Managing Respiratory Failure in Obstructive Lung Disease

Stephen P. Bergin, MD, Craig R. Rackley, MD*

KEYWORDS

• Asthma • COPD • Obstructive lung disease • Hyperinflation • Noninvasive ventilation
• Mechanical ventilation

KEY POINTS

- Clinical findings suggesting impending acute respiratory failure from obstructive lung disease include paradoxic absence of wheezing, upright posture, paradoxic respiratory muscle movement, and lethargy.
- Short-acting bronchodilators and systemic glucocorticoids are the foundation of pharmacologic management for the majority of patients with severe exacerbations of obstructive lung disease.
- Noninvasive ventilation reduces the risk of endotracheal intubation and death in hypercapnic patients with chronic obstructive pulmonary disease.
- Noninvasive ventilation should be considered for acute respiratory failure from obstructive lung disease management.
- Controlling minute ventilation and prolonging expiratory time limit morbidity associated with dynamic hyperinflation in patients with obstructive lung disease requiring invasive mechanical ventilation.

INTRODUCTION

Obstructive lung diseases rank among the foremost causes of morbidity and mortality worldwide.[1,2] Asthma and chronic obstructive pulmonary disease (COPD), the 2 most common types of obstructive lung disease, affect an estimated 24.6 million and 15 million people, respectively, in the United States alone.[3,4] Acute exacerbations of obstructive lung disease are leading causes of acute respiratory failure. In-hospital mortality rates for acute COPD exacerbations with hypercapnia range from 11% overall to 21% for those requiring mechanical ventilation.[5,6] Severe asthma exacerbations account for more than 3600 deaths in the United States every year, and significantly greater mortality rates are observed in other regions.[7,8]

Central tenants of managing acute respiratory failure associated with obstructive lung disease include rapid identification and risk stratification. The signs of impending respiratory failure (**Box 1**) correlate well with critical reductions in peak expiratory flow, a measurement recommended for stratifying risk associated with asthma exacerbations.[9,10]

Inhaled short-acting bronchodilators comprise the foundation of initial therapy. Systemic glucocorticoids improve lung function within hours and reduce the short-term risk of recurrent exacerbations. Noninvasive ventilation (NIV) may lessen respiratory workload and reduce the risk of endotracheal intubation for many patients who do not rapidly improve with initial inhaled therapy. Invasive mechanical ventilation (IMV) is typically

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Division of Pulmonary and Critical Care Medicine, Department of Medicine, Duke University Medical Center, 2301 Erwin Road, Durham, NC 27710, USA
* Corresponding author. Division of Pulmonary and Critical Care Medicine, Department of Medicine, Duke University Medical Center, 330 Trent Drive, Hanes House 101, Durham, NC 27710.
E-mail address: craig.rackley@duke.edu

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Box 1
Signs of impending respiratory failure

- Inability to speak in full sentences
- Accessory respiratory muscle use
- Upright posture
- Paradoxic absence of wheezing
- Pulsus paradoxus
- Lethargy
- Paradoxic respiratory movements
- Cyanosis
- Hemodynamic instability

required in the setting of NIV failure or contraindication. This review provides an overview of the management of acute respiratory failure from obstructive lung diseases, with a particular focus on the optimal provision of invasive mechanical ventilatory support.

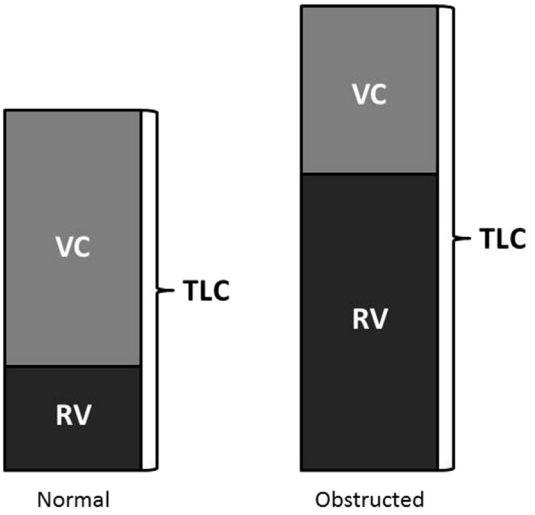

Fig. 1. Patients with exacerbations of obstructive lung disease have progressive air trapping leading to increased total lung capacity (TLC), which is mostly composed of trapped air as noted by the increased residual volume (RV) compared with normal. As a consequence, vital capacity (VC) decreases.

PATHOPHYSIOLOGY

Chronic airway inflammation triggers a spectrum of smooth muscle hypertrophy, airway ciliary dysfunction, excessive mucous secretion, and respiratory bronchiole destruction, ultimately increasing airway resistance and hyperreactivity.[11,12] In COPD, parenchymal destruction associated with emphysema increases lung compliance, which further reduces expiratory airflow.[13] Common precipitants of acute exacerbations, including exposure to allergens, inhaled irritants, and bacterial and viral infections, incite superimposed acute inflammation with further bronchoconstriction, increased airway vascular permeability, and edema. Consequently, high airway resistance prevents efficient exhalation. Dynamic hyperinflation occurs because air is trapped from incomplete exhalation. Progressively increasing functional residual capacity and decreasing inspiratory capacity places overdistended respiratory muscles at a mechanical disadvantage, further reducing expiratory flow[14] (**Fig. 1**). Extrinsic bronchiole compression from hyperinflated alveoli also worsens airflow restriction (**Fig. 2**). Dynamic hyperinflation progressively increases respiratory workload and decreases muscular efficiency, ultimately resulting in overt hypercapnic respiratory failure.

NONINVASIVE VENTILATION

Ventilatory support is indicated for patients with acute hypercapnia or severe respiratory distress that persists despite initial bronchodilators and systemic glucocorticoids. For patients with COPD, NIV should be considered first-line therapy for hypercapnic respiratory failure if there are no contraindications. NIV reduces the risk of endotracheal intubation, treatment failure, and mortality associated with severe exacerbations of COPD.[7,15,16] Patients with acute hypercapnia derive the greatest benefit, whereas NIV in milder exacerbations has not been associated with improved outcomes and is often poorly tolerated.[17] Use of NIV for severe asthma exacerbations is associated with improved pulmonary mechanics, reduced bronchodilator use, and lower hospitalization rates.[18,19] Although definitive data supporting routine NIV use for severe asthma exacerbations are lacking, small studies suggest that an approach similar to current COPD management is reasonable.[20]

Contraindications to NIV include cardiopulmonary arrest, severe or refractory hemodynamic instability, excessive respiratory secretions, nausea and vomiting, craniofacial abnormalities, and impaired level of consciousness.[2,21] Notably, many patients with hypercapnia-induced coma can be treated successfully with NIV, and respiratory acidosis frequently improves within 1 to 2 hours after NIV initiation, even in significantly altered patients.[22,23] Importantly, the risk of NIV failure correlates well with severity of mental status impairment, and should be used cautiously in these patients.