Turbocharging NIV: how to increase oxygen delivery in home mechanical ventilators

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In patients with hypoxaemic respiratory failure, supplement oxygen is added to a non-invasive ventilator to increase the fraction of inspired oxygen (FiO_2). The FiO_2 delivered through these domiciliary, non-critical care ventilators is limited and it is determined by a number of factors, including mode of ventilation, location of the oxygen connection point, intentional and unintentional leak, oxygen flow rate, length of circuit and type of interface.[1 2] In this issue of the *Journal*, Mebrate *et al*[3] described a novel adaptation for two commercially available non-invasive ventilators, which increases FiO_2 delivery. The process of increasing oxygen mass in a motor engine is called turbocharging and the approach by Mebrate *et al*[3] can be viewed as turbocharging non-invasive ventilation (NIV). The simple modifications described allowed capture of the gas mixture expelled by the ventilator during expiration so that in the subsequent inspiration the ventilator drew from an oxygen enriched gas mixture and mixed it with oxygen added in the usual manner.

As the global COVID-19 pandemic continues, there is a requirement to have ventilators that provide high fractions of inspired oxygen to manage the large number of patients with severe hypoxaemic respiratory failure. This patient demand has been substantially greater than ventilator stock availability and it has even been proposed that one ventilator could be used to support two patients.[4] However, there are significant concerns to sharing a ventilator between two patients as without measuring and matching of the respiratory resistance and elastance, there will be subsequent overventilation of one patient and underventilation of the other, resulting in adverse clinical consequences.

The turbocharging modifications ensure that the patient receives both adequate oxygenation and adequate ventilation as the airway pressure delivery is unaltered by the modifications. In addition, the recycling and conservation of oxygen reduces the hospital oxygen demand, which is important, in particular, in those hospitals in which the oxygen supply is limited. Furthermore, this adaptation to the ventilator could be considered as a useful clinical approach for the management of acute respiratory failure of other causes, in particular, in patients with hypoxaemic respiratory failure, with or without hypercapnic respiratory failure, who have limits on their escalation of care plan.

The use of these turbocharging adaptations is clearly outside of the recommendations of the manufacturer and only appropriate when the ventilator stock has been exhausted. To evaluate the clinical applicability of turbocharging NIV, a pilot clinical feasibility study in healthy humans, stable patients and unstable hypoxic patients is essential, however, it is expected that during the pandemic, the institutional risk and assurance board would provide agreement for the use of turbocharged NIV. Any such approach would require clear communication with the patient and their family. Industry should consider supporting the commercialisation of turbocharged NIV such that the device would undergo safety, health and environmental protection assessment and approval to receive a Conformitè Europëenne mark. In the meantime, the authors should be congratulated on engineering a turbocharged non-invasive ventilator. Full access to the instruction files detailing the three-dimensional printed adapters is available.

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