EDITORIAL

Noninvasive Respiratory Devices in COVID-19

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Can We Defeat the Air Hunger?

The world is still reeling under the effect of the COVID-19 pandemic ever since it started in December 2019. This pandemic has proven to be challenging and different from other viral pandemics in more than one way. It crippled even the most robust of healthcare systems in the world. As of this day, COVID-19 has claimed 6.29 million lives worldwide and about half a million lives in India. Its disease trajectory remains to be unraveled, and the scientific fraternity is yet to have a strong grasp on it. Because of its propensity to spread rapidly, both first and second epidemics had seen overwhelming numbers of COVID-19 patients having fulminant hypoxemic respiratory failure.[1]

An optimal approach to oxygen therapy has remained controversial in these patients, and different techniques have shown varying success rates. The use of noninvasive ventilation (NIV) was quite restricted during the initial period.[2] Many reports, especially from China, had encouraged early invasive mechanical ventilation (IMV) to NIV. In COVID-19 patients, NIV has been considered to have significant disadvantage of dispersion of viral droplets and spread of disease.[2,3]

This approach, however, had to be abandoned for a few reasons. First, because number of ventilators available fell short to meet the unprecedented patient load. In this issue of IJCCM, we have this large retrospective multicenter study from Pune (more than 1200 patients in 12 ICUs) that has addressed this very issue of limited ventilator reserves. The authors did an analysis to see the outcome with noninvasive respiratory devices like high-flow nasal cannula (HFNC), NIV, or HFNC+NIV in COVID-19 patients who were not getting IMV due to resource crunch!

The next reason was that weaning these patients was not straightforward and not always successful.[4] Third, there was an increase in nosocomial infections secondary to combination of prolonged ventilatory needs and immunosuppressive nature of the drugs used for the disease (like IL 6 inhibitors, steroids, etc.).[2]

Noninvasive strategies include the use of standard non-rebreathing oxygen masks, HFNC therapy, continuous positive airway pressure (CPAP), and bilevel positive airway pressure (BiPAP) ventilation.[5]

The HFNC was, in the early days of the pandemic, the preferred therapy for COVID-19 pneumonia-related respiratory failure when compared to NIV. It meets the patient's oxygen and flow demands and, at the same, time gives patients the liberty to change their body positions. A HFNC may be commenced at flow rates of 60 liters per minute, targeting SpO_2 to more than 90% with an appropriate FiO_2 setting. If the FiO_2 requirement is more than 60%, a timely decision to intubate should be kept in mind.[5]

In recent years, about 15% of patients with acute respiratory failure have been treated with NIV, and it increased to up to 30% during the current pandemic. Indian Society of Critical Care Medicine (ISCCM) guidelines advocate the use of NIV in acute hypoxemic respiratory failure related to acute cardiogenic pulmonary edema, early acute respiratory distress syndrome (ARDS) (PaO_2/FiO_2<300, >200), and early acute respiratory failure in immunocompromised patients, in palliative care setting, and in post-operative settings except in esophageal surgeries.[6] Noninvasive ventilation has not been recommended as a treatment of choice for patients with viral pneumonia, including H1N1 pneumonia. But in the face of these extraordinary circumstances of the COVID-19 pandemic, both NIV and HFNC have been used extensively to handle the patient load with limited resources, even in outside of ICU settings.[7]

It was an initiative of Italian ICUs of using CPAP for COVID-19 in this period of crisis. And now, there is ample evidence that early CPAP use may prevent deterioration and decrease the need for ventilatory support in these patients. Severe COVID-19, however, may require higher CPAP settings of more than 5 cm of H_2O, up to 10 cm of H_2O, and FiO_2 to target SpO_2 >90%. And an adequately sealed system should be in place, a tight-fitting mask or a hood, for it to be effective. Since the patient's lungs are less compliant, a close watch for barotrauma or pneumothorax is required. The major challenge to its successful application is the patient's compliance with therapy, as the tight-fitting mask has to be applied for extended periods of time. It may also be challenging in patients producing copious amounts of sputum that requires the mask to be removed frequently resulting in loss of positive pressure and alveolar derecruitment.[8]

Noninvasive Bilevel positive airway pressure (NIV BiPAP) is another mode used more routinely in ICU than the CPAP mode. It refers to providing different pressures during the inspiration and expiration of the patient. It supports the patient's breath and clinically alleviates the work of breathing to a great extent. But the downside is that even the slightest of suboptimal settings may allow the patient to take inappropriately large tidal volumes with multifold increased chances of barotrauma. Bilevel positive airway pressure (BiPAP) has been found to be more useful in presence of

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multiple comorbidities, and hypercapnic respiratory failure in the setting of COVID-19 infection. It faces challenges similar to that of CPAP.[5]

Frat et al. used the technique of sequential application of HFNC and NIV (HFNC applied in between NIV sessions) in patients having PaO_2/FiO_2 <300. As observed in this study, only 36% of patients required intubation with this approach. This strategy may help overcome the problem of prolonged application of tight-fitting masks during the NIV sessions.[9]

There are some common dangers with all these noninvasive respiratory devices, i.e., delay in intubation and risk of barotrauma. In one study, it was reported that tidal volumes of more than 9 mL per kg in a patient on NIV were strongly associated which self-inflicted lung injury (SILI), leading to increased mortality and the need for invasive ventilation. Usually an observation of 2–3 hours with noninvasive respiratory device should be sufficient to assess the response to therapy. It can be assessed clinically by reduced respiratory rate, decreased work of breathing, and better blood gases, i.e., improved PaO_2/FiO_2 ratio and decreased $PaCO_2$. It becomes problematic only if we extend the trial beyond 3–4 hours. This approach leads ultimately to delay in IMV and adverse outcomes. So, it is mandatory not to give in to the temptation of prolonging the trial beyond the first few hours.[10,11] Self-inflicted lung injury (SILI) has been a major concern during COVID-19, more so when delay in initiation of IMV occurs.

For effective use of noninvasive respiratory devices, a deeper evaluation is needed. We need to have an accurate understanding of the timing of initiation of noninvasive respiratory support, appropriate settings, duration of trial, SpO_2 target, operator efficiency, and P/F ratio to be used. The need for intubation also depends on whether NIV is the initial mode of therapy used or as a rescue therapy after failed HFNC trial. Mortality is significantly higher if used as a rescue therapy. As per the ERS/ATS clinical practice guidelines, NIV should be used by an experienced team on a highly selected cooperative patient group. Some studies from China showed that early intervention with either NIV or HFNC, with or without proning, led to lower mortality and reduced need for IMV (less than 1% vs 2.3% of the national average).[6,12] One more study found that early proning, with either NIV or HFNC, decreased the intubation rate by 50% in moderate to severe ARDS including those having viral pneumonia. Larger studies are needed for these standardizations.

The decision to intubate is based on the PaO_2/FiO_2 ratio, degree of fatigue, and work of breathing. Italian society of emergency medicine recommends waiting for invasive ventilation until the pulse oximeter reading is below 92% for at least 30 minutes while receiving maximum noninvasive oxygen support and if there are signs of clinical deterioration such as anxiety, diaphoresis, confusion, and tachypnea. Another parameter studied is respiratory rate-oxygenation (ROX), formula = ratio of peripheral oxygen saturation and fraction of inspired oxygen, to respiratory rate, index (SpO_2/FiO_2/respiratory rate). Initially, it was examined in HFNC patients, but can be extrapolated to other settings. ROX less than 4.8 predicts a higher rate of intubation.[6,13]

This study from Pune by Jog et al. highlights the role of HFNC or NIV in severe COVID-19 infections. In this retrospective study, the authors were forced to use either HFNC or NIV or both in COVID-19 patients with PaO_2/FiO_2 <150 (who were actually candidates for invasive ventilation), due to a severe crunch of ventilators and ICU beds.

There are limited numbers of studies that have compared these two modalities prospectively. Most of them are retrospective in nature. The most prominent prospective study is the helmet noninvasive ventilation vs high-flow oxygen therapy in acute hypoxemic respiratory failure trial (HENIVOT) randomized controlled trial. In this study, the authors assessed the impact of helmet NIV vs HFNC on the days free of respiratory support in moderate to severe hypoxemia in COVID-19 patients. No significant difference was found in this parameter between the two groups.[14] However, they did find a statistically significant lower rate of endotracheal intubation in helmet NIV group than in the HFNC group (30% vs 51%, $p = 0.03$). Another randomized controlled trial by Nair et al., from Delhi, has been published recently comparing NIV vs HFNC in severe COVID pneumonia. It did not show any statistical improvement either in oxygen parameters or in the intubation rate at 48 hours between NIV and HFNC. However, this study was underpowered.[15–17]

In this current adequately sampled study, the authors showed that about 36% of patients did not require intubation and were successfully treated with either HFNC or NIV, which is quite encouraging as far as managing severe respiratory failure is concerned. They also found the rate of intubation to be lower in the HFNC group. Although the study has its limitations like no standardized indications for either of the modalities, retrospective nature, etc., still it's a commendable joint effort. This may lead to many more such studies in India similar to the Australian and New Zealand Intensive Care Society (ANZICS) group.

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References

1. D'Silva C. Oxygenation indices in noninvasive ventilation: could they predict mortality in COVID-19? Indian J Crit Care Med 2021;25(8): 841–842. DOI: 10.5005/jp-journals-10071-23956.
2. Frat J-P, Thille AW, Arrive F, Lujan M, Rello J. What is the most adequate non-invasive oxygen support for acute hypoxaemic respiratory failure due to COVID-19? Anaesth Crit Care Pain Med 2021;40(4):100909. DOI: 10.1016/j.accpm.2021.100909.
3. Neto AS, Checkley W, Sivakorn C, Hashmi M, Papali A, Schultz MJ, et al. Pragmatic recommendations for the management of acute respiratory failure and mechanical ventilation in patients with COVID-19 in low- and middle-income countries. Am J Trop Med Hyg 2021;104(3):60–71. DOI: 10.4269/ajtmh.20-0796.
4. Wang Z, Wang Y, Yang Z, Wu H, Liang J, Liang H, et al. The use of non-invasive ventilation in COVID-19: a systematic review. Int J Infect Dis 2021;106:254–261. DOI: 10.1016/j.ijid.2021.03.078.
5. Winck JC and Ambrosino N. COVID-19 pandemic and non-invasive respiratory management: every Goliath needs a David. An evidence based evaluation of problems. Pulmonology 2020;26(4):213–220. DOI: 10.1016/j.pulmoe.2020.04.013.
6. Chawla R, Dixit SB, Zirpe KG, Chaudhry D, Khilnani GC, Mehta Y, et al. ISCCM Guidelines for the Use of Non-invasive Ventilation in Acute Respiratory Failure in Adult ICUs. Indian J Crit Care Med 2020;24 (Suppl 1):S61–S81. DOI: 10.5005/jp-journals-10071-G23186.
7. Vaschetto R, Barone-Adesi F, Racca F, Pissaia C, Maestrone C, Colombo D, et al. Outcomes of COVID-19 patients treated with continuous positive airway pressure outside the intensive care unit. ERJ Open Res 2021;7(1):00541-2020. DOI: 10.1183/23120541.00541-2020.

8. Carter C, Aedy H, Notter J. COVID-19 disease: non-invasive ventilation and high frequency nasal oxygenation. Clinics in Integrated Care 2020;1:100006. DOI: 10.1016/j.intcar.2020.100006.
9. Frat JP, Brugiere B, Ragot S, Chatellier D, Veinstein A, Goudet V, et al. Sequential application of oxygen therapy via high-flow nasal cannula and noninvasive ventilation in acute respiratory failure: an observational pilot study. Respir Care 2015;60(2):170–178. DOI: 10.4187/respcare.03075.
10. Nasibova EM, Pashayev CN. The use of non-invasive ventilation (NIV) in the treatment of patients with COVID-19. J Intensive Crit Care 2020;6(2):5. DOI: 10.36648/2471-8505.6.2.5.
11. Fu Y, Guan L, Wu W, Yuan J, Zha S, Wen J, et al. Noninvasive ventilation in patients with COVID-19-related acute hypoxemic respiratory failure: a retrospective cohort study. Front Med 2021;8:638201. DOI: 10.3389/fmed.2021.638201.
12. Abbas KA, Semedi BP, Sumartono C, Hamzah H. Prolonged of non-invasive ventilation in COVID-19 patient: intubate or not–a case report. Bali J Anesthesiol 2021;5(2):118–121. DOI: 10.4103/bjoa.bjoa_207_20.
13. Raoof S, Nava S, Carpati C, Hill NS. High-flow, noninvasive ventilation and awake (nonintubation) proning in patients with Coronavirus disease 2019 with respiratory failure. Chest 2020;158(5):1992–2002. DOI:10.1016/j.chest.2020.07.013.
14. Grieco DL, Menga LS, Cesarano M, Rosà T, Spadaro S, Bitondo MM, et al. Effect of helmet noninvasive ventilation vs high-flow nasal oxygen on days free of respiratory support in patients with COVID-19 and moderate to severe hypoxemic respiratory failure: the HENIVOT randomized clinical trial. JAMA 2021;325(17):1731–1743. DOI:10.1001/jama.2021.4682.
15. He Y, Liu N, Zhuang X, Wang X, Ma W. High-flow nasal cannula versus noninvasive ventilation in patients with COVID-19: a systematic review and meta-analysis. Ther Adv Respir Dis 2022. DOI:10.1177/17534666221087847.
16. Nair PR, Haritha D, Behera S, Kayina CA, Maitra S, Anand RK, et al. Comparison of high-flow nasal cannula and noninvasive ventilation in acute hypoxemic respiratory failure due to severe COVID-19 pneumonia. Respir Care 2021;66(12):1824–1830.DOI: 10.4187/respcare.09130.
17. Jog S, Zirpe K, Dixit S, Godavarthy P, Shahane M, Kadapatti K, et al. Noninvasive Respiratory Assist Devices in the Management of COVID-19-related Hypoxic Respiratory Failure: Pune ISCCM COVID-19 ARDS Study Consortium (PICASo). Indian J Crit Care Med 2022;26(7):791–797.