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## Lesson from Clinical Practice

# Low flow nasal oxygen supplementation in addition to non-rebreathing mask: An alternative to high flow nasal cannula oxygenation for acute hypoxemic COVID-19 patients in resource limited settings

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## ABSTRACT

Approximately 14% COVID-19 patients, develop acute hypoxic respiratory failure. A high flow nasal cannula device might be preferred to obtain an oxygen saturation above 90% in these cases. In resource limited settings, where high flow nasal cannula is not an option, additional low flow oxygen therapy through nasal prongs could be added to non-rebreathing mask with a reservoir bag. The possible mechanisms of the improved oxygenation could be: 1. improved oxygen-air mixing in large airways, 2. increased oxygen concentration inside the non-rebreathing mask, 3. decrease in rebreathing of carbon-dioxide from the non-rebreathing mask. This method of oxygen supplementation is easy to assemble, cost-effective and helpful in management of acute hypoxemic COVID-19 patients, whenever there is crisis of high flow nasal cannula machine. Its effectiveness needs to be assessed by a randomized controlled trial.

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## 1. Introduction

Approximately 14% patients diagnosed to have COVID-19 infection develop acute hypoxic respiratory failure. Literature reveal 5% of these patients require admission in intensive care unit [1]. Severe hypoxemia in such patients can be attributed to high physiological dead space, as compared to previously published series of non-COVID-19 acute respiratory distress syndrome patients [2]. For acute hypoxemic failure in these cases, a high flow nasal cannula (HFNC) device is preferred to obtain an oxygen saturation (SaO<sub>2</sub>) above 90% [3]. The HFNC oxygenation is a well-known technique allowing heated and humidified gas with a maximum flow rate of 70 L/min and an adjustable oxygen fraction. Non-rebreathing masks have an additional one-way valve that prevents room air entrainment and rebreathing of exhaled gases.

Non-rebreathing mask with a reservoir bag can deliver an FiO<sub>2</sub> above 0.8, provided there is a good mask fit, and airflow is more than three times of minute ventilation. However, there is always some rebreathing due to accumulation of exhaled gas in mask, which is not vented out.

We propose the use of 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 combines the principle of HFNC (by low flow oxygen through nasal cannula) and oxygen through reservoir bag of the non-rebreathing mask.

**Case 1:** A 62-year-old female COVID-19 patient without any comorbidities presented with respiratory distress to our intensive care unit. The patient was started on remdesivir, dexamethasone, low molecular weight heparin, and put on supplemental oxygenation with non-rebreathing mask at 15 L/min. Chest X-ray revealed severe involvement of both the lungs. The arterial blood gas analysis after 1 h of non-rebreathing mask trial showed (Pao<sub>2</sub>/Fio<sub>2</sub><100) with a pH of 7.50, a PaCO<sub>2</sub> of 29.8 mmHg, a PaO<sub>2</sub> of 61.5 mmHg, and Na 133, K 4.25, bicarbonate of 20.4. She became

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tachypnoeic with a respiratory rate of  $>35$  and peripheral oxygen saturation less than 90%. Extra-oxygen through nasal prongs at 6 L/min [Fig. 1] was added. After implementation of supplementation oxygen for 30 min, we found improvement in oxygen saturation ( $\text{SaO}_2 > 95\%$ ) with arterial blood gases, showing  $\text{PaO}_2$  88 mmHg and  $\text{PaCO}_2$  38 mmHg. The patient was continued on same oxygen support for 3 days and then shifted to non-rebreathing mask and finally to face mask oxygenation.

**Case 2:** A 75-year-old male COVID-19 patient having history of myocardial infarction was admitted to the intensive care unit with respiratory distress. Patient was started on remdesivir, dexamethasone, low molecular weight heparin and put on supplemental oxygenation with non-rebreathing mask at 15 L/min. Chest X-ray showed bilateral diffuse infiltrates. Arterial blood gases on 15 L/min of oxygen by non-rebreathing mask showed severe hypoxia ( $\text{PaO}_2/\text{FiO}_2 < 100$ ), with a pH 7.45,  $\text{PaO}_2$  73.2 mmHg,  $\text{PaCO}_2$  41.7 mmHg and  $\text{SaO}_2$  92%. He was tachypneic with a RR  $> 40$ /min. We gave additional supplemental oxygen by nasal prong at 6 L/min by another flow meter [Fig. 1]. After that the patient became more comfortable, and peripheral  $\text{SaO}_2$  increased to 98%. After 30 min of supplemental oxygen, arterial blood gases showed a pH of 7.45,  $\text{PaO}_2$  100.4 mmHg,  $\text{PaCO}_2$  39 mmHg, and  $\text{SaO}_2$  98%. The patient was continued on same oxygen support for 6 days and then shifted to non-rebreathing mask and subsequently to face mask oxygenation.

## 2. Discussion

The initial therapy of hypoxemia and respiratory failure focuses on oxygen administration via nasal tube, Venturi mask, and HFNC. The Surviving Sepsis Campaign COVID-19 suggests the use of HFNC over non-invasive positive-pressure ventilation [3]. Recent study even observed an HFNC- positive response in moderate hypoxemic patients while failure rate increased as long as the  $\text{PaO}_2/\text{FiO}_2$  decreased [4]. The ineffective seal of the airway passage during mouth breathing can lead to leakage of air and loss of the positive airway pressure, which in turn might cause failure of HFNC in COVID 19 acute respiratory distress syndrome. Furthermore, in HFNC mitigation of air leak requires breathing from nose with mouth closed [5]. In our assembly, oxygen supplementation was given by nasal prongs (6 L/min) with an additional flowmeter along with non-rebreathing mask. In our assembly, the adherence to closure of the mouth is not mandatory. Any escape of oxygen

through mouth would increase the oxygen concentration of mask and thus decreases the  $\text{CO}_2$  concentration and hence rebreathing. We evaluated the effectiveness of the assembly in some of the patients who were not maintaining oxygenation on non-rebreathing mask and found it to be effective in increasing oxygenation. Interestingly, none of our patients had subjective complaints of discomfort by use of this assembly.

The possible mechanisms of oxygenation improvement could be: 1. improved oxygen-air mixing in large airways, 2. increased oxygen concentration inside the non-rebreathing mask mask, 3. decrease in rebreathing of  $\text{CO}_2$  from the non-rebreathing mask mask.

This method of oxygen supplementation is easy to assemble, cost-effective and helpful in management of acute hypoxemic COVID-19 patients, whenever there is less availability of HFNC machine for the demand. The approximate cost of our assembly is one dollar. Instant increase in oxygenation might have made the patient feeling more comfortable and prevented intubation and its complications in the described cases. The possible complications (dryness of nasal mucosa, and chances of nasal bleeding) of low flow nasal cannula therapy should be considered which using the assembly. The effectiveness and improved patient outcome needs to be established with a randomized controlled trial.

## 3. Conclusion

We suggest that additional low flow nasal cannula oxygen supplementation to improve oxygenation in acute hypoxemic COVID-19 patients under a non-rebreathing mask as useful in resource limited settings instead of high flow nasal cannula oxygenation. Our observation is based on two patients, hence a well conducted randomized controlled trial might be required to substantiate our findings.

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## Consent

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## Declaration of competing interest

Nil.

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Fig. 1. Patient on non-rebreathing mask, with low flow nasal oxygen supplementation.