Noninvasive Options

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KEYWORDS

• Noninvasive ventilation • Critical care • Chronic obstructive pulmonary disease
• Pulmonary edema • Ventilator weaning • Equipment and supplies

KEY POINTS

- Noninvasive ventilation should be considered in the management of critically ill patients with acute respiratory failure of various origins, particularly those with chronic obstructive pulmonary disease exacerbation and acute cardiogenic pulmonary edema.
- Noninvasive ventilation may have a role in preventing postextubation acute respiratory failure.
- Identifying patients who are proper candidates for noninvasive ventilation can help avoid inappropriate application of noninvasive ventilation or dangerous delays before endotracheal intubation.
- Patients at high risk of noninvasive ventilation failure should be managed only by experienced personnel, using an extremely prudent approach.
- The presence of strong inspiratory effort during noninvasive ventilation may result in nonprotective ventilation, with excessive levels of transpulmonary pressure and a hidden lung overstretch even if airway pressures are not high.

INTRODUCTION

Noninvasive ventilation (NIV) refers to the provision of ventilatory assistance using techniques that do not bypass the upper airway. The main advantages of NIV over invasive ventilation include preventing complications related to endotracheal intubation (ETI), reducing patient discomfort, and maintaining airway protective mechanisms. NIV is now the recommended first-line method of ventilator support in selected patients with chronic obstructive pulmonary disease (COPD) exacerbation or acute cardiogenic pulmonary edema (CPE), and it has also been found useful to prevent postextubation acute respiratory failure (ARF).[1] The potential of avoiding complications of ETI, lowering morbidity and mortality rates in selected patients with ARF,

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has been the major driving force of the increasing use of NIV in the acute care setting over the past decades.

Currently, the utilization rates for NIV vary enormously among different acute care hospitals, mainly due to differences in physician knowledge, respiratory therapist training, and equipment availability. A French study in a large cohort of patients admitted to the ICU with ARF and the need of mechanical ventilation over a 15-year period (between 1997 and 2011) showed that the use of NIV increased steadily throughout the study period, up to 42% in 2011, and first-line NIV was associated with better 60-day survival and fewer ICU-acquired infections compared with first-line intubation.[2]

This article discusses the use of NIV in patients with ARF or who are at risk of ARF, focusing on the criteria for patient selection, choice of the interface, ventilator settings, and monitoring.

NONINVASIVE VENTILATION AND CONTINUOUS POSITIVE AIRWAY PRESSURE

The terms, *continuous positive airway pressure (CPAP)* and *NIV*, should not be used interchangeably. CPAP delivers a constant pressure throughout spontaneous inspiration and exhalation without assisting inspiration. Because spontaneous breathing is not assisted, this technique requires an intact respiratory drive and ability to accomplish adequate alveolar ventilation. CPAP increases functional residual capacity and opens underventilated alveoli, thus decreasing right-to-left intrapulmonary shunt and improving oxygenation and lung mechanics.[3] Moreover, CPAP may reduce the work of breathing and dyspnea in COPD patients by counterbalancing the inspiratory threshold load imposed by autointrinsic positive end-expiratory pressure (PEEP).[4] Finally, by lowering left ventricular transmural pressure in patients with left congestive heart failure, CPAP may reduce left ventricular afterload without compromising cardiac index.[5]

In contrast, NIV provides a pressure during the inspiratory phase greater than the pressure applied during exhalation, thus providing ventilatory support to unload respiratory muscles (**Fig. 1**). In hypoxemic patients, NIV has been demonstrated to improve dyspnea and gas exchange, lowering neuromuscular drive and inspiratory muscle effort, whereas CPAP used alone can improve oxygenation, but it is less effective in unloading respiratory muscles.[6]

NONINVASIVE VENTILATION AND HIGH-FLOW NASAL CANNULA OXYGENATION

High-flow nasal cannula oxygenation (HFNCO) (**Fig. 2**) is increasingly used in critically ill patients. Use of nasal prongs to deliver high heated and humidified flows (maximum 60 L/min) at a prescribed fraction of inspired oxygen (Fio_2) is an attractive alternative to conventional oxygen therapy. The main potential mechanisms through which HFNCO may alleviate symptoms of respiratory distress and enhance gas exchange include dead space washout with subsequent facilitation of carbon dioxide (CO_2) removal, provision of a moderate flow-dependent positive airway pressure, reduction in inspiratory nasopharyngeal resistance, and a better tolerance and comfort with the technique.[7] Levels of airway pressure (generally <4 cm H_2O) measured in the nasopharynx or the trachea increase as flow increases and are higher during breathing with mouth closed compared with mouth open.[8,9] **Table 1** describes the technical and physiologic aspects of noninvasive ventilation compared with HFNCO. Over the past years, some studies have compared HFNCO with NIV in the ICU, supporting the use of HFNCO in hypoxemic ARF patients having adequate muscular endurance[10]