

Noninvasive Positive-Pressure Ventilation in Postoperative Hypoxemic Respiratory Failure—With a Helmet?

For over 15 years the critical care community has been fascinated with the use of noninvasive positive-pressure ventilation (NPPV) to manage acute respiratory failure. Indeed, the number of randomized controlled trials of NPPV, from my count, exceeds 50. More randomized controlled trials of NPPV have been conducted than almost any other aspect of respiratory care.

SEE THE ORIGINAL STUDY ON PAGE 1463

This abundance of data has defined the circumstances where NPPV can successfully avoid intubation. In patients with an exacerbation of chronic obstructive pulmonary disease (COPD), NPPV is considered the standard of care,¹ and in my opinion should be available as first-line therapy in any institution that treats acutely ill COPD patients. In patients with cardiogenic pulmonary edema, both noninvasive continuous positive airway pressure (CPAP) and NPPV have been shown to avoid intubation and, again, should be considered the standard of care.² In patients weaning from ventilatory support it has been shown that NPPV can be used to transition COPD patients who fail a spontaneous breathing trial to spontaneous unassisted breathing.^{3,4} Patients who pass a spontaneous breathing trial but are at high risk for reintubation benefit from NPPV after extubation.^{5,6} However, we also have learned that patients who develop hypoxemic respiratory failure following extubation do not benefit from NPPV.^{7,8} In numerous other settings, including immunosuppression,⁹ asthma,¹⁰ patients with do-not-resuscitate/do-not-intubate orders,¹¹ and others, there are data that support the use of NPPV. However, limited data exist that support the use of NPPV in postoperative hypoxemic respiratory failure.¹²

In this issue of *RESPIRATORY CARE*, Conti and colleagues¹³ provide data that support the use of NPPV in patient with acute hypoxemic respiratory failure after abdominal surgery. Of the 50 patients they report on, 33 (66%) avoided intubation with the use of NPPV. Their study was a matched control study in which 25 historical controls who received NPPV via face mask were compared to 25 patients managed with an NPPV helmet (CaStar, Starmed, Mirandola, Italy). Their data indicate that 18 of 25 patients ventilated with a mask, and 14 of 25 ventilated with the helmet initially demonstrated im-

proved gas exchange. However, eventually, 12 of the mask patients and only 5 of the helmet patients required intubation ($p = 0.036$). The single factor that distinguished the 2 groups was tolerance of the patient-ventilator interface. Of the patients intubated, 8 in the mask group and 3 in the helmet group required intubation because of intolerance of the mask or helmet. In addition, the rate of NPPV complications (mask intolerance, major mask leaks that caused ventilator malfunction, and ventilator-associated pneumonia) were higher in the mask group ($p < 0.03$). Conti and colleagues conclude that the use of the helmet in managing these patients is superior to the use of a full-face mask.

Does this mean we should all petition the Food and Drug Administration to approve the CaStar helmet for use in the United States, or can there be other reasons why the helmet performed better than the full-face mask in this study? Since the helmet is not available in the United States, I have included Figure 1. Yes, it is a plastic bag that is placed over the patient's head and secured by straps that pass under the arms in the axillary area. Contrary to its appearance, it is extremely comfortable. The only pressure point is in the axillary area, and intolerance is associated with axillary abrasion or the development of axillary deep venous thrombosis, although, as indicated by Conti et al,¹³ this is rare.

Now here is the problem: the helmet is a large capacitor. As a result, it is ineffective with bi-level pressure noninvasive ventilators that maintain a continuous flow. If ventilation is going to be provided, it must be provided with an intensive care ventilator that has a separate inspiratory and expiratory limb. If CPAP is going to be provided with the helmet, a continuous high-flow system must be used.¹⁵ If a high continuous flow is not used, CO₂ accumulates in the helmet. As a result, no ventilator currently on the market can be used to provide CPAP with the helmet.

Ventilation with the helmet has been shown to be less effective than with a face mask.¹⁶ This same group, in a previous publication, showed that the decrease in CO₂ after initiation and at discontinuation of NPPV was higher with the helmet than with a face mask.¹⁶ In the group of patients in the study in this issue,¹³ it is important to note that hypercarbia and acidosis were not issues that man-

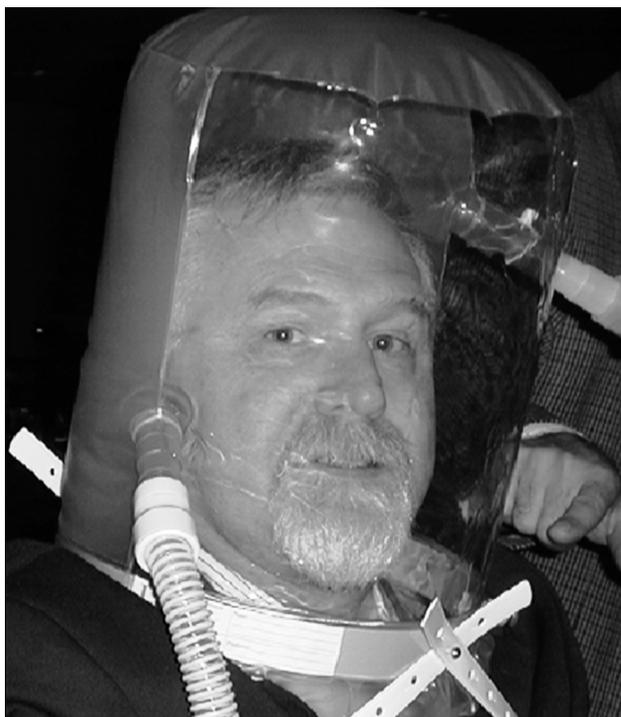


Fig. 1. The helmet has a large compressible volume. The gas enters the helmet at the upper right and exits at the lower left. Some helmet designs include ports for nasogastric tubes and drinking straws. (From Reference 14.)

dated ventilation. As noted in Table 3 of this study, the P_{CO_2} of both groups was 37–43 mm Hg and the pH was 7.42–7.46. These patients presented with uncomplicated acute hypoxemic respiratory failure. Based on current information, caution should be exercised regarding the use of the helmet. I would not recommend its use in the setting of severe acute hypercapnic respiratory failure. And if used for CPAP, a continuous flow system must be employed.

Now for the issue of mask intolerance! As the authors point out, a Servo 300 ventilator was used in both arms of the study. This choice of ventilator is of concern with a face mask, where leaks are much more of an issue than they are with the helmet. The Servo 300 cycles to exhalation in pressure support when the inspiratory flow decreases to 5% of the peak flow; it does not incorporate an expiratory cycling adjustment or compensate for leaks. The standard for most ventilators that do not incorporate adjustment of cycling criteria in pressure support is a termination criteria of 25% of peak flow. The Servo 300 also does not incorporate an NPPV mode. As a result, it is one of the least accommodating intensive care ventilators for the application of NPPV, because it cannot tolerate any leak. Thus, the face mask must be strapped very tightly to ensure proper functioning of the ventilator, which increases the likelihood of

the development of pressure sores and poor tolerance. The patients in the face mask group were historical controls, and no data is presented on when they were studied or the particular type of mask provided by Vital Signs or Dar-Tyco. Dramatic improvement in the quality of NPPV masks has occurred over the last few years. It is possible that the use of newer face masks, along with a different ventilator—particularly one designed for NPPV that compensates for leaks—may have greatly improved mask tolerance.

I am delighted to see this data on the successful application of NPPV in the treatment of hypoxemic respiratory failure in postoperative abdominal surgery patients, but I am not ready to accept the helmet as the superior method of applying NPPV in these patients! In the setting of eucapnic acute hypoxemic respiratory failure the helmet does provide adequate ventilatory support, but my guess is no better than *optimally* applied NPPV with a face mask!

Robert M Kacmarek PhD RRT FAARC
Respiratory Care Services
Massachusetts General Hospital
Harvard Medical School
Boston, Massachusetts

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NPPV IN POSTOPERATIVE HYPOXEMIC RESPIRATORY FAILURE—WITH A HELMET?

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Correspondence: Robert M Kacmarek PhD RRT FAARC, Respiratory Care Services, Massachusetts General Hospital, 55 Fruit Street, Boston MA 02114. E-mail: rkacmarek@partners.org.

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