#### 1-MINUTE CONSULT





**BRIEF ANSWERS** TO SPECIFIC **CLINICAL QUESTIONS** 

# **Does noninvasive positive pressure ventilation** have a role in managing hypercapnic respiratory failure due to an acute exacerbation of COPD?

ARI J. GERSHMAN, DO

Department of General Internal Medicine, Cleveland Clinic

ANITA J. REDDY, MD

Respiratory Institute, Cleveland Clinic

MARIE M. BUDEV. DO. MPH

Respiratory Institute, Cleveland Clinic

PETER J. MAZZONE, MD, MPH

Respiratory Institute, Cleveland Clinic

**Compared** with medical therapy alone, **NIPPV** reduces the mortality rate

• Yes. In selected patients with hyper-• capnic respiratory failure due to an acute exacerbation of chronic obstructive pulmonary disease (COPD), noninvasive positive pressure ventilation (NIPPV) is an effective adjunct to usual medical therapy. In controlled trials, it reduced the need for endotracheal intubation, the length of hospital stay, and the risk of death.

Acute COPD exacerbations are responsible for more than 500,000 hospitalizations yearly in the United States, and 6% to 34% of patients die.1

Many patients need invasive ventilatory assistance via an endotracheal tube, but such therapy puts the patient at risk of ventilatorassociated pneumonia, pneumothorax, and tracheal stenosis.

# WHAT IS NONINVASIVE POSITIVE PRESSURE VENTILATION?

With NIPPV, the patient wears a tightly fitting nasal or full facial mask, avoiding the need for an endotracheal tube, laryngeal mask, or tracheostomy (FIGURE 1).<sup>2</sup> The mask can be connected to a standard mechanical ventilator or, more commonly, to a continuous positive airway pressure or bi-level airway pressure unit. NIPPV has been used with variable success in a variety of conditions, including COPD exacerbations,<sup>3–6</sup> acute cardiogenic pulmonary edema, hypoxemic respiratory failure, 8 and ventilator weaning.9

#### WHY IS IT BENEFICIAL?

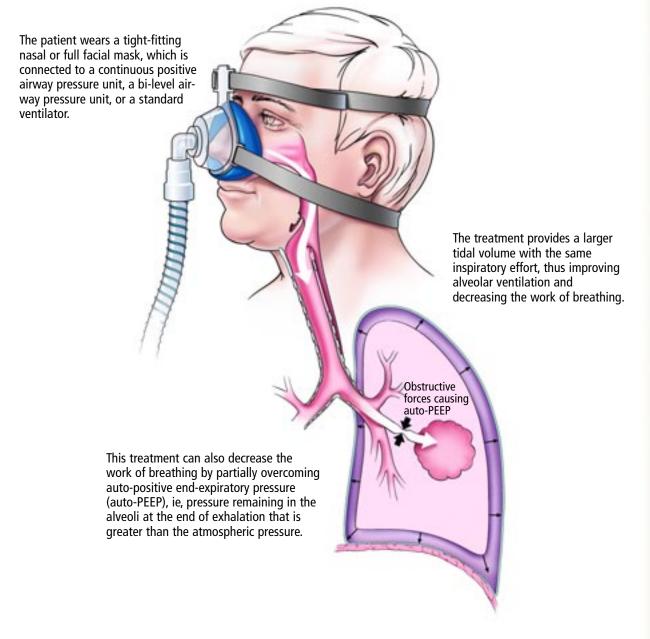
Several mechanisms may explain why noninvasive positive pressure ventilation is beneficial in acute exacerbations of COPD.

Patients with decompensated respiratory failure lack sufficient alveolar ventilation, owing to abnormal respiratory mechanics and inspiratory muscle fatigue. 10 For these patients, breathing faster does not fully compensate. Noninvasive positive pressure ventilation partially counteracts these factors by providing a larger tidal volume with the same inspiratory effort. 10,11

Additionally, this treatment decrease the work of breathing by partially overcoming auto-PEEP (positive end-expiratory pressure) in certain situations.<sup>2</sup> Auto-PEEP is pressure greater than the atmospheric pressure remaining in the alveoli at the end of exhalation.<sup>12</sup> This condition is related to limited expiratory flow and is common in those with severe COPD. Noninvasive positive pressure ventilation decreases the pressure difference between the atmosphere and the alveoli, thereby reducing the inspiratory force needed for initiation of inspiratory effort, which may reduce the work of breathing. However, caution should be used when using this therapy in tachypneic patients, in whom NIPPV may not fully overcome the auto-PEEP.

# Noninvasive positive pressure ventilation: An effective therapy in acute exacerbations of COPD

In selected patients with hypercapnic respiratory failure due to an acute exacerbation of chronic obstructive pulmonary disease (COPD), noninvasive positive pressure ventilation, added to usual medical therapy, reduces the need for endotracheal intubation, the length of hospital stay, and the risk of death.



CCF

Medical Illustrator: Joseph Pangrace ©2008

## TABLE 1

# Who should receive noninvasive ventilation for acute respiratory failure in COPD

### Does the patient need ventilatory assistance?

Consider noninvasive positive pressure ventilation if the patient has: Symptoms and signs of acute respiratory distress Moderate to severe dyspnea, increased over usual, and

Respiratory rate > 24, accessory muscle use, paradoxical breathing Gas exchange abnormalities

 $Paco_2 > 45 \text{ mm Hg, pH } 7.25-7.35; \text{ or } Pao_2/Fio_2 < 200$ 

# Would noninvasive ventilation place the patient at risk?

Do not use this therapy if the patient:

Has had respiratory arrest

Is medically unstable (hypotensive shock, uncontrolled cardiac ischemia or arrhythmias)

Cannot protect the airway (impaired cough or swallowing mechanism)

Has excessive secretions

Is agitated or uncooperative

Has facial trauma, burns, or surgery, or anatomic abnormalities interfering with mask fit Has an Acute Physiology and Chronic Health Evaluation (APACHE) score > 29

DATA FROM AMERICAN RESPIRATORY CARE FOUNDATION CONSENSUS CONFERENCE. NON-INVASIVE POSITIVE PRESSURE VENTILATION. RESPIR CARE 1997; 42:364–369; CONFALONIERI M, GARUTI G, CATTARUZZA MS, ET AL. A CHART OF FAILURE RISK FOR NONINVASIVE VENTILATION IN PATIENTS WITH COPD EXACERBATION. EUR RESPIR J 2005; 25:348–355; BRITISH THORACIC SOCIETY STANDARDS OF CARE COMMITTEE. NON-INVASIVE
VENTILATION IN ACUTE RESPIRATORY FAILURE. THORAX 2002; 57:192–211.

If this therapy is appropriate, it should be delay

#### WHAT STUDIES SHOWED

Several randomized trials have shown started without NIPPV to be beneficial in acute hypercapnic COPD exacerbations. A recent meta-analysis of eight studies<sup>13</sup> showed that, compared with usual care alone, this therapy was associated with:

- A lower mortality rate (relative risk 0.41; 95% confidence interval [CI] 0.26–0.64)
- Less need for endotracheal intubation (relative risk 0.42: 95% CI 0.31–0.59)
- A lower rate of treatment failure (relative risk 0.51; 95% CI 0.38-0.67)
- Greater improvements in the 1-hour posttreatment pH and Paco<sub>2</sub> levels
- A lower respiratory rate
- A shorter length of stay in the hospital.

# ■ WHICH PATIENTS SHOULD RECEIVE IT?

Consensus groups have offered guidelines for deciding who should receive NIPPV (TABLE 1).14-16 Patients who benefit the most include those who have moderate to severe dyspnea, tachypnea, and hypercarbia and whose pH is 7.25 to 7.35. Of importance, if this treatment is appropriate it should be started without delay, as studies have shown a higher success rate when it is applied early.<sup>17</sup>

NIPPV is not suitable for all patients with hypercapnic respiratory failure. It should not be substituted for endotracheal intubation and mechanical ventilation if they are indicated, eg, in patients who are medically unstable because of hypotension, sepsis, hypoxia, or other life-threatening systemic illness. In addition, those who cannot protect the airway, who have had a worsening in mental status, or who have excessive secretions should not undergo NIPPV because they have a high risk of aspiration. Factors that predict that this therapy will fail include an Acute Physiology and Chronic Health Evaluation (APACHE) score of 29 or higher, a respiratory rate of 30 or higher, and a pH lower than 7.25 after 2 hours of this therapy.<sup>15</sup>

### GENERAL WARD OR INTENSIVE CARE UNIT?

Mild to moderate COPD exacerbations (in which the pH is 7.30 or higher) can be effectively treated with NIPPV in a general ward if the staff has appropriate expertise.<sup>5,18</sup> Keeping the patient in a general ward reduces cost and provides a favorable outcome in selected patients.<sup>5,19</sup> However, if the patient's hemodynamic or mental status deteriorates or if gas exchange, pH, respiratory rate, or dyspnea fail to improve, he or she should be transferred to an intensive care unit and endotracheal intubation should be considered.<sup>18</sup> The use of NIPPV in general wards should always be approached with caution and should never be attempted without adequate patient supervision and an experienced respiratory therapy team.

#### ■ TAKE-HOME MESSAGE

NIPPV has been shown to be an effective adjunct in the treatment of acute hypercapnic respiratory failure secondary to a COPD exacerbation, reducing the need for endotracheal intubation, the length of hospital stay, and the mortality rate. On the basis of controlled trials, NIPPV is now considered the ventilatory therapy of choice in selected patients with this condition. However, it should not be used as a substitute for intubation and mechanical ventilation if these are needed or if the patient is at risk of aspiration.

#### REFERENCES

- Connors AF Jr, Dawson NV, Thomas C, et al. Outcomes following acute exacerbation of severe chronic obstructive lung disease. The SUPPORT investigators (Study to Understand Prognoses and Preferences for Outcomes and Risks of Treatments). Am J Respir Crit Care Med 1996; 154:959–967. (Erratum in: Am J Respir Crit Care Med 1997: 155:386).
- Mehta S, Hill NS. Noninvasive ventilation. Am J Respir Crit Care Med 2001: 163:540–577.
- Brochard L, Mancebo J, Wysocki M, et al. Noninvasive ventilation for acute exacerbations of chronic obstructive pulmonary disease. N Engl J Med 1995; 333:817–822.
- Kramer N, Meyer TJ, Meharg J, Cece RD, Hill NS. Randomized, prospective trial of noninvasive positive pressure ventilation in acute respiratory failure. Am J Respir Crit Care Med 1995; 151:1799–1806.
- Plant PK, Owen JL, Elliott MW. Early use of non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease on general respiratory wards: a multicentre randomised controlled trial. Lancet 2000; 355:1931–1935.
- Wysocki M, Tric L, Wolff MA, Millet H, Herman B. Noninvasive pressure support ventilation in patients with acute respiratory failure. A randomized comparison with conventional therapy. Chest 1995; 107:761–768.
- Masip J, Betbesé AJ, Páez J, et al. Non-invasive pressure support ventilation versus conventional oxygen therapy in acute cardiogenic pulmonary oedema: a randomised trial. Lancet 2000; 356:2126–2132.
- Antonelli M, Conti G, Rocco M, et al. A comparison of noninvasive positive-pressure ventilation and conventional mechanical ventilation in patients with acute respiratory failure. N Engl J Med 1998; 339:429–435.
- 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; 160:86–92.
- Brochard L. Noninvasive ventilation for acute respiratory failure. JAMA 2002; 288:932–935.

- Brochard L, Isabey D, Piquet J, et al. Reversal of acute exacerbations of chronic obstructive lung disease by inspiratory assistance with a face mask. N Engl J Med 1990: 323:1523–1530.
- Mughal MM, Culver DA, Minai OA, Arroliga AC. Auto-positive endexpiratory pressure: mechanisms and treatment. Cleve Clin J Med 2005: 72:801–809.
- Lightowler JV, Wedzicha JA, Elliott MW, Ram FS. Non-invasive positive pressure ventilation to treat respiratory failure resulting from exacerbations of chronic obstructive pulmonary disease: Cochrane systematic review and meta-analysis. BMJ 2003; 326:185.
- British Thoracic Society Standards of Care Committee. Non-invasive ventilation in acute respiratory failure. Thorax 2002; 57:192–211.
- Confalonieri M, Garuti G, Cattaruzza MS, et al. A chart of failure risk for noninvasive ventilation in patients with COPD exacerbation. Eur Respir J 2005; 25:348–355.
- American Respiratory Care Foundation Consensus Conference. Noninvasive positive pressure ventilation. Respir Care 1997; 42:364–369.
- Celikel T, Sungur M, Ceyhan B, Karakurt S. Comparison of noninvasive positive pressure ventilation with standard medical therapy in hypercapnic acute respiratory failure. Chest 1998; 114:1636–1642.
- 18. Organized jointly by the American Thoracic Society, the European Respiratory Society, the European Society of Intensive Care Medicine, and the Société de Réanimation de Langue Francaise, and approved by ATS Board of Directors, December 2000. International Consensus Conferences in Intensive Care Medicine: noninvasive positive pressure ventilation in acute respiratory failure. Am J Respir Crit Care Med 2001: 163:283–291.
- Plant PK, Owen JL, Parrott S, Elliott MW. Cost effectiveness of ward based non-invasive ventilation for acute exacerbations of chronic obstructive pulmonary disease: economic analysis of randomised controlled trial. BMJ 2003; 326:956.

ADDRESS: Peter J. Mazzone, MD, MPH, Department of Pulmonary, Allergy, and Critical Care Medicine, A90, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195; e-mail mazzonp@ccf.org.

JUNE 2008