygen through NRBM, 24 received additional oxygen @6L/min through nasal prongs along with NRBM and 24 received oxygen through HFNC devices.

Figure1and 2 shows the age and sex distribution of the patients in different groups respectively. The mean age of patients in group N was 43.29, in group NL was 44.08 and in group H was 42.08 respectively with 14 males and 10 females in group N, 15 males and 9 females in group NL, and 17 males and 7 females in group H.

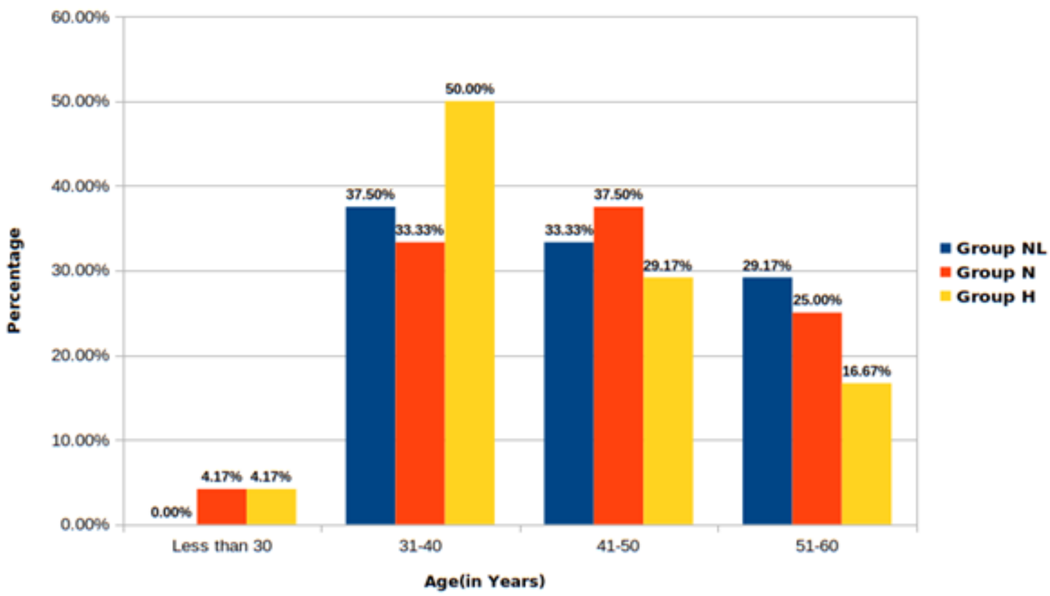

Figure 1: Age distribution graph

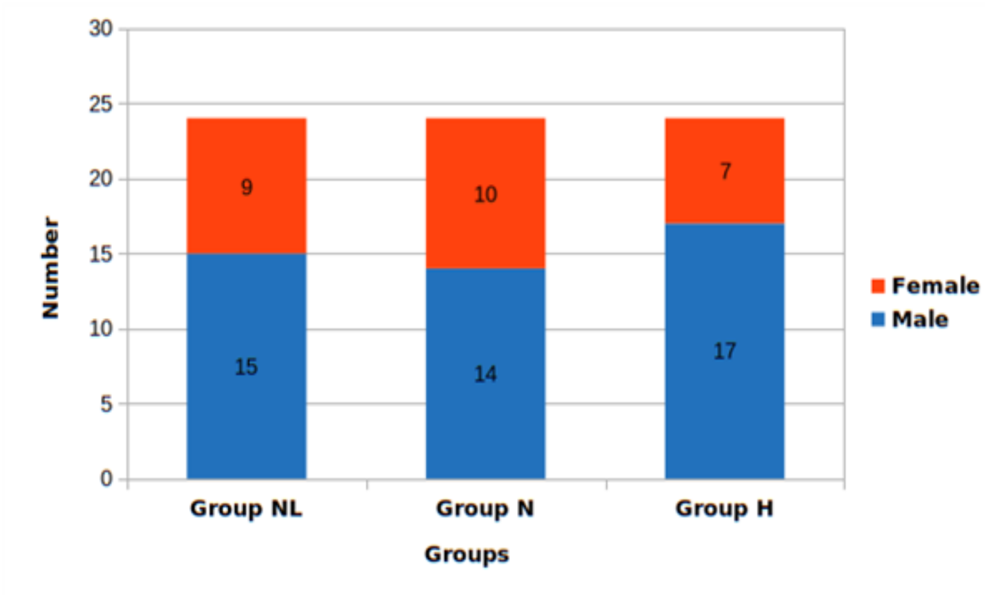

Figure 2: Sex distribution graph

Paired t test was applied to compare pre and post intervention parameters. There was significant improvement in PaO2 values before intervention (60.83) and after applying NRBM (67.13) with p value 0.000, but parameters like PaCO2 and SaO2 does not improved much after intervention with p values 0.425 and 0.198 respectively.

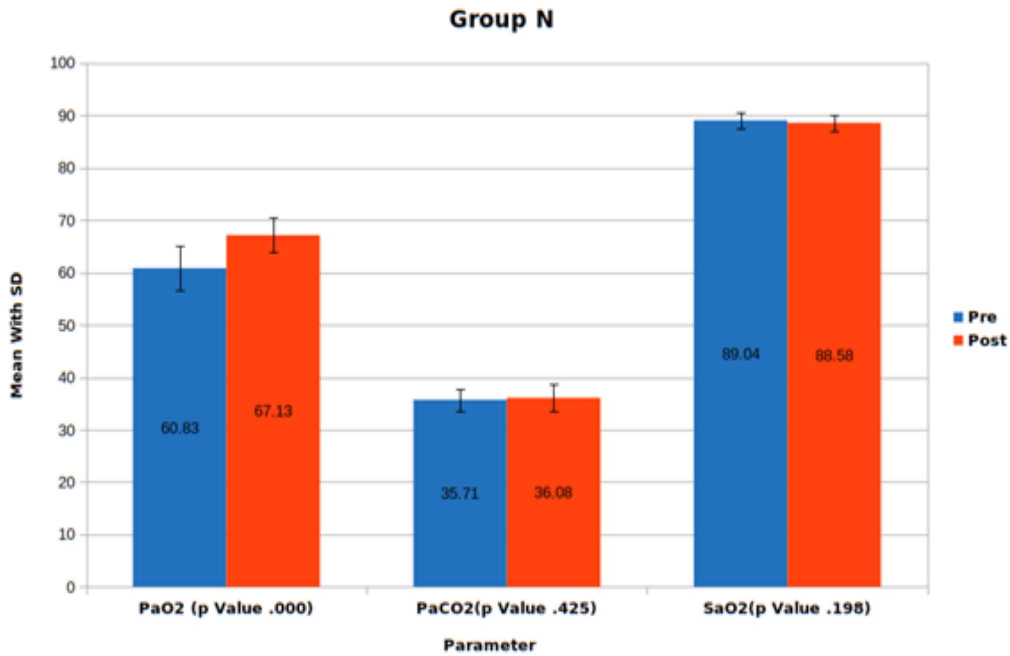

Figure 3: Pre and Post oxygen therapy ABG values in Group N

Similarly pre and post interventional parameters were compared in group NL, which shows significant improvement in all the parameters including PaO2, PaCO2 and SaO2 with p value of 0.000, 0.002 and 0.006 respectively.

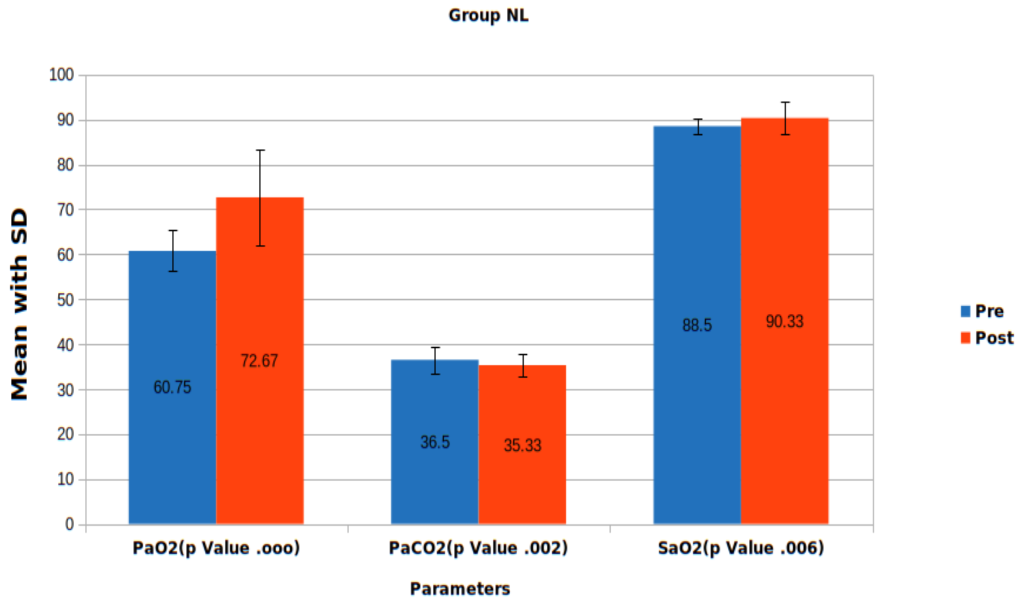

Figure 4: Pre and post oxygen therapy ABG values in Group NL

While comparing the oxygenation parameters pre and post intervention in group H, we found significant improvement in oxygenation status of patients with p values of 0.000, 0.002 and 0.000 for PaO2, PaCO2 and SaO2 respectively.

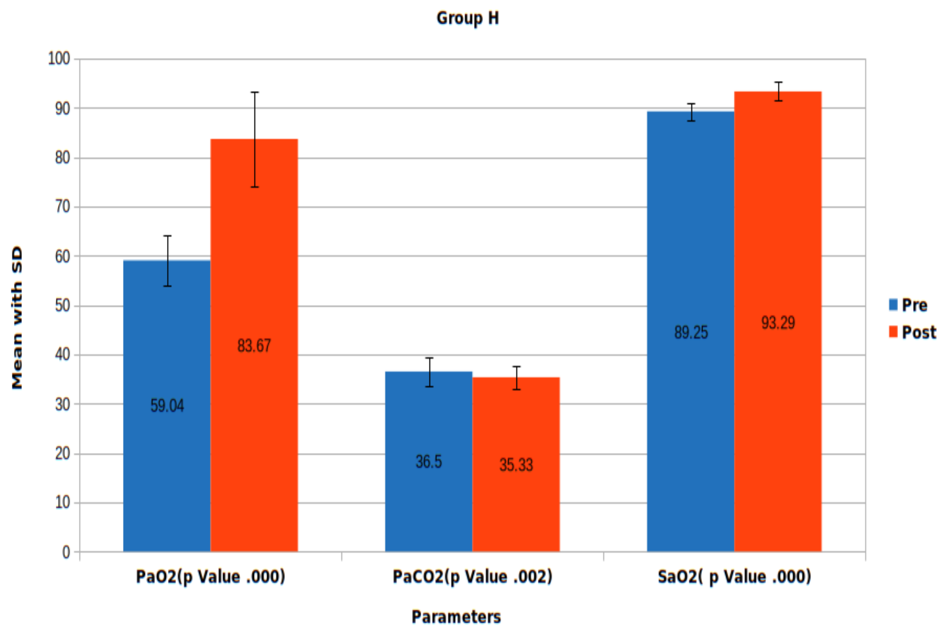

Figure 5: Pre and Post oxygen therapy ABG values in group H

For comparing the oxygenation status among group N and NL, we applied unpaired t test. We found that in group NL due to additional low flow oxygen with NRBM improved PaO2 and SaO2 significantly with p values of 0.020 and 0.031 respectively which is shown in table 1, Suggesting that this assembly is more helpful during respiratory crisis as compared to NRBM alone.

Table 1: Comparison of Group N and Group NL ABG values

	Mean Difference	t value	Df	p value (2 tailed)
PaO2n	0.08	0.07	46.00	0.948
PaCO2n	-0.79	-1.07	46.00	0.289
SaO2n	0.54	1.11	46.00	0.272
PaO2nl	-5.54	-2.41	46.00	0.020
PaCO2nl	0.75	1.05	46.00	0.301
SaO2nl	-1.75	-2.22	46.00	0.031

But on comparing group NL and group H it was clear that HFNC device are best and standard modalities for respiratory crisis with significant improvement in PaO2 and SaO2 values (p value 0.001 and 0.001 respectively) shown in table 2. Thus proving that HFNC devices are more efficient for patient in respiratory failure.

Table 2: Comparison of Group NL and Group H ABG values

	Mean Difference	t value	Df	p value (2 tailed)
PaO2nl	1.71	1.23	46.00	0.227
PaCO2nl	0.00	0.00	46.00	1.000
SaO2nl	-0.75	-1.50	46.00	0.141
PaO2h	-11.00	-3.73	46.00	0.001
PaCO2h	0.00	0.00	46.00	1.000
SaO2h	-2.96	-3.59	46.00	0.001

Table 3 shows need for higher modalities in different groups, which was maximum in group N (62.5%), followed by (45.8%) in group NL and (20.83%) in group H, suggesting that HFNC devices are standard modality for patients in hypoxemic respiratory crisis.

Table 3: Need for higher modality

Group	No. of patients requiring higher modality	%
N	15	62.5%
NL	11	45.8%
H	5	20.83%

Discussion

Non-rebreather mask are easy way to provide supplemental oxygen during respiratory crisis (like COVID-19). NRB mask can provide supplemental oxygen fraction of up to 80% at flow rates approaching 15 L/min [6].But to provide adequate oxygen the mask should be properly fitted and the bag should be inflated all the time, but despite this there is always some rebreathing. In acute respiratory crisis the peak flow rate required by the patient increases which cannot be provided by NRBM alone and hence patients require higher modality like HFNC, NIV, ventilators, but during COVID pandemic due to lack of availability of these equipments we proposed assembly of NRBM with additional low flow oxygen @6L/min in one of our group. We found this assembly to be more effective in improving oxygenation of patients as compared to non-rebreathing mask alone. The possible causes of improvement in oxygenation could be improvement in mixing of oxygen and air in large airways, increased fraction of oxygen inside the reservoir and decrease in rebreathing of exhaled gasses. Although this assembly of oxygen delivery is helpful in managing acute hypoxemic patients whenever there is resource limitation and unavailability of equipments like HFNC devices and Ventilators, this cannot be used as an alternative to them.

High flow nasal cannula provide humidified and heated oxygen-rich gas to the patient at flow rates which are capable of delivering a constant, precisely set high fraction of oxygen. HFNC device decreases dead space, and is capable of providing low positive end expiratory pressure, and decreases patients work of breathing[7].HFNC devices also decreases risk of subsequent ICU admission and endotracheal intubation and [8,9]. WHO guidelines for clinical management of patients with COVID-19 disease supported use of high flow nasal device and stated that its use is associated with lower need of intubation[10], the Italian Thoracic Society[11], the Respiratory Care Committee of the Chinese Thoracic Society[12] also supported use of high flow nasal device along with face mask in COVID -19 patients which also helps to minimize aerosol generation, The Australian and New Zealand Intensive Care Society recommended use of high flow nasal devices for hypoxia which is associated with progressing COVID-19 disease[13], joint statement of the German Intensive Care, Anesthesia, and Emergency Medicine Societies[14], and the joint guidelines by the European Society of Intensive Care Medicine and The Society of Critical Care Medicine suggested use of high flow nasal device over non-invasive ventilation and have given evidences that use of high flow nasal device reduces risk of intubation[15].

In our study we found that using NRBM alone improved PaO2 but does not have significant improvement in parameters like PaCO2 and SaO2, thus being ineffective during respiratory crisis. Whereas after additional low flow oxygen (at 6 lit/min) PaO2, SaO2 and PaCO2 had significant improvement with p values of 0.000, 0.006 and 0.002 respectively. In comparing the oxygenation parameters of group N with group NL, significant improvement in PaO2 and SaO2 values was noted in group NL, thus making this assembly a good choice as rescue during unavailability of higher modalities like HFNC devices and ventilators. Whereas comparing oxygenation parameters of group NL with H, significant improvement in PaO2 and SaO2 values in group H was noted. Need for higher modality was 62.5%, 45.8% and 20.83% in group N, NL and H groups respectively, thus suggesting HFNC devices as modality of choice in hypoxemic respiratory crisis.

Limitation of Study

1. As our study was retrospective it is difficult to provide conclusive evidence.
2. Due to lack of randomization there can be selection bias.
3. In our study we did not account for final outcome of the patients.

Conclusion

We found that simple NRBM was not much effective during respiratory crisis and was also ineffective in preventing need for higher modalities. An additional low flow with NRBM significantly improved oxygenation status and reduced the need for NIV or endotracheal intubation but was not as effective as HFNC device, thus this assembly can be used in resource limited settings or during crisis of devices such as HFNC during situation like COVID 19 pandemic, but it cannot be used as an alternative to HFNC device. HFNC device proved best in improving oxygenation and saturation of patients and also reduced need for higher modality. Previous studies and guidelines as mentioned above favours use of HFNC devices in COVID induced hypoxemic respiratory failure and is established modality for the same.

Reference

1. Sohrabi C, Alsafi Z, O'Neill N, Khan M, Kerwan A, Al-Jabir A, et al. World Health Organization declares global emergency: a review of the 2019 novel coronavirus (COVID-19). Int J Surg. 2020; 76:71–6.

2. Truog RD, Mitchell C, Daley GQ. The toughest triage—allocating ventilators in a pandemic. N Engl J Med. 2020.
3. Z. Wu, J.M. McGoogan, Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention, J. Am. Med. Assoc. 2020; 323(13): 1239e1242.
4. Wang K, Kang S, Tian R, Zhang X, Zhang X, Wang Y. Imaging manifestations and diagnostic value of chest CT of coronavirus disease 2019 (COVID-19) in the Xiaogan area. Clin Radiol. 2020
5. Alhazzani W, Møller MH, Arabi YM, Loeb M, Gong MN, Fan E, et al. Surviving sepsis campaign: guidelines on the management of critically ill adults with coronavirus disease 2019 (COVID-19). Crit Care Med. 2020.
6. Farias E, Rudski L, Zidulka A. Delivery of high inspired oxygen by face mask. J Crit Care. 1991;6(3):119-124.
7. Nishimura M. High-flow nasal cannula oxygen therapy in adults: physiological benefits, indication, clinical benefits, and adverse effects. Respir Care. 2016; 61(4):529-541.
8. Nagata K, Morimoto T, Fujimoto D, et al. Efficacy of high-flow nasal cannula therapy in acute hypoxemic respiratory failure: decreased use of mechanical ventilation. Respir Care. 2015;60(10): 1390-1396.
9. Plate JDJ, Leenen LPH, Platenkamp M, Meijer J, Hietbrink F. Introducing high-flow nasal cannula oxygen therapy at the intermediate care unit: expanding the range of supportive pulmonary care. Trauma Surg Acute Care Open. 2018;3(1):e000179.
10. WHO. Clinical management of severe acute respiratory infection when Novel coronavirus (2019-nCoV) infection is suspected: Interim Guidance. WHO/ nCoV/Clinical/2020. 3 January 28, 2020.
11. Harari SA, Vitacca M, Blasi F, Centanni S, Santus PA, Tarsia P. Managing the Respiratory care of patients with COVID-19. Italian Thoracic Society - Associazione Italiana Pneumologi Ospedalieri-Societa Italian Di Pneumologia; 2020.
12. Respiratory care committee of Chinese Thoracic S. [Expert consensus on preventing nosocomial transmission during respiratory care for critically ill patients infected by 2019 novel coronavirus pneumonia]. Zhonghua Jie He He Hu Xi Za Zhi. 2020; 17(0): E020.
13. ANZICS. COVID-19 Guidelines. Australian and New Zealand Intensive Care Society. Melbourne: ANZICS; 2020.
14. Kluge S, Janssens U,Welte T, et al. [Recommendations for critically ill patients with COVID-19]. Medizinische Klinik, Intensiv medizin und Notfallmedizin. 2020.
15. Alhazzani W, Møller MH, Arabi YM, et al. Surviving Sepsis Campaign: guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19). Intensive Care Medicine. 2020.