



NONINVASIVE OXYGEN DELIVERY DEVICES IN COVID ICU

Anaesthesiology

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ABSTRACT

Oxygen (O₂) therapy has a profound role in the treatment of COVID-19 patients. The pandemic has drawn special attention to ensure uninterrupted Oxygen supply to all hospitals, especially for COVID-19 patients. Treatment of COVID-19-related respiratory failure and acute respiratory distress syndrome continues as an ongoing challenge. The choice of different oxygen delivery devices depends on the patient's status and its availability. In this review we will discuss several noninvasive oxygen delivery devices, their diagrammatic representation and the utility of noninvasive respiratory supports as appropriate bridging adjuncts in the early stages of the disease process and has the potential to prevent intubation or invasive ventilation. A number of non-invasive options exist to avert mechanical ventilation and ICU admission.

KEYWORDS

COVID-19, non-invasive ventilation, intubation, oxygen delivery devices

INTRODUCTION

Oxygen (O₂) therapy has a profound role in the treatment of COVID-19 patients. The pandemic has drawn special attention to ensure uninterrupted O₂ supply to all hospitals, especially for COVID-19 patients. COVID-19 can cause multiorgan failure, but primarily targets the respiratory tract, causing widespread inflammation in the lungs. Accordingly, it was classified as (1) mild (symptoms of acute upper respiratory tract infection including fever, dry cough, and tiredness); (2) moderate (pneumonia with cough and frequent fever with no obvious hypoxemia, chest computed tomography with lesions.) (3) severe (pneumonia with hypoxemia where SpO₂ <92% in room air) and (4) critical (acute respiratory distress syndrome [ARDS], with multiorgan failure).[1] While choosing a delivery device, we must consider 3 P's: Purpose, patient, and performance. [2] A number of non-invasive options exist to support COVID-19 patients with mild or moderate respiratory distress and may reduce the numbers of patients requiring intubation, mechanical ventilation, and ICU admission in some severely ill patients.[3] In this review we will discuss several noninvasive oxygen delivery devices, their diagrammatic representation and the utility of noninvasive respiratory supports as appropriate bridging adjuncts in the early stages of the disease process.

Low Flow and Low-Performance Devices Nasal Cannula And Nasal Catheters-

The nasal cannula and catheters provide low to a moderate fraction of inspired oxygen (FiO₂) of 0.24-0.4 at oxygen flows of 1-6 L/min, as higher flows are associated with nasal crusting and irritation. The actual FiO₂ may be variable depending on the patient's inspiratory peak flow. The nasal cannula has the advantage that it can be used with a face mask/N95 mask.



Advice-

In mild-to-moderate symptomatic patients, nasal cannula can be used at flows of 4-6 L/min, with the patient's face covered with N95 mask or face mask along with other precautions applicable.

Simple Face Mask And Nebulizers-

Simple facemask can deliver FiO₂ of 0.35-0.5 at flows of 5-8 L/min and is used for the moderate duration of oxygen therapy. Respiratory rate and exhalation are controlled by the patient and these individually affect the actual FiO₂ delivered. Nebulizers function and form droplets of different sizes to deliver the drugs.



Advice-

facemask can be used, Only in co-operative patients with mild-to-moderate respiratory distress. Open nebulizers should be avoided; rather a metered-dose inhaler with spacer device or manual in-line nebulization should be used.

High Flow Devices, Reservoirs And Noninvasive Ventilation Partial Rebreathing Mask

Partial rebreathing mask having a reservoir bag that can lead to some air entrainment and can deliver FiO₂ of 0.4-0.7 at 10-15 L/min flows.

Non-rebreathing Mask

Non-rebreathing masks (NRBMs) have an additional one-way valve that prevents room air entrainment and rebreathing of exhaled gases. It can deliver FiO₂ above 0.8, provided there is a good mask fit also and airflow is more than three times of minute ventilation.



Advice-

Venturi Mask

FiO₂ is delivered in discrete levels, typically between 24% and 60% oxygen. The mask uses an air/oxygen entrainment device (venturi) to more precisely mix air and oxygen. Venturi masks (VM) Mixes a specific volume of air and oxygen depending on the desired FiO₂ but require moderate to high flows.

Rebreathing masks can be used to provide moderate-to-high FiO₂ for moderate duration, e.g., before intubation and postextubation. NRBM are the preferred mode for preoxygenation before intubation. VMs can be used to provide lower and fixed FiO₂. Nasal cannula combined with NRBM can be used to provide higher FiO₂. [4]

High-flow Nasal Cannula

High-flow nasal cannula (HFNC) provides heated humidified oxygen at flows from 10 L/min up to 60 L/min. At high flows, it provides positive pressure. It has been used in the conditions such as respiratory distress, preoxygenation, and apneic diffusion of oxygen in airway procedures, in both adult and pediatric age groups.[5] A combination of HFNC and noninvasive ventilation (NIV) mask has shown to reduce re-intubation rates at day 7 postextubation in critically ill patients, as compared to high-flow nasal oxygen alone.[6]



Advice-

HFNC can be used to provide oxygen, preferably in patients with acute respiratory failure. It should be ensured that the nasal cannula used with HFNC is properly fit and the patients are instructed to wear surgical facemask/N95 masks and breathe nasally.

Noninvasive Ventilation

Continuous positive airway pressure (CPAP) and bilevel positive airway pressure (BiPAP) are the commonly used noninvasive modes of respiratory support. The indications of their use are based on the respective underlying pathology and clinical presentations, for example, life-threatening respiratory conditions such as pulmonary edema or when the risks related to invasive ventilation are higher than benefits as in Type 2 respiratory failure in chronic obstructive pulmonary disease (COPD) patients.[7] Multiple position statements and guidelines have emphasized potential of CPAP in supporting COVID-19 patients with Type 1 respiratory failure. Regardless of the earlier concerns of barotrauma and aerosolization, the current circumstantial evidence suggests CPAP benefits COVID-19 patients as an option of care.[8,9-12]

CPAP is usually initiated at a higher than normal intrinsic positive end-expiratory pressure (PEEP) of around 5 cmH₂O. The application of PEEP helps to maintain the patient's airway pressure to prevent alveolar collapse, thereby increasing lung volumes and improving gaseous exchange.[7,13,14] In severe COVID-19, initial CPAP settings of 5–10 cmH₂O and 60% oxygen are suggested. CPAP of >10 cmH₂O is used, if required, after consultation with a respiratory or critical care consultant. Oxygen flow is titrated to maintain oxygen saturation of above 94%.[15]

BiPAP is usually used in patients with chronic respiratory conditions such as COPD. Hence, it is recommended for COVID-19 patients who have underlying comorbid conditions such as COPD.[16] In COVID-19, BiPAP is thought to improve the work of breathing. Furthermore, the lack of properly fitting masks and accessories preclude the use of NIV in many settings.[17]

NIV can be used in the conditions such as cooperative patients with acute exacerbation of COPD (AECOPD) and acute congestive heart failure (ACHF). Due to COVID infection, taking all precautions related to the airborne spread. Inspiratory pressures should be kept at a

minimum level, preferably ≤10 cm H₂O. Air leak should be minimized by the use of snuggle-fitting masks. Vented masks should be avoided. Breathing circuits should be used with exhalation port high-efficiency particulate (HEPA) filters.



Advice-

ROLE TO PREVENT INTUBATION

To date, no evidence-based guidelines are available, describing when to initiate intubation and mechanical ventilation for patients with COVID-19.[18] Nevertheless, it is a known fact that patients who are in worsening hypoxemia and severe respiratory distress, refractory to oxygen supplementation, and noninvasive respiratory support are the candidates for intubation and invasive mechanical ventilation.[19]

Hence, it is advised to consider decision to intubate on the basis of the patient's clinical and physiological status. We have noticed from COVID-19 clinical management that patient end up with high mortality rate once intubated who were presented late with respiratory failure to the emergency room. That led some hospitals to initiate NIV and HFNC to avoid intubation as a trial approach.

CONCLUSION

Treatment of COVID-19-related respiratory failure and ARDS continues as an ongoing challenge. What is most important is to continuously adapt the treatment approaches that are currently available from literature and experiences, based on physiological changes and clinical presentations, advancing from noninvasive respiratory support to invasive mechanical ventilation with or without other adjuncts such as prone ventilation as per the severity of hypoxemia. This review summarizes various O₂ therapy devices and selection of the appropriate O₂ delivery device is most crucial for the success of O₂ therapy.

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