Noninvasive Face-Mask Mechanical Ventilation in Patients With Acute Hypercapnic Respiratory Failure

To the Editor:

We read with interest in the August 1991 issue of Chest about the experience of Meduri and co-workers1 with face-mask ventilation in patients with COPD and hypercapnic respiratory failure. However, our experience with face-mask ventilation has been disappointing, with patients failing because of an inability to tolerate the mask. 

We have attempted face-mask ventilation on four patients (three men and one woman). All had severe COPD (mean FEV1 = 0.62 ± 0.24 [SD] L; FEV1/FVC = 31 ± 7 percent) and were admitted with hypercapnic respiratory failure. All had previously refused intubation and reaffirmed this request on admission. All patients were admitted to our medical intensive care unit and were treated with frequent aerosolized bronchodilators, systemic corticosteroids, and antibiotics (to treat bronchitis, as none had evidence of pneumonia). Two patients were receiving theophylline prior to admission, and this was continued. All patients underwent a trial of noninvasive mechanical ventilation through a nasal continuous positive airway pressure (CPAP) mask (Respirronics, Murrysville, Pa) with a volume ventilator (MA-1 Bennett or Bear II). All were unable to tolerate nasal mechanical ventilation because of an inability to minimize mouth leaks. Three patients were edentulous or partially edentulous, which prevented a tight mouth seal. All patients were developing dyspnea and hypercapnia, and were offered a trial of face-mask ventilation using a Benefit face mask (Puritan-Bennett, Carlsbad, Calif) and rubber straps. Before face-mask ventilation, arterial blood gas values (mean ± SD) on supplemental oxygen were as follows: pH, 7.25 ± 0.04 (range, 7.20 to 7.28); PaCO2, 86 ± 12 mm Hg (range, 68 to 92 mm Hg); PaO2, 68 ± 13 mm Hg. All patients were initially cooperative with mask fitting and adjustment. Initial ventilator settings included assist control with a rate of 14 breaths per minute, tidal volume of 10 ml/kg, and peak flow of 60 L/min. The mask was well seated without leaks during ventilation. None of the patients was able to tolerate face-mask ventilation for more than a few minutes. Two of the patients were mildly lethargic (secondary to CO2 narcosis), but became agitated, refusing to wear the mask shortly after initiation of assisted ventilation. All patients stated that they were unable to tolerate the mask because of an overwhelming sensation of suffocation associated with face-mask ventilation. Another attempt at face-mask ventilation was made after minor adjustments in ventilator settings (tidal volume, ventilator sensitivity) and after readjustment of the mask in three of the four patients with the same results. The fourth patient refused to allow another attempt at face-mask ventilation. One of the patients eventually recovered with intensive medical therapy to be discharged. The other three continued to deteriorate and died of respiratory failure.

These patients appeared to have gas exchange abnormalities and severity of illness similar to those of the patients who underwent face-mask ventilation in the studies by Meduri et al1 and other investigators.2 The successful reports with face-mask ventilation have involved ventilation with a pressure-support ventilator. Pressure support may facilitate assisted ventilation since breaths are patient-initiated with a lower propensity for patient-ventilator asynchrony.3 However, there are numerous reports of successful treatment of hypercapnic respiratory failure with nasal masks and volume-cycled ventilators.4,5 Patient-ventilator asynchrony did not appear to be a major contributor to failure of face-mask ventilation in these patients, as they all made sufficient efforts to cycle with the ventilator.

The sensation of suffocation can be quite intense and in our experience overwhelmed any relief in dyspnea that may have occurred during face-mask ventilation. This intolerance of the face mask was not reported by Meduri and co-workers, although one patient was unable to continue face-mask ventilation because of unspecified discomfort. The use of sedation or analgesics to improve adaptation to the mask is tempered by the risk of further respiratory depression. This may become a limiting factor to the use of face-mask ventilation as noninvasive ventilation gains wider acceptance.

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To the Editor:

The experience of Drs. Soo Hoo and Williams using face-mask mechanical ventilation (FMMV) in patients with hypercapnic respiratory failure due to COPD is quite different from our own,1,4 including our experience with patients who refused endotracheal intubation.3
Soo Hoo and Williams reported the cases of four patients with COPD and acute respiratory failure who were unable to tolerate nasal ventilation with a volume respirator and who later received FMMV using the assist-control mode and a tidal volume of 10 ml/kg. Although initial fittings were uneventful, none of their patients could tolerate the mask due to the sensation of suffocation. Of interest is the fact that three of these four patients were edentulous, which may prevent proper fitting of the face mask.

In our experience, FMMV is an effective alternative to endotracheal intubation in patients with acute hypercapnic respiratory failure. Most of our patients tolerate the face mask well. We have found that a significant decrease in the sensation of dyspnea occurs soon after initiating FMMV and persists throughout treatment. Our positive experiences are similar to those reported by other groups.

Since our original report in 1989, several articles have been published in the literature on the effectiveness of FMMV. To date, 13 studies have been done of noninvasive ventilation using nasal or face mask on a total of 239 patients with acute respiratory failure. Of these 238 patients, 50 were ventilated with use of the volume-control mode, predominantly via nasal mask (four of five studies), with an overall success rate of 74 percent. The remaining 189 patients were ventilated with pressure-support ventilation (PSV), mainly via face mask (6 of 8 studies), with success rates of 83 percent. Marino used both nasal and face-mask ventilation in his study, but it is unclear whether the 4 (of 13) patients who failed to respond were receiving nasal or face-mask ventilation.

Differences in methodology that might explain our success compared with the failure of Soo Hoo and Williams with FMMV are as follows:

1. Mode of ventilation: Volume-cycled mode causes high peak pressure, which uniformly leads to air leak around the mask or distention of the cheeks and consequently poor ventilation of the lower airways. Pressure-support ventilation, which is used as the major mode of ventilation on all our patients, allows for better synchronization between patient and ventilator, is associated with lower peak pressure and minimal air leak, and produces a more comfortable flow pattern. Of 18 patients in our series, 15 described relief of dyspnea with this method.

2. Use of low-level CPAP: Low-level CPAP allows overcoming of intrinsic PEEF (PEEP), a common phenomenon in patients with severe airway obstruction that is known to increase the work of breathing despite mechanical ventilation. Relief of dyspnea can be significantly improved with use of CPAP at a level of 3 to 5 cm H₂O without causing any significant air leak. In seven COPD patients who had acute respiratory failure and were ventilated through a nasal mask, Donner et al.* showed that the application of low levels of CPAP offset PEEP, and improved the efficiency of PSV by reducing the magnitude of inspiratory effort. Work of breathing was computed using the pressure-time product (PTT) while patients were on PSV alone or PSV and CPAP. A reduction of 25 percent of the PTT of the respiratory muscles and 37 percent of the PTT of the diaphragm was demonstrated with the addition of CPAP (80 percent of baseline PEEP) over PSV.

3. Tidal volume: In setting the ventilator, we titrate PSV to achieve a tidal volume of 5 to 7 ml/kg. We feel that the traditional use of a tidal volume of 10 to 12 ml/kg is not necessary to overcome ventilatory muscle fatigue present in patients with hypercapnic ventilatory failure at this stage. We are able to improve alveolar ventilation and correct respiratory acidosis with a tidal volume of 600 to 750 ml. A relatively large VT may be associated with high peak pressure, more air leak, and less patient comfort. Using proportional-assist ventilation, a new method of partial ventilatory support with which ventilator pressure is proportional to instantaneous patient effort, Marantz et al. showed that patients who were given the option of choosing their tidal volume with mechanical constraints opted for a level on average of 7.1 ml/kg (range, 3.0 to 10.4 ml/kg).

We agree that the use of sedatives is extremely dangerous with FMMV due to lack of control of the airway and need of spontaneous respiratory effort with PSV. In our experience, sedatives are rarely needed since FMMV is effective in correcting gas exchange abnormalities that cause depression in mental status (hypercapnia) and agitation (hypoxia).

Finally, we believe that there is a learning curve in using FMMV for both physicians and respiratory technicians.

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7 Pennock BE, Kaplan PD, Carlin BW, Sabangan JS, Magovern JA. Pressure support ventilation with a simplified ventilatory support system administered with a nasal mask in patients with respiratory failure. Chest 1991; 100:1371-76

Training and Competence in Bronchoscopy
The Thoracic Surgeon's Viewpoint

To the Editor:

We read with interest in the December 1991 issue of Chest the results of the ACCP survey on bronchoscopy* and the related commentary by Prakash and Stubbbs.* In their commentary the authors assume that "if a substantial number of other specialists, such as thoracic surgeons and otolaryngologists, who also perform..."