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High Pressure versus High Flow: What Should We Target in Acute Respiratory Failure?

In this issue of the *Journal*, Grieco and colleagues (pp. 303–312) compare high-flow nasal cannula (HFNC) oxygenation versus noninvasive ventilation (NIV) delivering high levels of pressure using a helmet (1). In this physiological study, 15 patients with acute respiratory failure ($Pa_{O_2}/FI_{O_2} < 200$ mm Hg) were treated in a randomized crossover fashion by HFNC with a flow of 50 L/min or by NIV using a helmet with a high pressure-support level (10–15 cm H_2O) and a positive end-expiratory pressure (PEEP) of at least 10 cm H_2O, with each phase lasting 60 minutes. Compared with HFNC, NIV with a helmet markedly improved oxygenation and significantly reduced dyspnea, respiratory rate, and patient effort, whereas comfort and P_{CO_2} did not differ between the two techniques.

The management of acute hypoxemic respiratory failure in the ICU is challenging. In the most recent clinical practice guidelines, the use of NIV with a face mask was discussed, but the experts were unable to offer a recommendation (2). Patients with acute respiratory failure who have failed NIV are now known to have a vigorous respiratory drive, and such patients have a particularly poor prognosis (3, 4). Therefore, management to protect the already injured lung from the patient's vigorous spontaneous efforts (i.e., self-inflicted lung injury) is needed in this particular setting (5). Furthermore, synchronization between the patient's intense respiratory drive to breath and the pressure support delivered by NIV may result in high V_Ts that may worsen lung injury (5–8). Thus, controlling spontaneous efforts and V_Ts could be of key importance in the management of acute hypoxemic respiratory failure.

HFNC is an alternative to standard oxygen that enables improved oxygenation and comfort and decreases the respiratory rate and work of breathing without increasing V_Ts (9). In a large randomized clinical trial, HFNC significantly decreased mortality in patients with acute respiratory failure when compared with standard oxygen, as well as when compared with HFNC with the addition of intermittent sessions of NIV using a face mask, suggesting deleterious effects of NIV (10). A *post hoc* analysis of this study showed that large V_Ts (>9 ml/kg of predicted body weight) 1 hour after initiation of NIV were independently associated with intubation and mortality (11). This could highlight the importance of controlling patients' efforts and V_Ts to prevent the progression of acute respiratory failure.

As compared with the face mask, the helmet is an interface that appears to be more comfortable for patients (avoiding facial pressure points), enabling the delivery of more prolonged NIV sessions with higher levels of pressure (12). A randomized controlled trial that included patients with acute respiratory distress syndrome found a spectacular decrease in intubation and mortality rates with NIV performed using a helmet as compared with a face mask (13). In this trial, NIV with a helmet (vs. a face mask) enabled the delivery of higher PEEP levels, likely resulting in less spontaneous effort (as suggested by lower respiratory rates), lower intubation rates, and better survival. Although these results are encouraging, this study had major weaknesses, including a small sample of patients ($n = 83$), a single-center design, and particularly high intubation rates in the group treated with a face mask (13). However, these results suggest that NIV with a helmet could be a useful technique to manage patients' efforts through an effective delivery of higher pressures.

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The above-mentioned trial (13) revived the debate on NIV and led to the current physiological study (1). Consistent with the previous study, Grieco and colleagues obtained pretty spectacular results on oxygenation and indexes of work of breathing measured using esophageal pressure (i.e., a negative swing in esophageal pressure and esophageal pressure–time product). Although the esophageal pressure–time product was estimated by simplified measurement because of the impossibility of accurately assessing the end of inspiration with HFNC, and because chest wall recoil was neglected, the study was well conducted and measurements were well executed.

The primary strength of the current study performed by Grieco and colleagues is that it reveals that the beneficial physiological effects of helmet NIV are more pronounced in patients who have more severe lung injury and make more vigorous spontaneous efforts. Patients who made more vigorous effort during HFNC received a greater benefit (i.e., a more pronounced reduction of spontaneous effort when switched to helmet NIV). Most of the results favor the use of NIV with a helmet, except for the transpulmonary pressure swing, which seemed to be higher with a helmet than with HFNC. Although the difference was not significant in the overall cohort, probably owing to the small sample size, patients who exhibited lower inspiratory effort with HFNC showed significantly increased transpulmonary pressure swings with NIV using a helmet. Unfortunately, it is not possible to measure exhaled V_Ts with NIV using a helmet. However, because the transpulmonary pressure swings were higher, we can assume that the V_Ts were probably larger with NIV using a helmet than with HFNC. Another limitation of the study is that only short-term use of each technique was assessed; it is not certain that NIV using a helmet would be as well tolerated as HFNC over longer periods.

NIV using a helmet seems to be a promising technique in terms of oxygenation and work of breathing, especially for those patients who display vigorous spontaneous effort during acute respiratory failure. However, the high transpulmonary pressures generated by the helmet may potentially worsen lung injury in some patients. Therefore, it would seem necessary to conduct trials to assess whether these beneficial physiological effects of helmet NIV are associated with better outcomes, and which patients would benefit most from this technique. In conclusion, the results of this study seem promising but need to be confirmed in a large multicenter controlled trial. ■

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