Editorial

High-flow nasal cannula is superior to noninvasive ventilation to prevent reintubation?

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In the ICU, when there is a do-not-intubate order, after extubation or lobectomy, during invasive diagnostic procedures such as bronchofibroscopy, and in other clinical situations, non-invasive ventilation (NIV) may be applied to enrich oxygenation before intubation. For acute exacerbation of COPD, acute cardiopulmonary edema, and respiratory failure in immunocompromised patients, NIV is strongly recommended because evidence shows that it reduces the mortality of such critically ill patients. There is no proof, however, that NIV reduces mortality for patients with other diseases. Because it recruits collapsed alveoli, increases end-expiratory lung volume, consequently improving oxygenation and decreasing the risk of lung injury due to atelectrauma, NIV appears to be beneficial. Unfortunately, patient discomfort limits administration of NIV, so it is usually applied for 4–7 hours a day (1). During periods when NIV support is withdrawn, end-expiratory lung volume may decrease and oxygenation might worsen. Such occurrences may explain why NIV fails to prevent re-intubation in patients with some types of respiratory failure. If it could be constantly applied until respiratory failure resolves to the point where support is no longer needed, NIV might be able to improve outcomes for more patients. By contrast, patients are far more tolerant of high-flow nasal cannula (HFNC), which can be applied for longer periods (2).

Meanwhile, NIV adds dead space, meaning that tidal volume and minute volume have to be increased to reduce work of breathing (3,4). With NIV, tidal volumes may rise as high as 9 mL/kg, a level that might worsen outcome for patients with acute respiratory failure (4). To support patient breathing or deliver oxygen, there are a number of devices and interfaces for NIV, including face mask, face mask with reservoir bag, full-face or total-face mask, and helmet. While not decreasing anatomical dead space, each of these delivery systems increases dead space. In this regard, too, HFNC is far more capable of washing out carbon-dioxide-rich gas and replacing it with fresh gas (5), thus reducing carbon dioxide rebreathing. Simulated breathing through a model lung has demonstrated that the replacement of expired gas with fresh gas starts before the end of expiration. Whereas low-flow gas administered through a nasal cannula does not wash out carbon dioxide rich gas in anatomical dead space, HFNC does this effectively enough to lessen minute volume, usually owing to decreased breathing frequency (6) and more regular respiration (7).

HFNC has become more and more widely adopted for patients with different kinds of respiratory failure. Besides providing positive end-expiratory pressure, which helps to wash out anatomical dead space, HFNC is better tolerated by patients and also facilitates secretion removal (6). Initially, HFNC was considered to be less effective than NIV via face mask but, in some situations, HFNC was considered superior to conventional oxygen therapy and applied because patients found it more comfortable than NIV. When HFNC seemed unable to prevent intubation,

however, escalation to NIV was indicated as the next step of respiratory support (8). More recently, however, clinical trials comparing HFNC with NIV have shown that HFNC is, at least, as effective as NIV.

There is still no conclusive evidence that NIV is the best choice for reducing the morbidity and mortality associated with extended mechanical ventilation, which would make it the first choice to support weaning from post-surgical mechanical ventilation; even so, it is used for recently extubated patients in ICUs. A meta-analysis of NIV use in selected subgroups of such patients suggests that judicious use of NIV may shorten ICU and hospital length of stay, reduce incidence of pneumonia, and improve hospital survival (9). As yet, for patients who undergoing major abdominal surgery, evidence is inadequate to confirm the benefit or harm of NIV during the postoperative period. Hernández *et al*., in high-risk patients, cross compared postextubation respiratory failure after HFNC or NIV. The patients were randomly assigned to undergo, for 24 hours after extubation, either HFNC or NIV supplemented with conventional oxygen therapy (10). The results show that HFNC was not inferior to NIV for preventing reintubation and postextubation respiratory failure. In the study, time to reintubation was similar in the two groups, probably because both NIV and HFNC were switched to conventional oxygen therapy after 24 hours. For those who received HFNC, from 24 hours after extubation the reintubation rate actually increased.

Although HFNC is an open system, high flow from the nasal cannula pushes against expiratory flow and increases pharyngeal pressure, thus increasing end-expiratory lung volume. As flow increases, mean pharyngeal pressure increases (11). Actual effects, however, are dependent on gender, body mass index, and whether the mouth is usually closed or open. In addition, the nasal cannula is liable to move around and its position also affects pharyngeal pressure. When the mouth is open, pharyngeal pressure drops to close to zero. Positive pharyngeal pressure is one beneficial physiological effect of HFNC, but this benefit will not be apparent for all patients. Even so, carbon dioxide washout is less dependent on mouth occlusion; in fact, washout is more effective with the mouth open. When HFNC is used as a means of oxygenation for patients with respiratory failure, the relative benefits of its various physiological effects remain unclear. Studies are required to clarify how HFNC might improve the outcome of patients with different types of respiratory failure. Meanwhile, individual studies consistently demonstrating that the use of NIV to treat rather than prevent post-extubation respiratory failure is, at best, unhelpful. Indeed when used in this way, NIV may increase the necessity for reintubation, which would have a knock-on effect on outcomes. The most important judgment when conducting less-invasive respiratory support is weighing the pros and cons of whether to reintubate or not. Hoping to avoid intubation, it is easily possible to prolong HFNC or NIV past the point where delayed reintubation worsens outcome.

A number of clinical trials have indicated that HFNC is, at least, not inferior to NIV. This recent study by Hernández *et al*. also shows that HFNC is as effective as NIV in preventing reintubation in high-risk patients. Physicians should be aware that for patients with respiratory failure the support provided by HFNC is as effective as that provided by NIV. Whichever therapy is applied, careful observation and consideration is essential to inform any decision about prolonging therapy or starting invasive ventilation.

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Footnote

Conflicts of Interest: The author has no conflicts of interest to declare.

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