Review Article

Strategies before Intubation in COVID-19: An Evidential Update

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Abstract

The coronavirus disease-19 (COVID-19) is impacting large patient populations, resulting in respiratory compromise, necessitating artificial respiratory supports. Early treatment modalities for severe respiratory failure during the pandemic focused on early intubation and invasive ventilation, as this was considered to be more effective than noninvasive respiratory strategies. However, emerging evidence proved that noninvasive respiratory supports such as noninvasive ventilation, high flow nasal cannula along with prone positioning might have a more significant and positive role than initially thought during the pandemic. Reflective evidence also suggests 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. This narrative review focusses on various strategies that are attempted in COVID-19 patients to avoid endotracheal intubation.

Keywords: Bilevel positive airway pressure, coronavirus disease-19, continuous positive airway pressure, dispersion, high flow nasal cannula, intubation, prone position

Introduction

Coronavirus disease-19 (COVID-19), caused by severe acute respiratory syndrome-related coronavirus 2 (SARS-CoV-2), has become a devastating global burden involving humanity not only from a health perspective but also from an economic, educational, vocational, and many other routine aspects of human life. Scientific research is ongoing to understand its virulence, the disease course, the definitive treatment, and the vaccines against it. A high infectivity nature and a predisposition to affect lung tissue are real concerns for this pandemic disease. 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 SpO_2 <92% in room air); and (4) critical (acute respiratory distress syndrome [ARDS], with multiorgan failure).[1] It is observed that the majority of the COVID-19 patients develop only mild or uncomplicated illness, approximately 14% of them develop severe disease requiring hospitalization and oxygen support, and 5% of those critically ill requiring intensive care admission.[2] It is widely accepted by the global medical community that those patients who develop severe COVID-19-induced respiratory failure may develop lung injury, worsening hypoxia, and require respiratory support.[3,4] In other words, a subset of patients with COVID-19 do not require intubation but develop hypoxemia unresponsive to simple oxygen therapy and thus need noninvasive respiratory support. This narrative review aims to emphasize that all patients with COVID-19 respiratory failure cannot be put into one category of noninvasive ventilation (NIV) but rather use an individualized basis on their need and risk-benefit ratio, pertinent to specific noninvasive respiratory support.

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Noninvasive versus Invasive Approaches: Balancing the Cart

It is evident that there is a significant risk of transmission of coronavirus during airway-related care of infected patients and while managing respiratory failure with an invasive approach, noninvasive support, or with oxygen delivery devices. Some of the key points to be highlighted while managing the airway of COVID-19 patients include (1) minimize aerosolization and exposure; (2) maximize first-attempt intubation success to reduce time and extent of exposure; and (3) reduce personnel exposure by wearing personal protective equipment (PPE) or devices.[5]

During the initial months of COVID-19, early intubation was favored in COVID-19 patients with respiratory failure so as to avoid patient self-induced lung injury.[6] However, as scientific and evidence-based data evolved, the World Health Organization (WHO) advocated the use of high flow nasal cannula (HFNC) and NIV but with the proper use of PPE.[7] Early intubation was discouraged in patients who could be managed with HFNC or NIV. Contrary to initial thought, it increased the risk of exposure to health-care professionals and resulted in improper delivery of resources. With the proper use of PPE in intensive care units, it was observed that the usage of noninvasive respiratory support was not associated with increased risk of transmission of coronavirus to health-care professionals, whereas endotracheal intubation was associated with an increased risk of aerosolization and infection of the health-care team.[8]

Noninvasive Respiratory Support

Oxygen delivery devices

Oxygen therapy is recommended in COVID-19 patients, possibly as soon as the SpO_2 levels are <92% to achieve a target range of 92%–96%.[9] However, no randomized controlled trials are available to date quantifying O_2 delivery in COVID-19 patients. Hence, some data are extrapolated from related studies.

WHO recommends using oxygen delivery devices such as nasal cannula, simple face masks, and nonrebreathing mask devices as per the symptomatic presentation in COVID-19.[10,11] One of the vital concerns to be addressed is the aerosol dispersion, since most of the patients with mild-to-moderate disease are started on these devices as per guidelines. Nasal cannula is used in patients with mild-to-moderate disease based on their symptoms, with flows between 4 and 6 L/min provided the patient's face is covered with an N95 or equivalent facemask along with other precautions applicable for aerosol-generating procedures.[12] It was observed that the aerosol dispersion from the nostril of a human patient simulator toward the end of the bed, while using nasal cannula was almost 66 cm horizontally with a flow of 1 L/min, 70 cm when the flow was 3 L/min, and 1 m when it is 3–5 L/min.[13] With a simple face mask, the dispersion distance was 40 cm with an oxygen flow of 4 L/min.[14] While using a nonrebreathing mask, it was observed that the exhaled air dispersion distance was <10 cm irrespective of the oxygen flow rate varying from 6 to 12 L/min.[15]

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.[16] 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.[7,17-20] A recent position statement highlights that CPAP with added O_2 can be considered to improve oxygenation if conventional O_2 therapy fails, and there is no urgent indication or as a stand-by approach for intubation.[9]

CPAP is usually initiated at a higher than normal intrinsic positive end-expiratory pressure (PEEP) of around 5 cmH_2O. The application of PEEP helps to maintain the patient's airway pressure to prevent alveolar collapse, thereby increasing lung volumes and improving gaseous exchange.[16,21,22] In severe COVID-19, initial CPAP settings of 5–10 cmH_2O and 60% oxygen are suggested. CPAP of >10 cmH_2O is used, if required, after consultation with a respiratory or critical care consultant. Oxygen flow is titrated to maintain oxygen saturation of above 94%.[23] Another study[24] emphasizes the initiation of CPAP with a trial of 120 min. They suggest to start with a PEEP of 7.5 cmH_2O, flow ≥60 LPM, titrating the FiO_2 to achieve a SpO_2 ≥94%, and a respiratory rate (RR) ≤25 bpm. Upon every 30 min of reassessment, PEEP is increased by 2.5 cmH_2O up to a maximum of 12.5 cmH_2O in case of failure to reach the established target RR, and no adjustment is indicated if the target is achieved. If the target of SpO_2 ≥94% and a RR ≤25 min, after the 120 min trial, the support can be stepped down with HFNC, with stable vital signs. The authors suggested early endotracheal intubation if a CPAP trial of 120 min fails to achieve the target ranges. For CPAP to be effective, a sealed system is required by applying a tight-fitting mask or a hood.[21,25] It needs to be highlighted that the aerosol dispersion with CPAP of 5–10 cmH_2O occurred up to 33 cm as mentioned by various manufacturers.[26]

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.[27] In COVID-19, BiPAP is thought to improve the work of breathing. Nevertheless, it carries a risk that inappropriate settings may result in patients taking excessively

large tidal volume, resulting in barotrauma or volutrauma. Inspiratory positive airway pressure (IPAP) is set to achieve adequate tidal volumes, and it varies from 12 to 35 cmH_2O, by allowing patients to breathe to the preset inspiratory pressure. Expiratory positive airway pressure (EPAP) is based on the same principle as PEEP in CPAP modes, preventing alveolar collapse on expiration, thereby improving gaseous exchange.[4] In a flowchart model, the authors suggested to start BiPAP with a pressure support of 5 cmH_2O and a PEEP between 5 and 10 cmH_2O, titrating the FiO_2 to reach the desired SpO_2 ≥94% and an RR ≤25 bpm. If the target and the tidal volume meets 6 mL/kg predicted body weight after 60 min of trial, BIPAP can be continued, alternatively with HFNC. They recommended arterial blood gas analysis in 30 min to evaluate the status of hypercapnia and respiratory acidosis. The authors suggested early endotracheal intubation if a BIPAP trial of 60 min fails to achieve the target ranges.[24]

Aerosol dispersion was found to be significantly higher with BiPAP. It is interesting to highlight that increasing the IPAP from 10 to 18 cmH_20 from an EPAP of 4 cmH_20 resulted in aerosol dispersion of 65–85 cm. If a whisper swivel adapter, a commercial one-way valve that prevents rebreathing, is attached, is found further to increase the dispersion beyond 100 cm.[28] Another recent study that looked into aerosol dispersion while on BIPAP ventilation confirmed that; (1) full mask with IPAP 18 cmH_2O and EPAP 5 cmH_2O, the dispersion is 92 cm; (2) helmet mask with setting IPAP 20 cmH_2O, EPAP 10 cmH_2O without airtight cushion, the dispersion distance was 27 cm, and with airtight cushion, the dispersion was negligible.[29]

High-Flow Nasal Cannula

HFNC provides heated humidified oxygen at flows ranging from 10 to 60–70 L/min. At high flows, it is thought to generate positive pressure and nasal airway splint. HFNC is used in patients with respiratory distress and evident Type 1 respiratory failure despite increased inspired oxygen concentration.[30] HFNC was found superior to conventional oxygen therapy in decreasing intubation requirement without impacting mortality. The authors mentioned the need for varying flow rates between the clinical presentations.[31] Another randomized controlled study concluded that higher the flow (60 L/min), better is the physiologic response.[32] There was an initial concern regarding the risk of aerosolization with HFNC, resulting in some recommendations to avoid the use of this device. Nevertheless, the degree of aerosolization was minimal with these devices and is now recommended as the oxygen therapy of choice in patients with respiratory distress.

Various health authorities and organizations such as the WHO, the Ministry of Health and Welfare, India, The Australian and New Zealand Intensive Care Society (ICS), the Italian thoracic society and consensus statement from the European Society of Intensive Care Medicine and the Society of Critical Care Medicine, the joint statement from the German Intensive Care, Anaesthesia, and Emergency Medicine Societies have recommended the use of HFNC in COVID-19-induced respiratory failure.[7,33-37]

HFNC systems with properly fitting interfaces are found to have lesser aerosol dispersion, hence low risk of airborne transmission.[7,34,36] HFNC therapy has its advantages in terms of comfort and low chances of dispersion aerosol compared to other noninvasive modalities, provided patient's oxygenation, and work of breathing are closely monitored. The following objective criteria are suggested as failure of HFNC: (1) Tachypnea >40 bpm; (2) copious of airway secretions; (3) Type 2 respiratory failure with acidosis of pH <7.35; and (4) SpO_2 <90% for >5 min of application.[38,39]

Prone Positioning

The development of acute hypoxemic respiratory failure in COVID-19 is not uncommon. The role of proning in intubated patients with severe ARDS is well documented, but the role of awake proning and particularly in COVID-19 patients is subject to debate. Recent guidelines from the UK ICS suggest awake prone positioning as standard of care for suspected or confirmed COVID-19 patients, where FiO_2 requirement is ≥28%.[40] This recommendation justifies the physiological principles, and clinical evidence shows that the characteristic lung injury seen in ARDS appears to be similar to that of SARS-CoV2 infection.[41] The physiological justification behind proning in ARDS is improving ventilation/perfusion mismatching, shunting, and hypoxemia. There are no published randomized control trials that investigated the effectiveness of awake prone positioning in ARDS patients. Some of the evidence is limited to case series and small observational studies with approaches supplementing noninvasive respiratory support, and they reported short-term improvements in oxygenation and a reduction in oxygen demand with adverse effects.[42-44] In addition, the minimum duration for awake proning to produce a clinically significant benefit remains unclear. It is challenging to keep an awake patient prone for 12–16 h/day, compared to a patient on mechanical ventilation. Even though some of the papers suggest a duration of 2–3 h of awake proning is tolerable for COVID-19 patients,[45,46] a more practical and rational method that allows patient comfort will be an acceptable one.[45,47]

Of note, early prone position with HFNC or NIV was found to be significant in a multicenter cohort, where the authors concluded the avoidance of intubation in up to half of their moderate-to-severe ARDS patients including those with viral pneumonia.[44] However, other authors reported a similar outcome,[48] and a randomized controlled trial is going on regarding the same.[49]

When to Intubate?

To date, no evidence-based guidelines are available, describing when to initiate intubation and mechanical ventilation for patients with COVID-19.[27] 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.[50] Silent hypoxemia is found to be a culprit in delayed intubation, where most of these patients who are in respiratory failure with hypoxemia present with only minimal signs of respiratory distress; this highlights that considering the work of breathing alone can be a potential unreliable indicator of failure of noninvasive respiratory supports.[51,52] Hence, it is recommended to consider the patient's global clinical and physiological status in the decision to intubate. We have noticed from COVID-19 clinical management that patients presenting late with respiratory failure to the emergency room, end up with high mortality rate once intubated. That led some centers 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 anecdotal 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 refractory hypoxemia. The absence of specific criteria for intubation in COVID-19 indicates that the decision to intubate depends on the symptomatic course, response to therapy, and clinical decision.

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Conflicts of interest

There are no conflicts of interest.

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