

Helmet Noninvasive Ventilation for Weaning From Mechanical Ventilation

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We saw a patient who presented with carbon dioxide narcosis and acute respiratory failure due to an exacerbation of chronic obstructive pulmonary disease. We intubated and 12 hours later he had recovered consciousness and could cooperate with noninvasive ventilation, at which point we extubated and used a helmet to provide noninvasive positive-pressure ventilation in assist/control mode, and then during the ventilator-weaning process, pressure support, and finally continuous positive airway pressure. The patient had no complications from the helmet, and he was discharged from intensive care 48 hours after helmet ventilation was initiated. Helmet noninvasive ventilation is a potentially valuable ventilator-weaning method for certain patients. *Key words: mechanical ventilation, ventilator weaning, chronic obstructive pulmonary disease.* [Respir Care 2004;49(9):1035–1037. © 2004 Daedalus Enterprises]

Introduction

One of the cornerstones of critical care medicine is support of the failing respiratory system. The 2 major components of managing respiratory failure are the acute intervention and the weaning process. Many of the studies to determine the optimal methods of ventilation and weaning have focused on noninvasive positive-pressure ventilation (NPPV) as an alternative to invasive ventilation, with various causes of acute respiratory failure.¹ However, standard face-mask and nasal-mask NPPV is associated with complications and dissatisfaction on the part of patients and staff. Thus, mask NPPV has disappointed some of those who viewed it as a potential breakthrough in critical care medicine.² In the era of increasing demand for intensive care unit beds, shortage of nurses, and increased multiple-drug-resistant, ventilator-associated pneumonias, it is essential to find new solutions to this problem. One of the

recommendations of the American Thoracic Society's international consensus conference on NPPV for acute respiratory failure was that health technology research should focus on improving the patient-ventilator interface.¹

We present the case of a patient with acute hypoxemic and hypercapnic respiratory failure with whom we used an NPPV helmet, which is a relatively new NPPV device for full ventilatory support following extubation and throughout the weaning process.

Case Summary

A 67-year-old man was admitted to the general intensive care department in a stupor due to acute hypoxemic and hypercapnic respiratory failure. The patient was known to have chronic bronchitis, having had 4 hospitalizations over the previous 2 years for exacerbations. He was also known to have chronic hypercapnia but had never required intubation and mechanical ventilation before the current hospitalization. He was not on home oxygen supplementation and was not using any NPPV devices. Three days prior to his admission he developed fever and a purulent cough that progressed in severity, and on the day of admission he developed shortness of breath. Physical examination revealed temperature 38.5°C, heart rate 120 beats/min, respiratory rate 38 breaths/min, and blood pressure 140/70 mm Hg. He was stuporous, cyanotic, and breathed with the aid of accessory muscles. He had normal heart

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sounds, without evidence of congestive heart failure. Auscultation revealed crackles over the left side of the chest. Arterial blood gas values on admission were P_{aO_2} 45 mm Hg (while receiving 100% oxygen), P_{aCO_2} 120 mm Hg, bicarbonate 40 mEq/L, and pH 7.13. His admission chest radiograph confirmed the diagnosis of left-lower-lobe pneumonia. The patient was intubated and mechanical ventilation was begun with a Puritan-Bennett 7200 ventilator in assist/control mode, fraction of inspired oxygen 0.6, tidal volume 0.6 L, respiratory rate 14 breaths/min, positive end-expiratory pressure (PEEP) 7.5 cm H₂O. Twelve hours later the patient was conscious and aware of his surroundings. Although his oxygenation and ventilation had improved (P_{aO_2} 60 mm Hg, P_{aCO_2} 60 mm Hg), he still needed ventilatory support. His airway reflexes were intact and the endotracheal tube caused him severe discomfort. At that point we had 2 options: (1) to sedate the patient and thereby perhaps delay weaning from mechanical ventilation, or (2) to switch to NPPV. We chose to extubate. We knew that mask NPPV is associated with low patient compliance and high nursing workload, whereas we were encouraged by our experience with the NPPV helmet (Castar, StarMed, Italy), so we initiated helmet NPPV. No ventilator settings were changed. The helmet's flow port was connected to the ventilator's inspiratory limb, and the PEEP port was connected to the expiratory limb (Fig. 1).

The patient was very comfortable with the helmet; after 6 hours we switched the ventilation mode to pressure support (15 cm H₂O) with PEEP of 5 cm H₂O, and checked to assure that the patient was comfortable. His respiratory rate was maintained at 16–20 breaths/min and his oxygen saturation was above 90%.

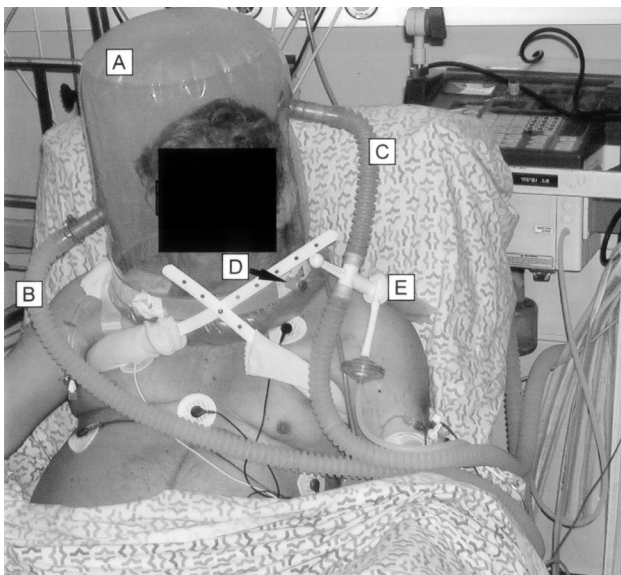


Fig. 1. The noninvasive-ventilation helmet. A: Helmet. B: Expiratory limb. C: Inspiratory limb. D: Feeding port. E: Nebulizer.

After gradual reduction of the pressure support, to 5 cm H₂O, we changed the ventilation mode to continuous positive airway pressure (using only the helmet with a PEEP valve, without a ventilator) at 5 cm H₂O. Twenty-four hours later we withdrew ventilatory support, and the patient was discharged from the intensive care department to a medical ward, with an air-entrainment oxygen mask. The patient had suffered no aspiration, lesions, or other adverse effects from the helmet.

Discussion

NPPV is used with patients with respiratory failure of various etiologies, but it cannot be used with patients who have a low level of consciousness or noncompetent airway.³ A few studies have suggested that NPPV can be used for post-extubation ventilator weaning, and those studies found that NPPV reduces the need for re-intubation and sedation and reduces the occurrence of ventilator-associated pneumonia.⁴

NPPV remains controversial as a post-extubation technique,^{5,6} but NPPV trials have used only face mask or nasal mask, and some of the extubation failures in those trials might be attributable to patient dissatisfaction with the masks.

The NPPV helmet is a relatively new interface, developed in Italy.⁷ Its main advantages over face masks are better patient compliance, fewer complications, and lower nurse workload.^{7,8} Like other NPPV interfaces, the NPPV helmet can be used for almost every mode of ventilation, provided that the respirator has the appropriate specifications (eg, leak compensation). It is also effective as a continuous positive airway pressure device that requires only oxygen flow.^{9,10} Recent studies demonstrated favorable outcomes with the helmet for hypoxemic⁷ and hypercapnic⁸ respiratory failure. The helmet has been tested in emergency rooms,¹¹ for ventilation during fiberoptic bronchoscopy,¹² and in other settings.¹³ However, to our knowledge the case presented above is the first report of using the helmet to wean a patient from mechanical ventilation.

On admission the patient could not be treated with NPPV because he was not adequately conscious to cooperate with the ventilator and thus his airway was compromised. As soon as ventilatory support had reduced the hypercapnia, the patient awoke and NPPV was deemed appropriate. The patient did not require sedation, and the preparations for helmet NPPV took less than 2 min. No special explanation or accommodation time was required, as is the case for face-mask or nasal-mask NPPV. The patient could speak, drink, and cough, and had a full view of his surroundings.

NPPV complications such as aspiration, poor patient compliance, pain, pressure sores, gastric dilation, and nasal-bridge necrosis are common and can lead to NPPV failure,¹⁴ but no such complications occurred with our pa-

tient, though perhaps the absence of complications was in part due to the short duration of NPPV.

One of the disadvantages of the helmet is that respiratory cycle volumes and pressures cannot be measured routinely or precisely. However, we had no difficulty estimating the efficiency of the ventilatory support or the progress of the weaning process by monitoring clinical and laboratory variables, including respiratory rate, heart rate, oxygen saturation, P_{aCO_2} , blood pressure, and respiratory pattern.

Our patient's excellent clinical course through acute respiratory failure should encourage other critical care providers to use the NPPV helmet in similar circumstances. With carefully selected patients the traditional sequence of (1) intubation, (2) mechanical ventilation, (3) weaning, and (4) extubation, can be changed to (1) intubation, (2) mechanical ventilation, (3) extubation, and (4) NPPV helmet weaning. The helmet could reduce the incidence of ventilator-associated pneumonia, the duration of intensive-care stay, staff work load, costs, and complications from sedation, invasive ventilation, and face-mask/nasal-mask NPPV. Further studies are needed to evaluate the role of routine helmet NPPV in weaning.

REFERENCES

1. American Thoracic Society. International consensus conferences in intensive care medicine: noninvasive positive-pressure ventilation in acute respiratory failure. *Am J Respir Crit Care Med* 2001;163(1):283–291.
2. Navalesi P, Fanfulla F, Frigerio P, Gregoretti C, Nava S. Physiologic evaluation of noninvasive mechanical ventilation delivered with 3 types of masks in patients with chronic hypercapnic respiratory failure. *Crit Care Med* 2000;28(6):1785–1790.
3. Liesching T, Kwok H, Hill NS. Acute applications of noninvasive positive pressure ventilation. *Chest* 2003;124(2):699–713.
4. Nava S, Ambrosino N, Clini E, Prato M, Orlando G, Vitacca M, et al. Noninvasive mechanical ventilation in the weaning of patients with respiratory failure due to chronic obstructive pulmonary disease: a randomized, controlled trial. *Ann Intern Med* 1998;128(9):721–728.
5. Girault C, Daudenthun I, Chevron V, Tamion F, Leroy J, Bonmarchand G. Noninvasive ventilation as a systematic extubation and weaning technique in acute-on-chronic respiratory failure: a prospective, randomized controlled study. *Am J Respir Crit Care Med* 1999;160(1):86–92.
6. Hill N, Lin D, Levy M, et al. Noninvasive positive-pressure ventilation (NPPV) to facilitate extubation after acute respiratory failure: a feasibility study (abstract). *Am J Respir Crit Care Med* 2000;161:A263.
7. Antonelli M, Conti G, Pelosi P, Gregoretti C, Pennisi MA, Costa R, et al. New treatment of acute hypoxemic respiratory failure: noninvasive pressure support ventilation delivered by helmet—a pilot controlled trial. *Crit Care Med* 2002;30(3):602–608.
8. Scandroglio M, Piccolo U, Mazzone E, Agrati P, Aspesi M, Gamberoni C, et al. Use and nursing of the helmet in delivering noninvasive ventilation. *Minerva Anestesiol* 2002;68(5):475–480.
9. Ferrario D, Lucchini A. [Helmet delivered CPAP for in-patients]. *Minerva Anestesiol* 2002;68(5):481–484. Article in Italian
10. Chiumello D, Pelosi P, Carlesso E, Severgnini P, Aspesi M, Gamberoni C, et al. Noninvasive positive pressure ventilation delivered by helmet vs. standard face mask. *Intensive Care Med* 2003;29(10):1671–1679.
11. Pelosi P, Severgnini P, Aspesi M, Gamberoni C, Chiumello D, Fachinetti C, et al. Non-invasive ventilation delivered by conventional interfaces and helmet in the emergency department. *Eur J Emerg Med* 2003;10(2):79–86.
12. Antonelli M, Pennisi MA, Conti G, Bello G, Maggiore SM, Michetti V, et al. Fiberoptic bronchoscopy during noninvasive positive pressure ventilation delivered by helmet. *Intensive Care Med* 2003;29(1):126–129.
13. Cavaliere F, Masieri S, Conti G, Antonelli M, Pennisi MA, Filippo R, Proietti R. Effects of non-invasive ventilation on middle ear function in healthy volunteers. *Intensive Care Med* 2003;29(4):611–614.
14. Mehta S, Hill NS. Noninvasive ventilation. *Am J Respir Crit Care Med* 2001;163(2):540–577.